INTERMEDIATE(TOSS)

GEOGRAPHY

Government of Telangana

TELANGANA OPEN SCHOOL SOCIETY HYDERABAD

INTERMEDIATE (TOSS) GEOGRAPHY

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GEOGRAPHY

TELANGANA OPEN SCHOOL SOCIETY HYDERABAD

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MODULE-I

THE STUDY OF GEOGRAPHY AS A DISCIPLINE

Chapter - 1

NATURE OF GEOGRAPHY

Contents

1.0 Objectives

1.1 Introduction

1.2 Geography in daily life

1.3 Development of geography

1.4 Scope of geography

1.5 Approaches to study of geography

1.6 Methods and techniques of geography

1.7 Branches of geography

1.8 Geography as an interdisciplinary subject

1.9 Summary

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1.0 Objectives

- After studying this lesson, you will be able to;
- Understand the importance of Geography in daily life.
- Trace the development of Geography as a discipline.
- Comprehend relationship between man and environment
- Elicited the systematic and regional approaches of Geography.
- Study the different branches of geography and its scope.

1.1 Introduction

Geography is one of the oldest earth science that studies the Earth's surface as the home of human being. It investigates how the Earth's surface varies from place to place and from time to time.

The word "Geography" was adopted /used in the 3rdcentury B.C by the Greek scholar Eratosthenes (276-194 B.C). The word "Geography" is the combination of two Greek words – Ge (Geo) = Earth, Graphene (Graphy) = to write-meaning "to write about the Earth or describe the Earth**".**

An idea of the fundamentals of Geography is essential for all. It helps to answer the questions such as where? Why? and How far ? or How do get there ?.Geography is a dynamic subject. It has undergone changes in its approach. The earlier geographers were descriptive geographers. Later, Geography came to be developed as an analytical science. Today the discipline is not only concerned with descriptions but, also analysis as well as prediction.

In this lesson an attempt is made how important geography is in human's everyday life .The Geography study will encourage you to understand your own place and space with greater interest

1.2 Geography in Daily Life

Geography plays a vital role in our daily life. You must have noticed that the Earth's surface is dynamic In general, the natural phenomena like mountains, rivers, lakes etc.change slowly, while the cultural elements like buildings, roads, crops changes drastically.You may notice that the trees number and types changes from area to area, while you travelling from one place to another. All this is because of the continuous interaction between the environment in which man lives in and the way he use it. The study of Geography is about observing such patterns. Another aspect of geography is to understand the factors or reasons behind areal differentiation, how does socio-economic factors matter our physical land scope and create new or altered landscapes by human interventions.

A “map” is flat, symbolic representation of the Earth or a part of the Earth’s surface. It gives information about the earth’s surface in a simple and graphic manner and helps understand where we are in relation to other people and places. The science of map-making is called “cartography”. As earlier, even today geographical information about an area is available through reports and travel diaries of ancient philosophers. At present maps can be drawn by using satellite images using GIS (Geographical Information System) tools. Computers easily convert the information from satellite images in to maps to show what changes development can bring about. The information is useful to the human society. The map makers are in great demand in the modern world. Nowadays geographers, engineers, environmental scientists, city planners, social sscientists and many others learning GIS applications to understand the surface of the earth in better way.

Today geography discipline is considered a science of humans on the earth and the study of their action and interaction. Interaction and the inter-relationship between humans and nature it is not only investigate. What is on the earth? But also why it is there?. Population distribution, diversity, settlement patterns, agricultural activities, food habits etc., influenced by the land forms of the particular religion.

Today local to global all over the world there are many problems related to providing food Security, health, effective energy use and environmental conservation, equality issues and sustainable development. All these can be achieved by using our resources in sustainable ways. Study of geography is, therefore necessary to understand more about environmental processes and how land use planning supports humans to overcome problems.

Basic Concepts:

Geographical work in ancient Greece had followed to distinct traditions. They are 1. The mathematical tradition, which was focused on fixing the location of places on the Earth’s surface. 2. Gathering geographical information through travel and field works. According to Greeks, the aim of geography was to provide a description of the physical features and condition in different parts of the world. Another important school of thought defined geography as the study of relationships between man and environment.

Check Your Progress

i) What is geography?

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ii) What is a map?

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iii) Which are the two distinct traditions followed by Greeks?

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1.3 Development of Geography

(A) Ancient period.

The earliest records illustrate the interests of scholars in understanding the physical domain of the earth by making maps and astronomical measurements. The Greeks are given the credit of being the earliest geographers, prominent among them being Hower, Herodotus, Thales Aristotle and Eratosthenes.

(B) Pre-modern period.

This period starting from the middle of 15th century and continuous with 18th early provides us enormous information about the physical and cultural nature of the world by the travels and explorations of early Geographers. The early seventeenth century witnessed the beginning of a new scientific Geography. Christopher Columbus and Vascodegama, Fesdinend Meghellan and Thomas cook were important explorers and travellers among those. Varenius, Kant, Humboldt and Ritter led the geographers of this period. They contributed in the development of cartography and discovering new lands, and developing geography into scientific disciplines.

C) Modern Period.

Ritter and Humboldt are frequently referred to us the founders of modern geography. Generally, latter half of nineteenth century is considered as a period of modern geography. The first modern geographer in true sense was Ratzel who built the structure of modren geography on the foundations laid down by classical geographers.

D) Recent Period:

The development of geography during the post Second World War period has been very rapid. The American and European geographers such as Hartshorne have contributed the maximum during this phase. Harthshorne described geography as a science dealing with areal differentiation.

The present day geographers look upon regional approach and systematic aproach as complimentary rather than contradictory.

1. 4 Scope of Geography

Geography has now acquired the status of science that explains the arrangements of various natural and cultural features on the earth surface. Geography is a holistic and interdisciplinary field of study engaged in understanding the changing spatial structure from past to the future. Thus, the scope of geography is in various disciplines, like armed services, environment management, water resources, disaster management, meteriology and planining and various social sciences. Apart from that, a geographer can help in day to day life like tourism, commuting, housing and health related activities.

Check Your Progress

i) Describe the development of geography nowadays?

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ii) What is the scope of the geography?

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1.5 Approaches to study of Geography

Today geography is the only discipline that brings all natural and human sciences on common platform to understand the dynamics of the spatial configuration of the earth surface. There are two main approaches in geography.

A.Systematic approach

B.Regional approach

A. Systematic Approach (Geography) :

A study of specific natural or human phenomenon that rises to certain spatial patterns and structures on the earth surface is called Systematic Study. It is divided into four main branches.

1. Physical Geography
2. Bio-Geography
3. Human-Geography
4. Geographical Methods and techniques

1. **Physical Geography** which deals earth systems like atmosphere (Air) the Hydrosphere (water), the lithosphere (Earth solid rocks) and Biosphere which, encompasses all of earth's of living organisms.

2. **Bio- Geography** is focuses on various kinds of forests, grasslands, distribution of flora and fauna, human nature relationships and the quality of the living environment and its implications for human welfare.

3. **Human Geography**: It is describes culture, population, dynamics of social, economic and political aspects of space

4. **Geographical Methods and Techniques**; Geographical Methods and techniques for field studies qualitative, quantitative and cartographic analysis and geographic information system (GIS) and Global Positioning System (GPS) and remote sensing.

B. Regional approach (Geography)

Unlike systematic geography, regional geography starts with the spatial in prints of one or all the systematic geographic processes discernible as regions of different sizes. Regions could be bases on a single factor like relief, rainfall, vegetation, per capita income. They could also be multi factor regions formed by the association of two or more factors. Administrative units like states, districts, Tehsils, Mandals also can be treated as regions. The mains sub-branches of regional geography are:

1. Regional Studies
2. Regional analysis
3. Regional Development
4. Regional Planning including areas and community planning

1.6 Methods and Techniques of Geography

To a geographer a map is as important as a Stethoscope is to a doctor. Geography has its tools, techniques and method on which it depends to further its basic objectives. Important tools of a geographer are globs, maps, Diagrams, relief models and spatial analytical methods. Cartography is concerned with preparation of maps in geography are deductive and inductive in nature. Various statistical techniques and models are used for regional analysis to understand spatial distribution and interaction.

A.Cartography :

The science of map-making is called cartography. A map is still prepared to a globe because a flat map can show large areas in a single piece of paper making it easy to compare cities, countries and other places. And also it can be rolled or folded and stored or carried around easily. Maps have traditionally been made using pen, ink and paper, but computers have revolutionised cartography and with GIS methods one can prepare maps and diagrams with greater choice and efficiency.

Current trends in cartography are moving away from drawing with ink, paper type method of map making towards the creation of increasingly dynamic, interactive maps that can be manipulated digitally. Most commercial quality maps are now made with map making software that falls in to one of three main type "1. Computer Aided Date Management (CAD), 2.Geographic Information Systems (GIS) and 3.Global Positioning Systems (GPS)". Many cartographers are employed by the Government to make maps for various purposes. The Survey of India employee cartographers to produce topographical maps.

Cartography has grown from a collection of drafting techniques into an actual science .Cartographers must understand which symbols convey information about the Earth most effectively and make such maps that will encourage everyone to use the maps to find places or use it for their daily work.

GIS technology is becoming an essential tool in the effort to understand the process of global change .Various mps and satellite information sources can combine in ways that recreate the interactions of complex natural systems. Such visualisation can help to predict what will happen to an area if it is repeatedly flooded or what changes are expected if a particular industry is located or developed in an area

B Quantitative Methods in Geography:

These aspects of geographical techniques deal with numerical methods most commonly found in geography. In addition to **spatial analysis** you are likely to find methods like **cluster analysis** ,**discriminant analysis** in geographic studies .You will find that when you undertake the local area study, you yourself will see how useful these methods are in finding patterns and identifying relationships between space and the actives that area performed in them.

C Regional Science Method:

In the 1950s, the regional science movement arose led by **Walter Isard**. This provided a more quantitative and analytical base to geographical questions, in contrast to the more qualitative tendencies of traditional geography .Regional science comprises the body of knowledge in which like regional economics, resource management, location theory ,urban and regional planning, transportation and communication, human geography ,population distribution ,landscape ecology and environmental quality are examined for regional development.

Check Your Progress

i) What is the main tool of a geographer?

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ii) What is Cartography?

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1.7 Branches of Geography

The study of geography covers all the phenomena on the Earth's surface and explains the principles of day and night, seasons, climate, surface features , erosion, plant and animal life as well as distribution and development of different human communities. It covers a vast field and includes many branches of different disciplines.

Variable phenomena on the Earth's surface can be treated separately or in association. They are classified and categorised into physical phenomena and human phenomena. Thus geography has three main branches;

1. Physical Geography
2. Human Geography
3. Regional Geography

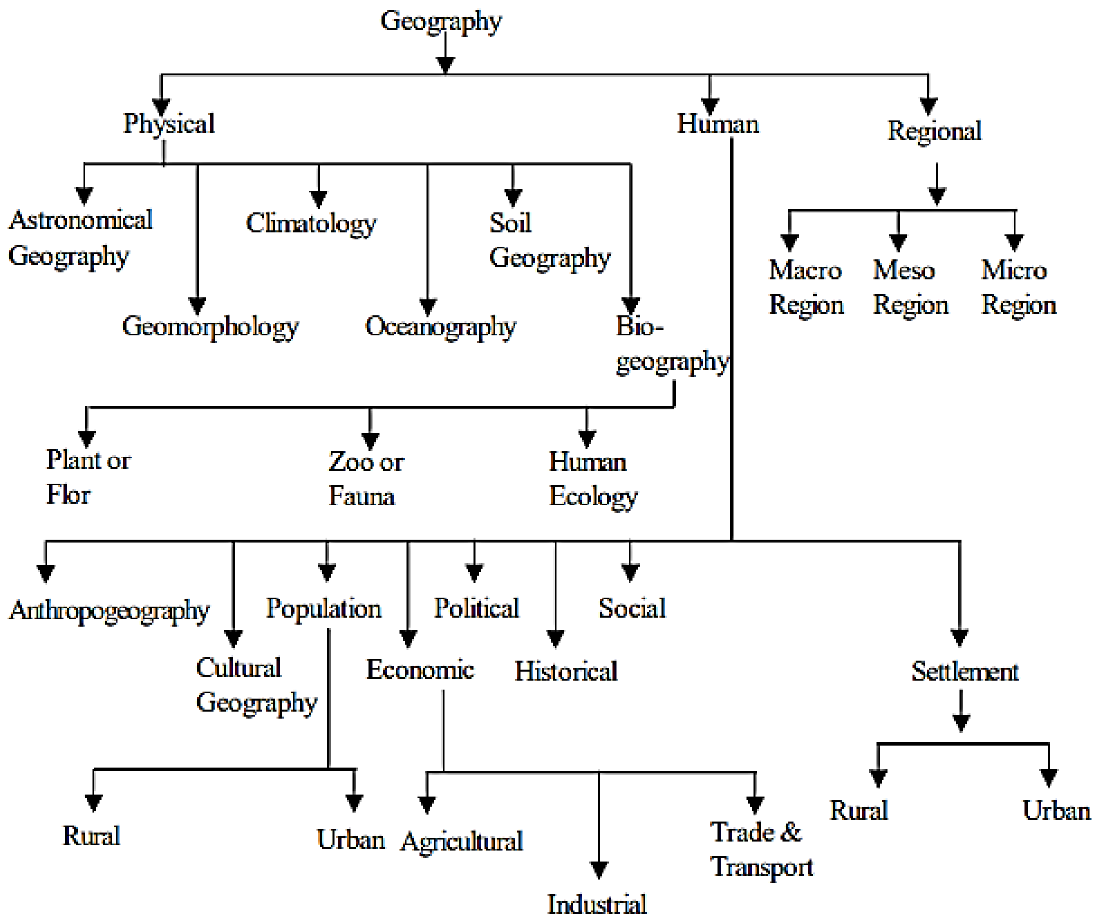

Fig.1-1 Branches of Geography

1. Physical Geography: Physical geography which deals with the natural features of the Earth's surface. There is some difference of opinion on the scope of physical geography, while geomorphology, meteorology, climatology, biogeography and hydrology are included; soils and oceanography are often omitted from its study. It became a very popular subject during the later part of the 19th century. It has a number of sub-branches which treat different kind of physical phenomena.

I) **Astronomical Geography**: It studies the Celestial Phenomena which concern the earth's surface particularly the sun, moon and planets of the solar system.

II) **Geomorphology**: it is concerned with study of the land forms on the earth's surface. It includes origin and development of land forms through emotional, transformational and depositional processes of water, wind and glaciers.

III) **Climatology**: Climatology is the study of the atmospheric conditions and related climatic and weather phenomena it includes the study of atmospheric composition, climatic regions, seasons etc.

IV) **Oceanography**: It is concerned with the study of various types of Oceanic format component and processes related to ocean floor depth, currents, corals, reefs and continental drifts etc.

V) **Soil Geography**: It studies various soil forming processes, their physical, chemical and Biological constituents, their colour and types, texture and distribution and carrying capacity etc.

VI) **Bio- Geography**: It is concerned with the biological Phenomena in space, especially in terms of the distribution of various kind of floral and faunal species. Bio geography maybe subdivided in to plat or floral geography, animals or faunal geography and human geography.

2. Human Geography

Human geography is the synthetic study of the relationship between human societies and the Earth's surface.It is made up of three closely linked components (i) the spatial analysis of the human population (ii) the ecological analysis of the relation between human population and its environment and (iii) the regional synthesis which combines the first two themes in an areal differentiation of the Earth's surface... It as a number of sub branches.

I) **Anthropogeography**: It largely deals with racial phenomena in their spatial context.

II) **Cultural Geography**: It focuses on the Origin, components and impact of human cultures both material and non-material.

III) **Economic Geography**: It refers to the study of the location and distribution of economic activities at local, regional, national and world scale. Economic geography can be studied under the following heads: Resource Geography, Agricultural Geography, Industrial and Transport Geography.

IV) **Political Geography**: It is the study of political phenomena in their special context. Main focus remains for creation and transformation of political and administrative region.

V) **Historical Geography:** Spatial and temporal trend of geographical phenomena are studied in historical Geography.

VI) **Social Geography:** It is the analysis of social phenomena in space. Poverty health, education, livelihood, are some important fields of study in social geography.

VII) **Population Geography:** It is the study of various dimensions of population like its population distribution, density, composition, fertility, mortality, migration etc.

VIII) **Settlement Geography:** It is the study of rural/urban settlements, their size, distribution, functions and off various other parameters of settlement system.

3. Regional Geography

The study in geography of regions and of their distinctive qualities. A precondition of this study is recognition of regions, its naming and the delimitation of its boundaries. One approach has been to identify "natural" regions while another was establish economic regions based on agriculture and or industry.

Check Your Progress

(viii)What are the three main branches of geography?

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(ix) What is Anthropogeography?

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1.8 Geography as an Interdisciplinary Subject

Geography has its strong relation with mathematics, natural sciences and social sciences. While other sciences deal with distinctive types of phenomena, geography studies several kinds of phenomena, each already studied by another science. In an integrated manner thus, geography has firmly established itself as a discipline of synthesis.

1.9 Summary

Geography is a science of space. It 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 health systems that create natural environment, 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 phenomena 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, social and biogeography. Human geography is also subdivided into other branches like cultural, population, social, economic and political geography. Regional geography is subdivided in other branches like **Macro, Meso** and **Micro**. All these subjects are interrelated to each other

1.10 Terminal Questions

Essay Questions

1. Write an Essay on Geography, how it will useful in our life?

2. Discuss about the development of Geography?

3. Explain in detail about approaches to study of Geography?

Short Questions

i) Define the term Geography.

ii) Define the term physical and human Geography

iii) Differentiate the Systematic and Regional Geography.

Very short Questions

i) Pre-Modern period of Geography

ii) Bio-Geography.

iii) Population Geography.

iv) Geomorphology

1.11 Further Readings

- A Text Book for Intermediate first Year Geography, Telugu Akademi, Hyderabad.
- Oxford Dictionary of Geography, Susan Mayhew
- Geomorphology for B.sc,, B.A, Telugu Akademi by Dr.S.Padmaja
- Elements of Practical Geography by R.L.Singh
- A Text Books of Geography Class VI,IX and X by Rita Rajan
- Geography, Senior Secondary Course, NIOS, Noida, India.
- Geography Text Book, NCERT, India

MODULE-II

INTERIOR OF THE EARTH AND ROCKS

Contents

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2.3.2 Importance of rocks

2.4 Summary

2.5 Check Your Progress – Model answers

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2.7 Further readings

2.0 Introduction

The earth is a unique planet because it is the only planet which has life on it in the universe. The planet earth is one of the eight planets in our solar system. Unlike the other planets, the earth is Geoid in shape. You have studied about the ejection of lava from below the surface of the earth during the volcanic activity. It means there is high temperature below surface. Since past times, several scholars have been put efforts to unfold the secrets of origin of the earth and its age, interior composition.

In this lesson, you will study about the interior of the earth and the sources support in understanding the earth's interior. You will also study about, rocks and their types, importance of rocks as well.

2.1 Objectives

After studying this lesson, you will be able to:

- Understand the various sources to study the earth's interior
- Explain the different layers of interior of the earth
- Classify the different types of rocks and explain the characteristics of rocks
- Recognize the economic importance of different rocks

2.2 INTERIOR OF THE EARTH

The size earth is large and the nature of its core composition is dynamic. So, it is not easily possible to directly observe the interior of the planet. We have only been able to directly examine the interior of the earth up to a few kilometres deep through mining and drilling operations. The principal factor restricting direct observation inside the earth is the quick rise in temperature below the surface. Any drilling tool can be melted because the temperature inside the earth is so great. This limitation on deep drilling makes it difficult to observe the materials of the earth's interior directly.

But, the information about the interior of the earth has remained limited upto 12 kms only. Human activities such as mining and drilling for petroleum helped us in better understanding the knowledge of interior of the earth. For coal and gold mining, man has been reached a maximum of 4 kms depth inside the earth. The deepest hole has been drilled upto 12 km deep into the earth at northern Kola Peninsula to extract crude oil. As you have learnt that no landform is fixed form on the surface of the earth and every landform is constantly changing in shape. Geomorphic processes are held responsible for changing shape of land forms and rocks in their original location.

Exogentic forces are responsible for weakening, changing and disintegration of already existing rocks and landforms and also shaping new landforms on the earth. These forces are partly responsible for evolution of soils which are important for plant community. The endogentic forces are held responsible for formation of various land features on the earth's surface.

2.2.1 THE MAIN SOURCES FOR THE STUDY OF EARTH'S INTERIOR

(A) Evidences Based on Artificial Sources

(i) **Density**: The average density of Earth is about 5.52 g/cm3 and the average density of Earth's crust is about 2.7 to 3.3 g/cm3. This indicates higher density below the crust and because the acceleration due to gravity is quite uniform everywhere therefore mass is distributed uniformly in the form of concentric layers. It is estimated that the relative density of the rocks of the interior part of the earth is about 11 to 13 grm/cm3.

(ii) **Pressure**: Pressure in itself is not responsible for the increase in density; rather the core is composed of intrinsically heavy metallic materials of high density.

(iii) **Temperature**: there is a rise of 1oC with every 32 meters of depth. This rate of increase is uniform everywhere on the earth. The temperature at the depth of 50 km should be around 1500 degree C. It is, therefore, clear that the solid layer of the Earth is a thin film over the otherwise molten material. Evidences based upon temperature indicate that middle layer exists between 1200 to 2900 km of depth. The lowest layer is considered to be 2900 to 6378 km deep.

(iv) **Meteorites:** Meteorites and Earth are born from the same nebular cloud. Thus, they are likely to have a similar internal structure. When meteoroids they fall to earth, their outer layer is burnt during their fall due to extreme friction and the inner core is exposed. The heavy material composition of their cores confirms the similar composition of the inner core of the earth. Meteorites (hitting earth) allow us to determine the density, mineralogy and chemistry of the nickel iron core of bodies having a similar composition to that of the earth.

(B) Natural Sources

(1) **Vulcanicity**: Some geologists on the basis of upwelling and spread of hot and liquid lava on the earth's surface during volcanic eruptions believe that there is at least a layer below the earth's surface which is in liquid state.

(2) **Evidences from Seismology**: It has been experimentally proved that three types of waves are produced at the time of earthquake. These waves are also known as seismic waves. These are as the following:

(i) Primary (P waves) waves: to and fro motion of particles in line of the propagation of the ray. These waves can pass through both the solid and the liquid medium

(ii) Secondary (transverse or distortional or S) waves-particles move at right angles to the rays. These waves cannot pass through the liquid.

(iii) Surface (Long-Period or 'L') waves: Affect only the surface of the earth and covers the longest distance of all seismic waves. They have lower speed than P and S waves but is of most violent and destructive nature.

These waves get reflected and refracted while passing through a body having heterogeneous composition and varying density zones at the discontinuities. P-wave velocity depends on the elasticity, rigidity, and density of the material. By contrast, S-wave velocity depends only on the rigidity and density of the material. In most rock types P-waves travel between 1.7 and 1.8 times more quickly than S-waves; therefore, P-waves always arrive first at seismographic stations. P-waves travel by a series of compressions and expansions of the material through which they travel. The slower S-waves, also called shear waves, move like a wave in a rope. This movement makes the S-wave more destructive to structures like buildings and highway overpasses during earthquakes. Because S-waves can travel only through solids and cannot travel through Earths outer core, seismologists concluded that Earths outer core must be liquid or at least must have the properties of a fluid. This proves that there are various layers of different densities and medium which split the waves in many parts. It is meant that earth is made up of various shells.

2.2.2 Internal Structure of the Earth

The earth comprises of three distinct layers, namely, (i) the crust, (ii) the mantle, and (iii) the core. The diagram (fig. 2.1) shows the three concentric layers of the interior of the earth.

(i) The Crust: The thickness of this layer is 40kms. Crust comprises of continental crust and oceanic crust. The crust is thicker beneath the continents (upto 70 kms under Himalayas) and thinner under the oceans (5 to 10 kms). The Conrod discontinuity separates the continental crust from the oceanic crust. Major constituent elements of continental crust are silica (Si) and aluminium (Al), thus this layer is termed as **'SIAL'**. It is made up of lighter rocks with density of 2.7 grm/cm^3. For example granite rocks. The principle elements of oceanic crust include Silica (Si) and Magnesium (Ma), thus this layer is known as **'SIMA'**. It is made up of heavier rocks having density of 2.9 grm/cm^3. For example basalt rocks. This layer makes up < 0.5 % of the earth's volume and < 1% of the mass of earth. Mohorovicic discontinuity separates crust from mantle.

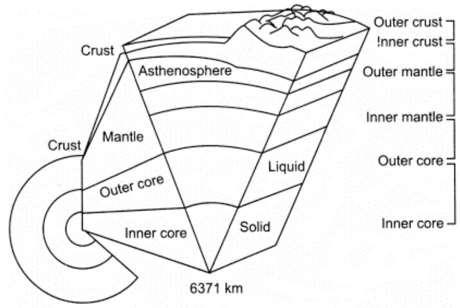

Fig. 2.1 Concentric Zones showing layers of the Earth's interior

(ii) The Mantle: The interior part beyond the earth's crust is called the mantle. Mantle is separated from the crust by a boundary which is called Mohorovicic discontinuity. This layer is about 2900 km thick. This layer is divided into two sections: the upper mantle (upto 700 km) and the Lower mantle (upto 2900 kms). These are separated by another boundary, called Repetti discontinuity, after which the rocks of the mantle become soft and pliable due to pressure and heat. The crust and upper part of mantle are called lithosphere. The upper portion of the mantle is called asthenosphere. It is the main source of magma that finds its way to the surface during volcanic eruptions. The density of rocks in upper mantle ranges 2.9 to 3.3 grm/cm3, while the density of rocks in lower mantle is higher i.e. between 3.3 to 5.7 grm/cm^3. Mantle layer accounts 83% of its volume and 67% of its mass. The dynamic processes which determine the movement of crust plates are powered by the mantle. The mantle is separated by Wiechert-Gutenberg discontinuity from core.

(iii) The Core: The central part of the earth is called as core and it consists of 33% of earth's mass but only 16% of earth's volume. It has a thickness of 3500 kms. Major constituent elements of core are nickel and ferrous, hence, this layer is termed as **NIFE** (Nickel + Ferrous). The average density of this layer is 13.5 grm/cm^3 and it varies varies from 9.5 to 14.5 grm/cm^3. The core is divided to two parts viz., outer core and inner core. The outer core commences at Gutenberg discontinuity from (2900 kms) and end at 5150 kms depth. This is liquid in nature. The inner core starts at 5150 km, where Lehman discontinuity is situated, continues upto 6371 kms and it has 1400 kms of radius. It is much denser and solid in nature.

- Core, mantle and crust are the three main concentric layers of the earth's interior.
- Core is the innermost layer and has the highest density. It is made up mainly of nickel and iron.
- Mantle is the layer lying between the core and lithosphere. Its major constitu- ents are silicon and magnesium.

Check Your Progress

(i) What are the artificial sources to study the interior of the earth?

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(ii) What are seismic waves? Explain.

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2.3 ROCKS AND THEIR TYPES

The outermost thin layer of earth is called crust. Due to the presence of humans, this layer is the most important part of the earth. Rocks make up the crust's constituent parts. There are various types of rocks. They are brittle like gravel, soft like clay, and hard as granite. There is a wide range in the colour, weight, and hardness of rocks.

Rocks are composed of minerals. They are physical mixtures or aggregates made up of one or more minerals. On the other hand, minerals are composed of two or more elements in a specific ratio. They have a distinct chemical make-up. More than 2000 minerals make up crust, but just six of them are most prevalent and contribute the most to this highest region of the globe. These include mica, olivine, feldspar, quartz, pyroxenes, amphiboles, and quartz.

Quartz, feldspar, and mica are rock constituents bonded together to form granite, which is a hard rock. Granites of various colours and hardness are produced when these minerals' ratios change. Metal-containing minerals are referred to as metallic minerals. A significant iron resource called haematite is a metallic mineral. Metal-containing minerals called ore can be mined for a profit. We place a great deal of economic value on rocks.

2.3.1 Types of Rocks

Rocks are classified into several types on the basis of mode of formation, physical and chemical properties, locations etc. On the basis of mode of formation rocks may be grouped into three types:

(a) Igneous Rocks

(b) Sedimentary Rocks and

(c) Metamorphic Rocks

(a) Igneous Rocks

The word igneous is derived from the Latin word ‘ignis’ which means ‘fire’. Igneous rocks are formed by the cooling, solidification and crystallization of highly heated molten fluid materials called as Lava or Magma. It requires a greater quantity of heat to melt the rocks under overlying pressure than at the surface. Although the precise depths at which magma occurs are unknown, it is most likely created at various depths of up to 40 km. Fractures or cracks in the crust are caused by an increase in volume produced by molten rocks. These gaps result in a decrease in the underlying pressure, which forces the magma through them. Otherwise, the intense overlying pressure prevents it from escaping.

The magma that has been ejected to the surface is called as lava. Igneous rocks are formed from solidified molten magma below or on the earth’s surface. These are referred to as the “primary rocks” since they make up the first layer of the earth’s crust and are the source of all other rocks. All rocks can be categorised as having an igneous origin as they have all been exposed to the surface at some point. . Hence they are also called as parent rocks. Igneous rocks of a more recent series are still forming. They make up around 95% of the earth’s outermost 16 km in volume. Due to their magmatic origin, these are primarily huge and crystalline in appearance.

On the basis of their mode of occurrence, igneous rocks can be classified as: extrusive or volcanic rocks and intrusive rocks.

(i) *Extrusive igneous rocks*: they are formed by the consolidation of lava on the earth’s surface. The rocks include lava flows and volcanic ash. These rocks are fine grained as lava cools very rapidly on coming out of the hot interior of the earth. These rocks are also called volcanic rocks. Gabbro, diorite, rhyolite, obsidian and basalt etc, are very common examples of such rocks. These rocks are found in volcanic areas. The black soils on parts of Deccan plateau derived from lava.

(II) *Intrusive igneous rocks*: these are formed when magma solidifies below the earth’s surface and remains surrounded by preexisting rocks. Large crystals formed in rocks due to low cooling process in the earth’s interior. The intrusive rocks at shallow depth are referred to as hypabyssal, and the deep seated intrusive rocks are known as plutonic rocks. Common examples of these rocks include granite and dolerite. From this point of view, igneous rocks can be categorised as (a) Plutonic, (b) Hypabyssal, and (c) Volcanic rock masses, according to their manner of production. The huge blocks of coarse granitic rocks are found both in the Himalaya and the Decean Plateau.

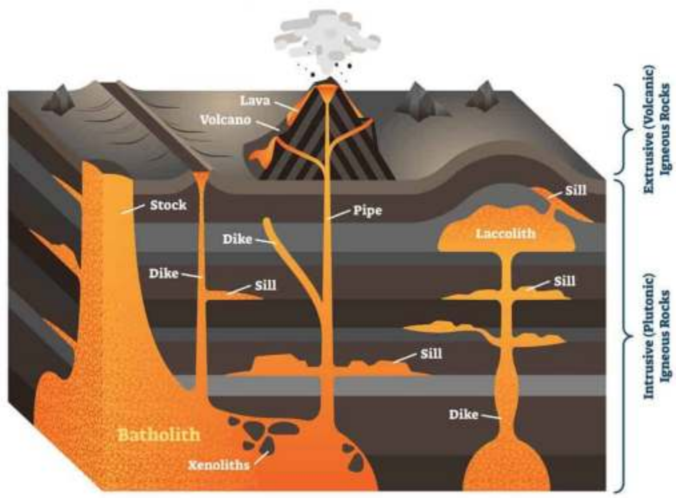

Fig. 2.2 Igneous Rocks

The Fig. 2.2, point ups various shapes and sizes of rocks produced on cooling magma, depending on the space available after it forces itself into the crust. Regular forms of intrusive igneous rocks are batholiths, laccoliths, sills and dykes etc. The huge masses of solidified magma are called as *Batholiths*. They vary in size; some are as much as several hundred kilometers across and thousands of kilometers thick. They generally form the core of the major mountains, as shown in this diagram. Their irregular dome shaped roofs sometimes appear on the surface after erosion of millions of years. *Laccoliths* are formed due to intrusion of magma along the bedding planes of horizontally bedded sedimentary rocks. They resemble mushroom shape with a convex summit. *Sills* are the horizontal intrusion of solidified magma between the layers of preexisting rocks. *Dyke* is similarly a more or less vertical formation from few metres to several kilometers in length and from few centimeter tto hundreds of metres in thickness.

On the basis of chemical properties, igneous rocks are classified into two types; (a) acidic rocks and (b) basic rocks. These are formed as a result of solidification of acidic or basic lava.

(a) **Acidic igneous rocks**: they are composed of 65% or more of silica. These rocks are light coloured, hard and very strong. Granite is an example of an acidic rock.

(b) **Basic igneous rocks**: they contain less than 55% of silica and have more of iron and magnesium. These rocks are dark coloured and weak enough for weathering. Gabbro, basalt and dolerite are examples of basic rocks.

- Igneous rocks are formed by the cooling and solidification of hot molten material called magma or lava.
- Extrusive igneous rocks are formed by cooling and solidification of lava on the earth's surface. Examples: basalt, gabbro etc.
- Intrusive igneous rocks are formed by cooling, solidification and crystallization of magma below the earth's surface. Examples; granite.

(b) Sedimentary Rocks

Sedimentary rocks are formed from the accumulation and compression of sediments, which can include minerals, organic matter, and fragments of pre-existing rocks (igneous or metamorphic rocks). Hence, they are known as 'secondary rocks'. These sediments are deposited by various processes such as erosion, weathering, transportation, and deposition. Over time, the layers of sediment become compacted and cemented together to form sedimentary rocks. In other words, sediments may be the debris eroded from any previously existing rock which may be igneous rock, metamorphic or old sedimentary rock. The thickness of strata varies from few millimeters to several metres. Thus, stratification is the most important characteristic of sedimentary rocks; they are called as 'stratified rocks'.

Sedimentary rocks can be divided into four main types: clastic, chemical, biochemical, and organic. Clastic sedimentary rocks are composed mainly of material that is transported as solid fragments (called clasts), and then cemented together by minerals that precipitated from solution. Chemical sedimentary rocks are composed mainly of material that is transported as ions in solution. Biochemical sedimentary rocks also form from ions in solution, but organisms play an important role in converting those ions into calcium carbonate or silica body parts. Organic sedimentary rocks contain large amounts of organic matter, such as from plant leaves and tree bark.

Depending upon the mode of formation, sedimentary rocks are classified into three major groups:

(i) Mechanically formed — sandstone, conglomerate, limestone, shale, loess etc. are examples;

(ii) Organically formed — geyserite, chalk, limestone, coal etc. are some examples;

(iii) Chemically formed — chert, limestone, halite, potash etc. are some examples.

(a) Metamorphic Rocks

In mountainous areas, the majority of rocks exhibit signs of alteration or change. All of these metamorphize into different types of rocks over time. Sedimentary or igneous rocks undergo metamorphosis under the influence of heat or pressure. All types of pre-existing rocks undergo significant changes in colour, hardness, structure, and composition under conditions of extreme pressure and heat. Metamorphism is the process that causes change, and metamorphic rocks are the final products that result from the operation of such processes.

The primary factors that cause metamorphism are temperature, pressure stress, and access to chemically reactive chemicals. The minerals in the rock recrystallize as a result of heat. Thermal or contact metamorphism is the name for the heat-induced transformation process. Surrounding rocks are baked and transformed into metamorphic rocks when molten magma or lava comes into contact with them. Dynamic or regional metamorphism is the term used to describe the production of metamorphic rocks under extreme pressure. The metamorphic rocks slate, gneiss, schist, marble, and diamond are good examples. Compared to the parent rocks from which they were created, metamorphic rocks are tough and unyielding.

Table 2.1

Parent Rock and its Metamorphic Changed Form

Name of the Rock	Type of Rock	Name of the Metamorphic Rock
Limestone	Sedimentary Rock	Marble
Dolomite	Sedimentary Rock	Marble
Sandstone	Sedimentary Rock	Quartzite
Shale	Sedimentary Rock	Slate
Slate	Metamorphic Rock	Phylite/Schist
Coal	Sedimentary Rock	Graphite/Diamond
Granite	Igneous Rock	Gneiss
Phyllite	Metamorphic Rock	Schist

All across the world, many kinds of metamorphic rocks can be found. Slates are widely available in Orissa, Andhra Pradesh, and Haryana whereas marble may be found in Rajasthan, Bihar, and Madhya Pradesh. Slates of various hues can be found in the Himalayan regions of Kangra and Kumaun.

- Metamorphic rocks are formed by the effect of heat or pressure on sedimentary or igneous or even metamorphic rocks.
- Thermal metamorphism is the process by which a rock under-goes change as a result of great heat.
- Dynamic metamorphism is the modification of rock, by tremendous pressure during

2.3.2 Economic Importance of Rocks

The earth's surface and man have long been in contact. He is using rocks and minerals in a variety of ways as technology and time pass. Following is a list of the significance of rocks:

- **Soils:** Rocks are the source of soils. The appropriateness of soils for agricultural goods that produce food for humans and serve as a source of raw materials for several industries.
- **Building Materials:** Directly or indirectly, rocks are the source of various building materials. Building materials like granite, gneiss, sandstone, marble, and slate are frequently employed. Tajmahal 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.
- **Mineral Sources**: The foundations of contemporary society are mineral resources. All metals, including the extremely valuable metals gold, platinum, silver, copper, aluminium, and iron, are produced by metallic minerals. These metals come from different types of rocks.
- **Raw Materials**: different industries use specific rocks and minerals as raw materials in production process. Different types of rocks and minerals are utilised to produce finished items in the cement industry and limestone kilns. Graphite is utilised as a raw material in the production of pencils and crucibles.
- **Precious Stones**: Various igneous or metamorphic rocks are the sources to extract precious stones and metals. Diamond is a precious stone used in jewelry and is a metamorphic rock. Similarly other precious stones like gems, rubies and sapphires are obtained from different type of rocks.
- **Fuels**: Rocks are the source of fuel in the forms of coal, petroleum, natural gas, and radioactive materials.
- **Fertilisers**: Some rocks are also used to make fertilisers. Phosphite, a mineral that is abundant in particular regions of the world, is used to make phosphoric fertilisers.

2.4 Summary:

Earth is a spherical body. The direct observations into its interior are limited to a depth of a few kilometers. 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 most dense 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. Molten mate- rial solidified beneath the earth's surface to form intrusive and above the earth surface to form extrusive igneous rocks. Sedimentary rocks are formed by the consolidation of sediments. These are layered and may contain fossils. Shale, limestone and sandstone which are examples of sedimentary rocks. Metamorphic rocks are formed by the effect of heat or pressure on any pre-existing rock. Rocks are of immense use to us. They provide precious metals and stones, building ma- terial and fuel etc. for our use.

Check Your Progress

(iii) Mention the different types of rocks?

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(iv) Classify the sedimentary rocks?

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2.5 Check Your Progress – Model answers

(i) There are different sources to study the internal structure of the earth. They are (a) evidences Based on Artificial Sources (b) natural sources. The artificial sources include- density, pressure, temperature, meteorites.

(ii) It has been experimentally proved that three types of waves are produced at the time of earthquake. These waves are also known as seismic waves. These are as the following: Primary (P waves) waves, secondary (transverse or distortional or S) waves and surface (Long-Period or 'L') waves.

(iii) There are three types of rocks. They are: igneous rocks, sedimentary rocks and metamorphic rocks.

(iv) Depending upon the mode of formation, sedimentary rocks are classified into three major groups: Mechanically formed — sandstone, conglomerate, limestone, shale, loess etc. are examples; Organically formed — geyserite, chalk, limestone, coal etc. are some examples; and Chemically formed — chert, limestone, halite, potash etc. are some examples.

2.6 Terminal questions

Essay questions

1. Describe the internal structure of the earth with a neat diagram?
2. Explain the different types of igneous rocks?
3. Give a detailed account on economic importance of rocks?

Short questions

4. Explain the crust?
5. Write a note on core of the earth?
6. Describe the sedimentary rocks?
7. Explain the types of metamorphism?
8. Mention the different intrusive igneous rocks?

Very short questions

9. What is Mohorovocic discontinuity?
10. Define igneous?
11. What is SIAL and SIMA?
12. What are stratified rocks?

2.7 Further readings

- Alka Gautum (2015), Geomorphology, Sharada Pustak Bhavan, Allahabad, Uttar Pradesh, India.
- Geography, Senior Secondary Course, NIOS, Noida, India.
- Geography Text Book, NCERT, India
- https://www.geo.fu-berlin.de/en/v/geolearning.

Chapter - 3

EARTH MOVEMENTS – ENDOGENIC AND EXOGENIC FORCES, THEORIES-ISOSTACY, CONTINENTAL DRIFT AND PLATE TECTONICS

Contents

3.0 Introduction

3.1 Objectives

3.2 Earth movements

3.3 Isostacy

3.4 Continental drift theory

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3.6 Summary

3.7 Check Your Progress – model answers

3.8 Terminal Questions

3.9 Further readings

3.0 Introduction

Due to numerous forces coming from both underneath (endogenic forces) and above the earth's surface (exogenic forces), the crust and surface of the planet are constantly evolving (changing). the extensive physical and chemical alterations brought forth by geomorphic processes on the surface of the earth. The two types of forces—Endogenic (inside) and Exogenic (external)—are responsible for the features seen on the surface of the earth. Endogenic forces are those that originate from below the surface of the earth. Exogenic forces are those that operate on or above the surface of the earth. In this milieu, we will learn the continental drift and its improvised version of plate tectonics. Its results like volcanoes and earthquakes which are also focused in this lesson.

3.1 Objectives:

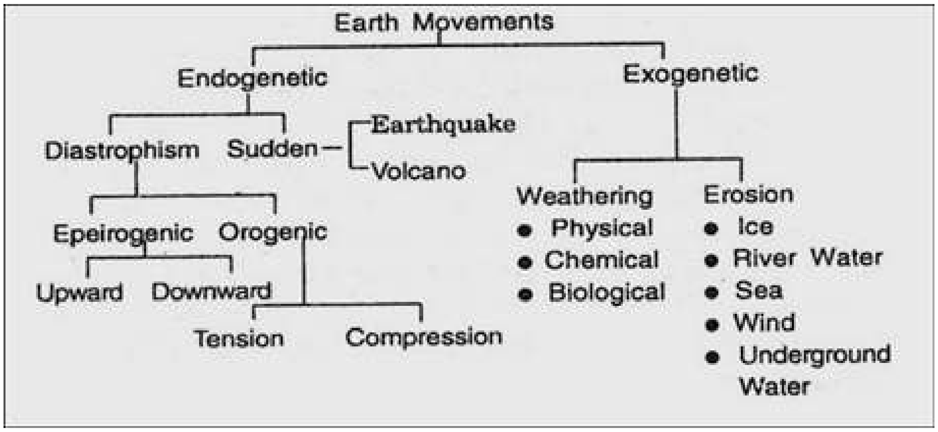
After learning this lesson, you will be able to:

- Understand the different earth crustal movements
- explain the resultant features by earth movements on the surface
- study the sudden movement viz., earthquakes and volcanoes
- explain the concept of isostasy
- explain the concept of continental drift
- Identify the plate tectonics and study plate boundaries

3.2 Earth movements

Movements caused by internal or endogenetic forces affecting the earth's crust are known as Earth Movements. Earth movements are also called tectonic movements as they help in building the relief features on earth's crust through subsequently or simultaneously undergoing changes. The earth movements are classified on various basis. On the basis of time taken by such movements, they are divided into: (I) Endogenic Movements and (II) Exogenic Movements.

Classification of Earth Movements



3.2.1 Endogenic Movements:

The large-scale movements on the earth's crust or its surface brought down by the forces emanating from deep below the earth's surface are called endogenic geomorphic movements or simply endogenic movements. The endogenic movements are divided into (a) diastrophic movements (Slow) and (b) Sudden movements.

(A) **Diastrophic Movements**: Slow movements are those that affect the Earth's crust extremely gently or slowly over a period of hundreds or thousands of years, lasting far longer than a human lifetime. These movements are further divided into epeirogenic movements (continent forming ¯ subsidence, upliftment) and orogenic movements (mountain building ¯ folding, faulting).

(i) ***Epeirogenic Movements***: these also known as **continent-forming** movements. They are **radial** movements (act along the radius of the earth). Their direction may be **towards (subsidence)** or **away (uplift)** from the centre of the earth. They cause upheavals or depressions of land exhibiting **undulations (wavy surface)** of long wavelengths and little folding. The broad central parts of continents are called **cratons** and are subject to epeirogeny, hence the name continent forming movements. ***Upliftment***: Raised beaches, some of them elevated as much as 15 m to 30 m above the present sea level, occur at several places along the Kathiawar, Orissa, Nellore, Madras, Madurai and Thirunelveli coasts. Several places which were on the sea some centuries ago are now a few miles inland. For example, Coringa near the mouth of the Godavari, Kaveripattinam in the Kaveri delta and Korkai on the coast of Thirunelveli, were all flourishing sea ports about 1,000 to 2,000 years ago. ***Subsidence:*** Submerged forests and valleys as well as buildings are evidences of subsidence. In 1819, a part of the Rann of Kachchh was submerged as a result of an earthquake. Presence of peat and lignite beds below the sea level in Thirunelveli and the Sunderbans is an example of subsidence. The Andamans and Nicobars have been isolated from the Arakan coast by submergence of the intervening land. On the east side of Bombay Island, trees have been found embedded in mud about 4 m below low water mark.

(ii) **Orogenic movements**: Orogenic or the mountain-forming movements act tangentially to the earth surface, as in plate tectonics. They are characterised by the folding and faulting of layers of rock, the intrusion of magma, and by volcanism. Tensions produce fissures (since this type of force acts away from a point in two directions) and compression produces folds (because this type of force acts towards a point from two or more directions). In the landforms so produced, the structurally identifiable units are difficult to recognize.

Folds: Folds are that surface of the earth which are wavy and rippling. These are resultant structures of compressional forces. the folds, in general form in sedimentary rocks. Folding comprises of upward and downward formations. Upward formation is known as anticline while the downward shape is termed as syncline; both the limbs are called hinge zones. Folds are of different types based on the appearance of the folds and their angle. The fold with both sides are similar in terms of length and angle of inclination are *symmetrical fold*. the fold with both sides are dissimilar in terms of length and angle of inclination. One limb is smaller than the other. Smaller side is steeply sloped while the longer side is gently sloped. This is called *Asymmetrical fold*. Over folds are formed **w**hen the greater force of compression is operational from one side the fold keeps on turning to the other side and thus inclination is observed. The overfold when it is further intensified, the greater turned side overlies the other side is called *recumbent fold*. when intensifying force take place the overlaying limb results *overthrusting fold*.

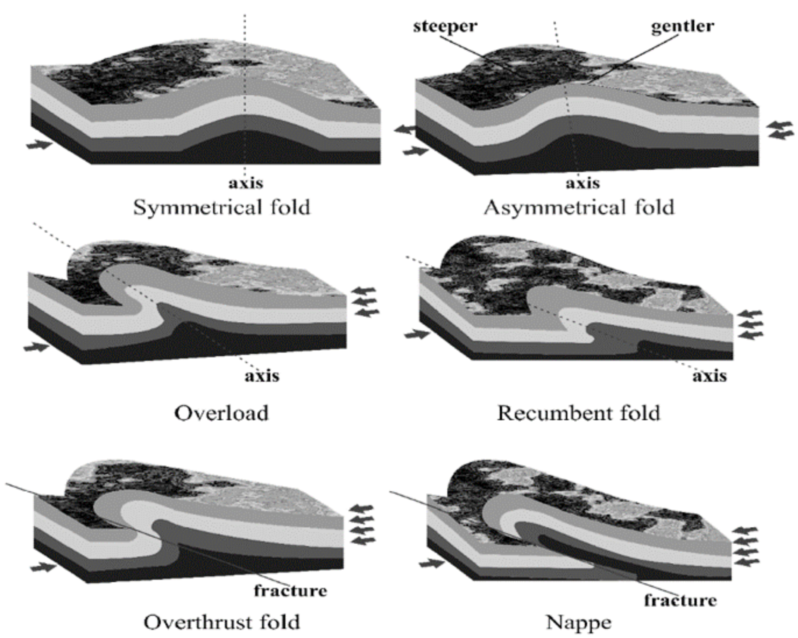


Fig. 3.1: Types of Folds

Faults: A fault is a fracture or zone of fractures between two blocks of rock. Faults allow the blocks to move relative to each other. This results displacement of crust in significant extent. Both tensional and compressional forces are responsible for faults.

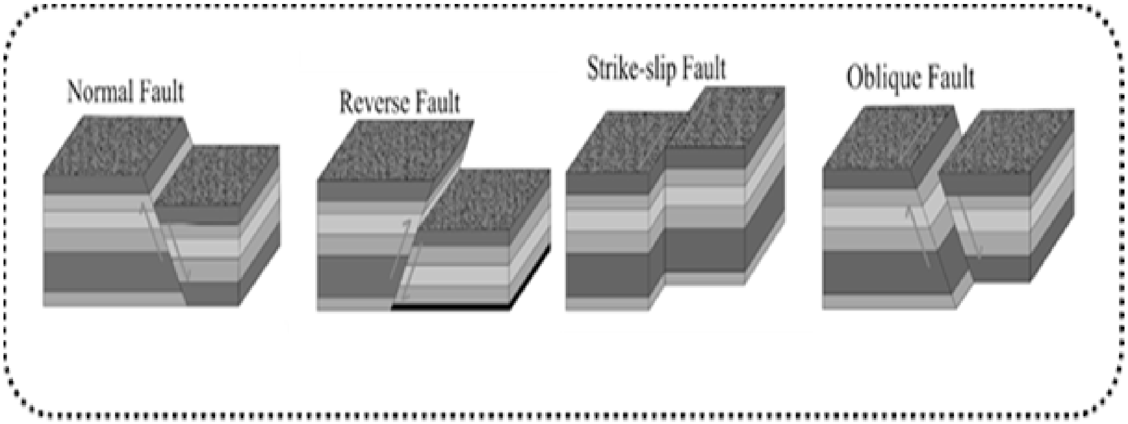


Fig. 3.2: Types of Faults

On the basis of process of faults, they are of different kinds. A fault formed due to tensional force caused from the interior is called a *normal fault*. the fault is formed due to compressional force caused from the interior is called a *reversal fault*. When the crustal block/mass slips past one another is known as a *strike-slip fault or a lateral fault*. The *Oblique Fault* is formed when the crustal mass is shifted not only away like the normal fault but also gets rotated by sideways movement. Due to excessive force, when the limb of the fold is broken, it gets detached and thrown away from its original position. This breaking no longer remains a fold but it turns into a fault known as *nappe*.

Two types of features are formed due to faulting Horst: One is depressed called *graben* or *rift valley* and the other is elevated called *horst*. When there is normal faulting, the downthrown side with respect to other forms the graben through which rivers generally occupy. When the widening of the depressed/ downthrown side gets widened, it becomes a rift valley. When there is an upthrown side with respect to other forms, horst. Horst is also sometimes known as Block Mountain if the height is more.

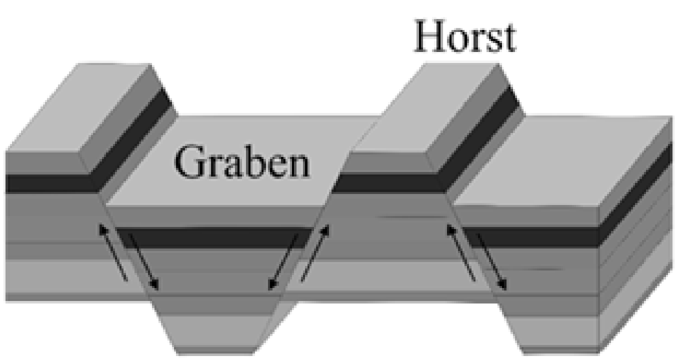


Fig. 3.0: Graben and Horst

(B) Sudden Movements: these movement occur mostly at the lithospheric (tectonic) plate margins and cause considerable deformation over a short period. The plate margins are highly unstable due to pressure created by pushing and pulling of magma by convectional currents in the mantle. They **may be of two types: earthquakes and volcanoes.**

(1) Earthquake: - An earthquake is a sudden shaking of the ground surface, ranging from a faint tremor to a wild motion. There are significant regional differences in the frequency of earthquakes. The world's network of seismographic stations records dozens of earthquakes each day. But there aren't many earthquakes that are very powerful. At or close to the epicentre, the intensity is at its peak. Due to this, the area in and around the epicentre experiences the most destruction. It occurs when the surplus accumulated stress in rocks in the earth's interior is relieved through the weak zones over the earth's surface in form of kinetic energy of wave motion causing vibrations (at times devastating) on the earth's surface. Such movements may result in uplift in coastal areas.

Causes and Effects of Earthquakes: Earthquakes are mostly caused by endogenic factors. Folding and faulting are the results. The surface shakes as a result of an abrupt shift or movement in the crust. The eruption of volcanoes is the second significant factor. Vibrations in the crust of the planet are brought on by the severe volcanic eruption. Only the regions where there is volcanic activity experience earthquakes. Strong earthquakes can have catastrophic effects. They run the risk of triggering floods, damming river courses, and landslides on their own. It modifies a region's drainage system, as was seen in Assam following its earthquake in 1951. The most devastating effects of earthquake-induced sea waves are found in coastal areas. Tsunamis are the name for these tidal waves. Cities on coasts might be destroyed by these waves. Thousands of people perish as a result of buildings and bridges collapsing. Transport, communication, and electric transmission lines are all interrupted.

Distribution of Earthquakes: Earthquakes are a common occurrence in practically all regions of the planet. However, they are more common in two clearly defined belts. These belts are the Circum-Pacific belt and the Mid-world mountain belt.

- The Circum Pacific belt comprises the western coast of North and South America; Aleutian Islands and island groups along the eastern coasts of Asia such as Japan and Philippines. As it encircles the Pacific Ocean, it is named so. The earthquakes in this belt are associated with the convergence boundary of the plates. It is estimated that about 68 percent of earthquakes of the world are occurring in this belt alone.
- The second belt extends from the Alps with their extension into the Mediterranean the Caucasus and the Himalayan region and continues to Indonesia. About 21 percent of total earthquakes of the world originate in this belt.

- Remaining 11 percent occurs in the other parts of the world.

(2) Volcanoes: A volcano is a vent or an opening in the earth's crust through which molten rock material, rock fragments, ash, steam and other hot gases are emitted slowly or forcefully. These materials are thrown out from the hot interior of the earth to its surface. a volcano is formed when the molten magma in the earth's interior escapes through the crust by vents and fissures in the crust, accompanied by steam, gases (hydrogen sulphide, sulphur dioxide, hydrogen chloride, carbon dioxide etc.) and pyroclastic material.

Types of Volcanoes: Volcanoes are of different types on the basis of the nature of volcanism . parameters for the classification of volcanoes: (i) frequency of eruption, (ii) mode of eruption and (iii) fluidity of lava.

(i) On the basis of the fluidity of lava

- **Acidic Lava Volcanoes**: Acid lava is rich in silica and has a relatively high melting point. Therefore, it is highly viscous and solidifies quickly. Hence, the acid lava volcanoes cause the formation of usually higher domes with steeper slopes.

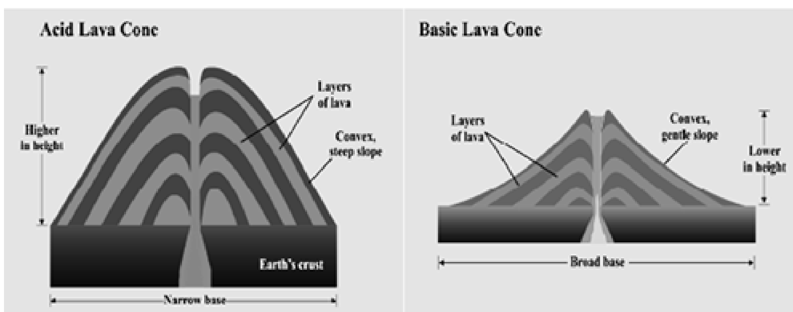


Fig. 3.3: Types of Lava

- **Basic Lava Volcanoes**: Since the basic lava is rich in metallic minerals and has a low melting point, it has greater fluidity. In this type of eruption, lava flows far and wide quietly with greater speed and spreads out in thin sheets over a large area. Thus, it leads to the formation of shields and lava domes. The shield volcano of Hawaii Island in the Pacific Ocean is one of these volcanoes.

(ii) On the basis of the frequency of eruption

on the basis of eruption frequency, volcanoes are of three types: active, dormant and extinct volcanoes.

- **Active volcanoes**: This group of volcanoes frequently erupts or has recently erupted. Important examples of these are tromboli in Mediterranean, Krakatoa in Indonesia, Mayon in Philippines, Mauna loa in Hawaii Islands and Barren Island in India.

- **Dormant Volcanoes**: Volcanoes that have not recently erupted are referred to as dormant volcanoes. They are known as "sleeping volcanoes" for this reason. Among these, Vesuvius in Italy and Cotopaxi in South America are significant.

- **Extinct Volcanoes**: Contrary to these two, there exist volcanoes that have never erupted in recorded history. We refer to them as extinct volcanoes. Important extinct volcanoes include Mount Popa in Myanmar and Kilimanjaro in Tanzania.

(iii) On the basis of mode of eruption

a) ***Conical or Central Type:*** When cooled lava particles from successive volcanic eruptions form a cone around the vent, a conical mountain shape emerges. This is a central type of volcano. Examples: Fujiyama (Japan) and Mount Vesuvius (Italy). The magma in such volcanoes is viscous, acidic and silicate.

b) ***Shield Type:*** The less viscous, less acidic and less silicate magma flows out slowly and quietly and gives rise to a wide-based plateau -like formation with a gentle slope. Thus, a 'shield shaped' volcano with thin horizontal sheets emerges. Example: Mauna Loa (Hawaii).

c) ***Fissure Type:*** Sometimes, a very thin magma escapes through cracks and fissures in the earth's surface and flows after intervals for a long time, spreading over a vast area, finally producing a layered, undulating, flat surface. Example: Deccan traps (peninsular India)

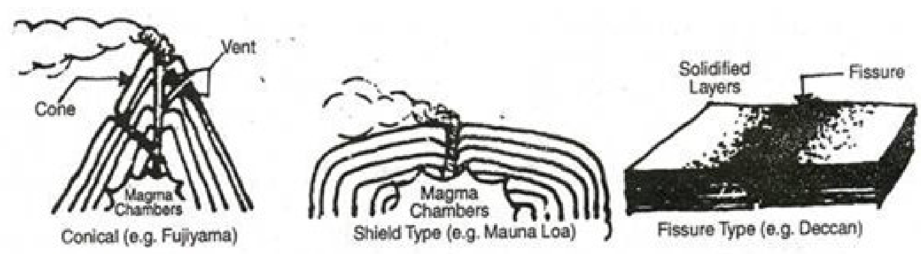


Fig. 3.4: Types of volcanic eruption

Distribution of Volcanoes:

The majority of these volcanoes are concentrated in three distinct belts.

First, the greatest number of volcanoes are concentrated in the circum-Pacific area. Because of this, it is known as the "Pacific Ring of Fire." This ring spans from the Aleutian Islands to Japan, the Philippines, Indonesia, and New Zealand along the South American Andes Mountains to Alaska.

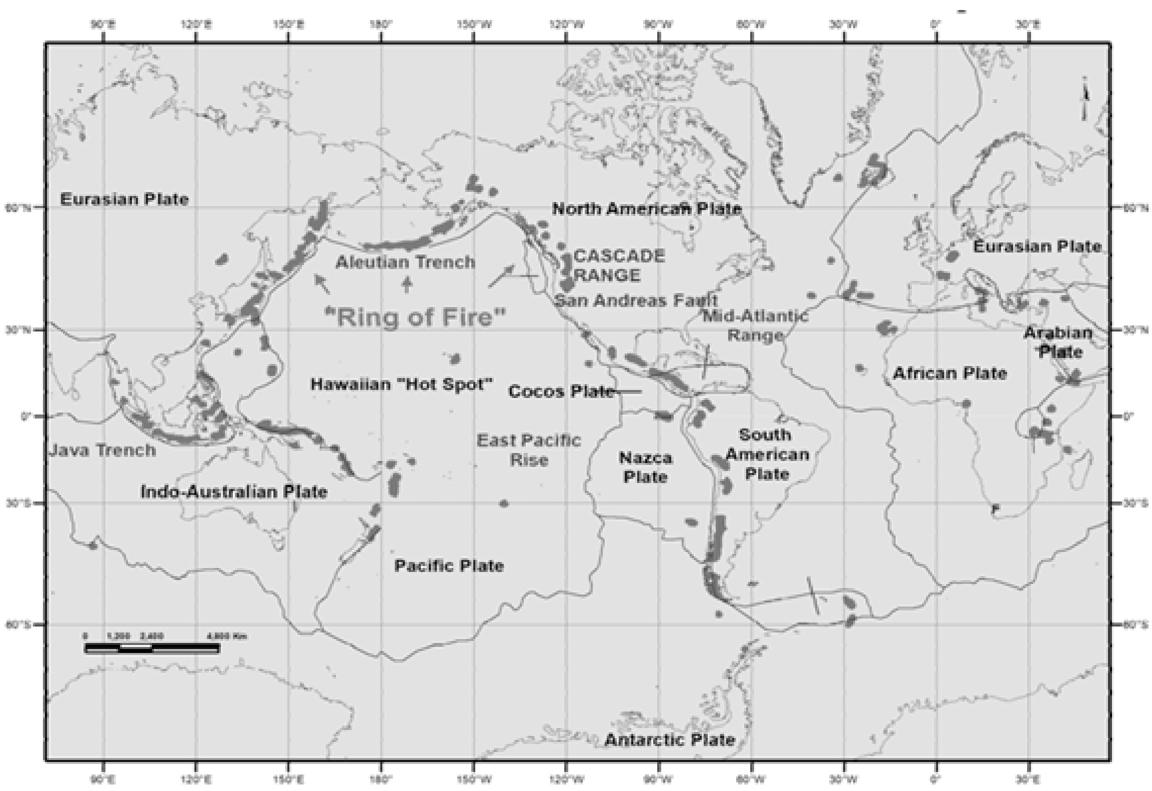


Fig. 3. 5: Distribution of Volcanoes and Earthquakes

- The Mid-world mountain belt occupies the second position with regard to the numbers of volcanoes. It runs from the Alps in Europe to the western parts of South west Asia.
- The third-placed region is the African Rift Valley.

Check Your Progress

(i) What are the types of earth crustal movements?

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(ii) Mention the different types of folds?

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(iii) Classify the volcanoes on the basis of frequency of eruptions?

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3.2.1 Exogenic Movements:

The geomorphic processes on the earth's crust or its surface brought down by the forces emanating from above the earth's surface (wind, water) are called exogenic geomorphic processes or movements. The exogenic geomorphic process gives rise to exogenic geomorphic movements or simply exogenic movements such as weathering and erosion.

Types of Exogenic Processes

Degradation and aggradation are the two processes used to grade irregularities on the earth's surface. Under the Degradation the upstanding landmass is lowered down by weathering (disintegration and decomposition and consequent downslope transfer of weathered materials), mass movement and erosional activities. The exogenetic forces involve two stages—firstly; the landforms (in form of rocks) weaken, break up, rot and disintegrate. This stage comes into play as soon as the newly created landform is exposed to the influence of weather. This stage is called Weathering. Then comes a stage of scraping, scratching and grinding on the surface rock. It includes removal or transportation of the weathered rock material from one place to another. This stage is called Erosion. The act of erosion is performed by a number of natural agents, such as running water, ground water, moving ice, wind, waves and currents of the sea. These agents use the eroded material as cutting tools to carve out and shape the landscape.

(A) Weathering: Weathering is the action of elements of weather and climate over earth materials. The process by which exposed rocks are broken down and decomposed in situ, or in their natural location, is known as weathering. There are several processes within weathering which act either individually or together to affect the earth materials in order to reduce them to fragmental state. Weathering is an in-situ or on-site process because there is little to no material motion during this process. Numerous intricate geological, topographical, climatic, and vegetal elements influence the weathering process. Climate was the most important factor. The three main categories of weathering processes are as follows: (i) Physical or Mechanical (ii) Chemical and (iii) Biological weathering.

(i) Physical Weathering

The disintegration of rocks into smaller fragments without any change in their chemical composition is called mechanical weathering. This type of mechanical force produces fine particles from massive rock by the exertion of stresses sufficient to fracture the rock, but does not change its chemical composition. Physical weathering may take place in many ways.

- **Block disintegration:** We are all aware that the subsequent heating and cooling causes the rocks to expand and contract. The daytime temperature is very high and the nighttime temperature is very low in hot desert regions. This high diurnal temperature variation causes the rocks to expand and contract repeatedly, which tends to enlarge the joints. The rocks finally break up into smaller pieces. Block disintegration is the term for this process.

- **Exfoliation:** In general, rocks are poor heat conductors. The outer layers of the rock rapidly expand as a result of intense heating, but the inner layers are essentially unaffected. The outer layer of the rock eventually peels off from the main mass of the rock in the shape of concentric shells as a result of repeated expansion and contraction. By using this method, rocks are peeled in layers in a manner very similar to how onions are peeled layer by layer. The action is referred to as exfoliation.

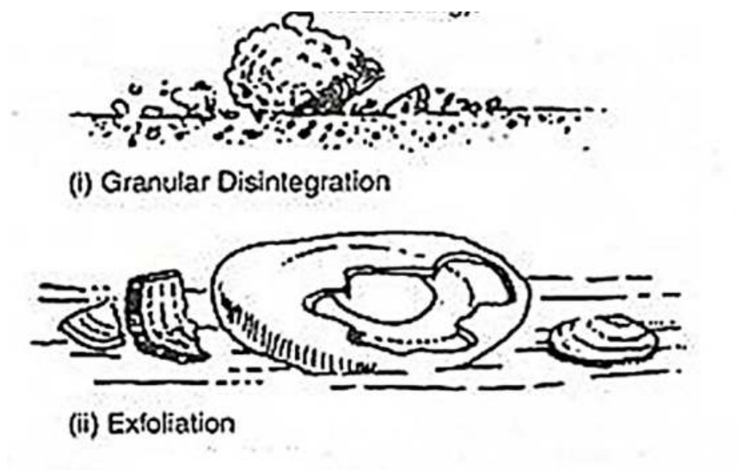

Fig. 3.6 Various Forms of Rocks Break-up by Physical Weathering

- **Frost Action:** This type of weathering is common in cold climates. During the warm season, the water penetrates the pore spaces or fractures in rocks. During the cold season, the water freezes into ice and its volume expands as a result. This exerts tremendous pressure on rock walls to tear apart even where the rocks are massive.

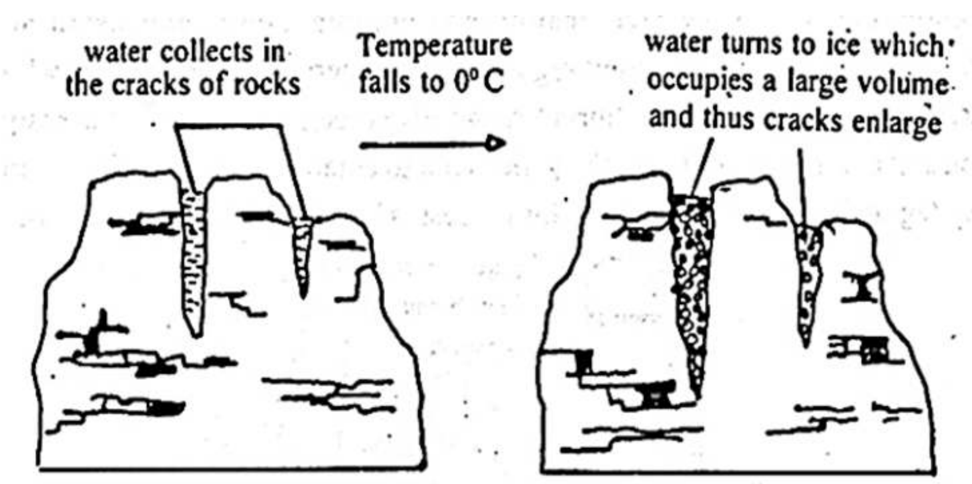

Fig 3.7 Frost action

(ii) Chemical Weathering

Chemical weathering is the process by which rocks break down chemically with the aid of water and gases from the atmosphere**.** This process involves carbonation, oxidation, hydration and solution.

(i) **Carbonation:** It takes place in rocks containing calcium, sodium, magnesium, potassium etc. when they come in touch with rain water which contains dissolved carbon dioxide. This process is common in lower humid climates.

(ii) **Oxidation:** This occurs in iron-based salts. The atmospheric oxygen present in rainwater unites with mineral grains in the rock, especially with iron compounds. This results in the decomposition of the rock and it starts crumbling. This process is called oxidation and is similar to the process of rusting.

(iii) **Hydration:** The chemical action of water detaches the outer shell of aluminium-bearing rocks through the process of hydration.

(iv) **Solution:** Some minerals, such as rock- salt and gypsum, are removed by the process of solution in water.

The chemical reaction of rainwater brings about decomposition of minerals more rapidly than its mechanical action. The chemical weathering is capable of breaking up even a hard crystalline rock into minute particles.

(iii) Biological weathering:

Biological weathering is the removal of minerals from the environment due to the growth or movement of organisms. Living organisms contribute to both mechanical and chemical weathering. Lichens and mosses grow on essentially bare rock surfaces and create a more humid chemical microenvironment. On a larger scale, seedlings sprouting in a crevice and plant roots exert physical pressure and provide a pathway for water and chemical infiltration. Burrowing and wedging by organisms like earthworms, rodents etc., help expose the new surfaces to chemical attack and assist in the penetration of moisture and air. Decaying plant and animal matter help produce humic, carbonic and other acids which enhance the decay and solubility of some elements. Algae utilise mineral nutrients for growth and help in the concentration of iron and manganese oxides.

(i) Define weathering?

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(ii) What are the types of chemical weathering?

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3.3 ISOSTASY

According to isostasy theory, a mass above sea level is supported below sea level, and there is a depth at which the total weight per unit area is equal all across the Earth. This depth is known as the depth of compensation. Clarence Dutton, an American geologist, coined the term isostasy in 1889 to describe the state of equilibrium that exists between vast upstanding regions of the Earth's surface, mountain ranges, and plateaus.

Concept of Isostasy

Dutton, an American geologist, coined the word isostasy. The Isostasy literally translates as "state of balance." On the rotating earth, it is the mechanical stability between the crust (upstanding parts such as plains, plateaus, mountains, etc.) and the mantle (low-lying parts such as the ocean floor). It maintains a balance between buoyancy and gravitational forces.

Airy's View of Isostasy

Isostasy was explained in-depth for the first time by Airy. According to Airy, continents are formed of a lighter element called Sial, and they float over a denser material called Sima. Because continents have the same density, the height of mountains is a proposition to deep root beneath them in order to maintain equilibrium. Himalayan is floating on Sima, and a big portion of Himalayan roots deep into Sima (denser rock) to keep it afloat in the same way as boats do. Individual mountain peaks and valleys do not need to be individually balanced because the crustal rocks are strong enough to preserve minor balance.

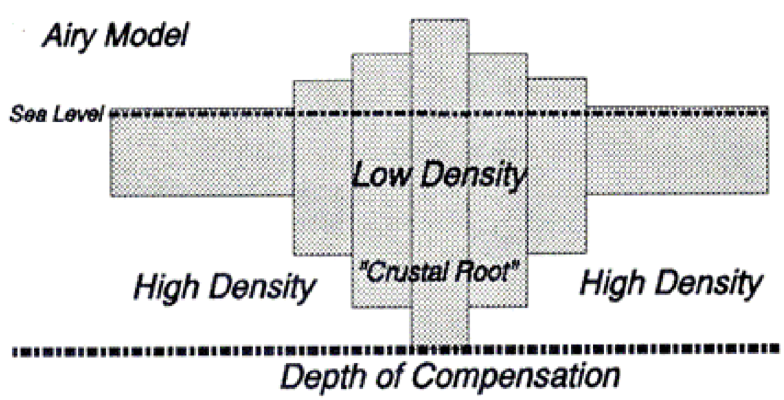

Fig. 3.8 Airy Model Theory of Isostasy

Pratt's View of Isostasy

Mountains, plains, and plateaus have differing densities. The density of mountains should be less than that of plateaus. The relationship between height and density is inverse. The uniform depth with changing thickness is his concept.

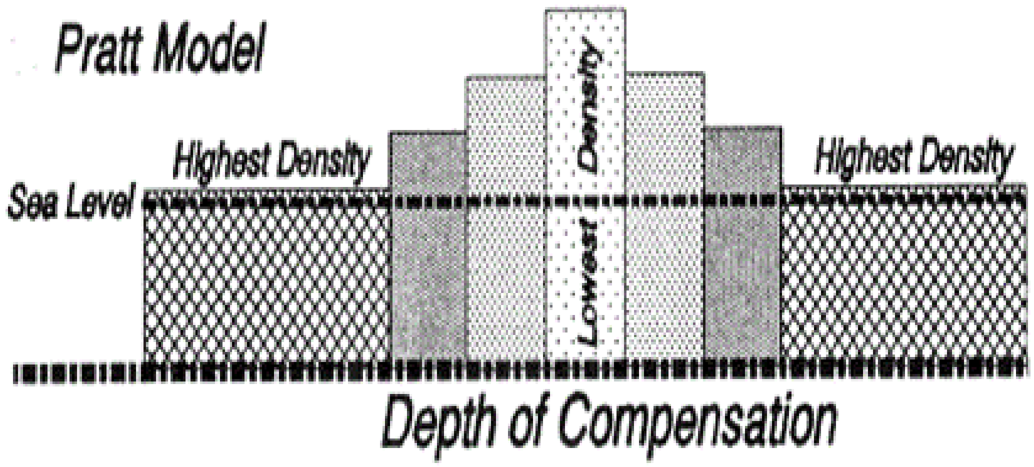

Fig. 3.9 Pratt Model Theory of Isostasy

3.4 CONTINENTAL DRIFT THEORY

The Continental Drift Theory by Wegener introduced the concept of shifting of continents for the first time in 1915. Until the early twentieth century, the continents were assumed to be fixed geographical masses. Wegener claimed that the Earth must have once been a single supercontinent before fragmenting into various continents.

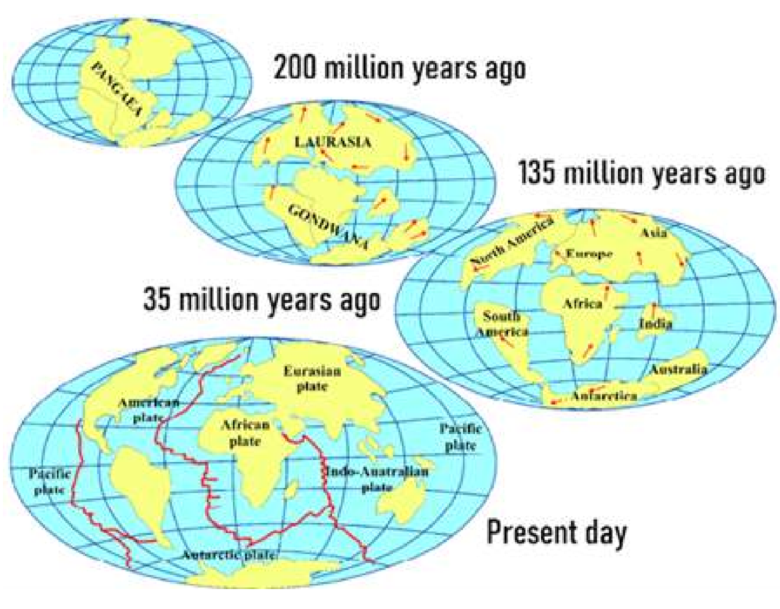

Fig. 3.10 Various Stages of Continental Drift Theory

Continental Drift Theory

Continental Drift: The movement of continents across the ocean bed is known as continental drift. This drifting takes millions of years to complete this process.

Continental drift theory was given by Alfred Wegener in 1915. This theory has explained the origin of continents and ocean basins. Though it was a Dutch cartographer, Abraham Ortelius who was the first to work on the concept of symmetrical coasts on the Atlantic Ocean's sides.

According to Wegener, all the continents formed a single continental mass which is called "Pangaea'' which means all earth. This supercontinent was surrounded by a mega ocean called "Panthalassa '' meaning all water.

Subsequently, Laurasia and Gondwanaland continued to break into various smaller continents that exist today. Thus, Wegener proposed that continents are floating and constantly drifting on the earth's surface. His hypothesis, later on, became the basis of present-day plate tectonic theory.

Various Stages of Continental Drift Theory

i. ***First Stage:*** The first stage occurred during the Carboniferous period, when Pangea, a supercontinent, was encircled by Panthalassa, a mega-ocean.

ii. ***Second Stage:*** In the second stage around 200 million years ago in the Jurassic period, the supercontinent, Pangaea, began to split. Pangaea first broke into large continental masses as Laurasia and Gondwanaland formed the northern and southern components respectively.

iii. ***Third Stage:*** In the third stage, the Tethys Sea progressively filled the area between Laurasia and Gondwanaland during the Mesozoic epoch, and it gradually broadened.

iv. ***Fourth Stage:*** In the fourth stage around 100 million years ago when North and South America drifted westward, resulting in the emergence of the Atlantic Ocean. The Rockies and Andes were formed by the westward drift of North and South America.

v. ***Orogenetic Stage:*** The Orogenetic Stage in which mountain-building activity took place is the fifth stage.

Forces Responsible for Continental Drift

i. The continental drift was equatorward due to the combined action of gravitational forces, pole-fleeing force, and buoyancy force because the planet is not perfectly round and has a bulge at the equator.

ii. The 'pole-fleeing force' is caused by an increase in centrifugal force from the poles towards the equator.

iii. The continental drift was westward due to tidal currents caused by the earth's rotation.

Evidence in support of continental drift theory:

a) ***The Matching of Continents (Jig-Saw-Fit):*** When facing one another, the shorelines of South America and Africa form a similarity. Similarly, when matched, Africa, Madagascar, and India's east coast all fit together.

b) ***Rocks of Same Age across the Oceans:*** Radiometric dating techniques have been used to correlate rock development across continents. It suggests that the 2,000 million-year-old strip of ancient rocks off the coast of Brazil corresponds to the mountain ranges of Western Africa. Similarities can also be found between the Caledonian and Appalachian mountains. It also implies that the early marine deposits along Africa's and South America's coastlines date from the Jurassic period, implying that the ocean did not exist before then.

c) ***Tillite:*** Tillite is a type of sedimentary rock formed by glacier deposits. The Gondwana system of sediments from India has been discovered to have parallels in six different landmasses of the Southern Hemisphere, including Africa, the Falkland Islands, Madagascar, Antarctica, Australia, and India. It reveals that the antiquity of both landmasses was strikingly similar.

d) ***Placer Deposits:*** Gold placer deposits can be discovered along the Ghana coast (West Africa). However, there is no source rock in the immediate vicinity. The fact that gold-bearing veins may be found in Brazil is incredible. When the two continents are laid side by side, it appears that Ghana's gold reserves are sourced from the Brazil plateau.

e) ***Distribution of Fossils:*** Identical species and animals were found on both sides of the marine barrier. For example, Mesosaurus, a freshwater crocodile-like reptile that lived between 286 and 258 million years ago, is only found in Southern Africa and Eastern South America.

The Continental Drift Theory was rejected by the majority of scientists, and it was intensely disputed for decades following his death in 1930.

3.5 THEORY OF PLATE TECTONICS

The term tectonics comes from the Greek word tektonikos, which means "building or construction," and refers to the deformation of the earth's crust caused by internal forces. Plate tectonics theory explains the large-scale motions of the earth's lithosphere. The term plate was first coined by JT Wilson in 1965. Though this theory was proposed by Harry H. Hess in 1962 still, it was explained scientifically by other important thinkers like Morgan, Mckenzie, Parker, and Holmes.

It is considered the most complex and comprehensive hypothesis about the drift of continents and the expansion of sea floors, and it is an improvement over Wegener's continental drift theory. According to this theory, the crust of the earth is divided into several big and several small fragments called plates. These lithospheric plates are about 100km thick. These plates are floating over the semi-molten asthenosphere.

The seven major plates are

1. North American plate (with the western Atlantic floor separated from the South American plate along with the Caribbean islands)
2. South American plate (with western Atlantic floor separated from the North American plate along with the Caribbean islands)
3. Pacific plate (Largest plate)
4. Antarctica and the surrounding oceanic plate
5. Eurasia and the adjacent oceanic plate)
6. Africa with the eastern Atlantic floor plate
7. India-Australia-New Zealand plate

Minor plates

1. Caribbean Plate
2. Cocos Plate
3. Caroline Plate
4. Juan de Fuca Plate
5. Juan Fernandez micro Plate
6. Iranian Plate
7. South Sandwich Plate
8. Myanmar Plate
9. Anatolian Plate
10. Nazca Plate
11. Nubian Plate
12. Philippines Plate
13. Okhotsk Plate
14. Scotian Plate
15. Eastern micro Plate
16. Somalian Plate
17. Arabian Plate
18. Solomon Plate
19. Fiji Plate
20. Bismarck Plate

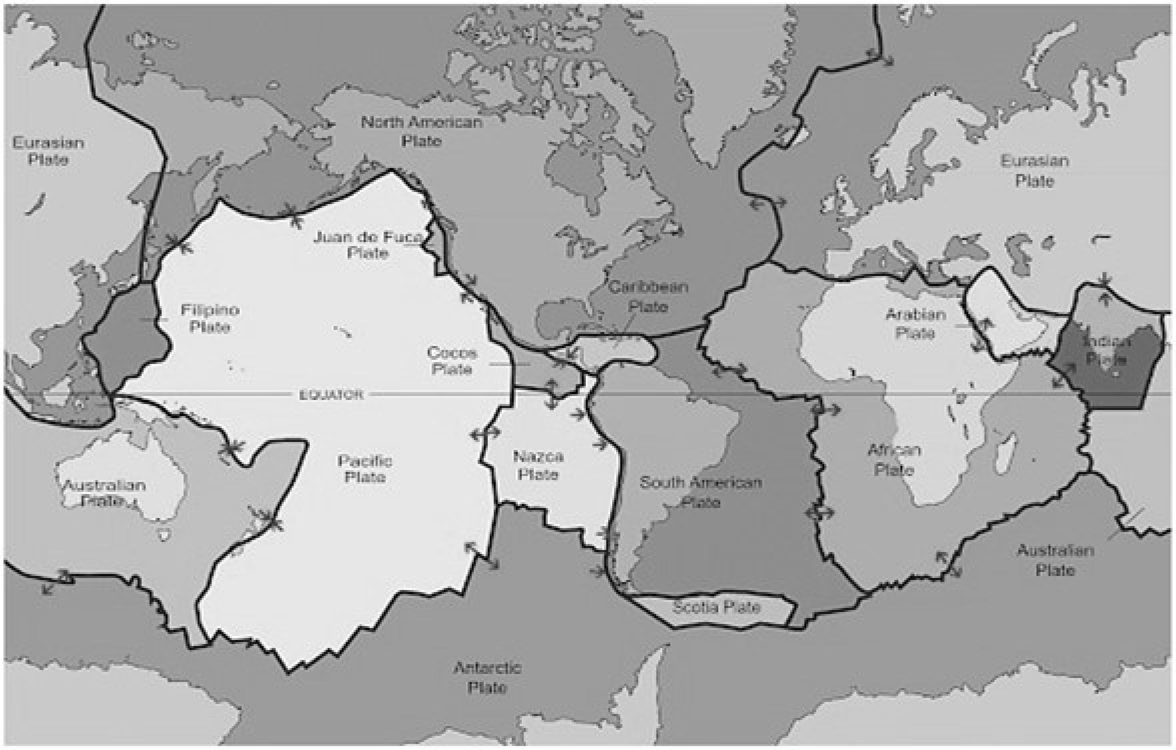

Fig. 3.11 Major and Minor Plates according to the Plate Tectonics Theory

Types of Plate Boundaries

Convection currents under the lithosphere have been proposed by British geologist Arthur Holmes. Due to the extreme heat there, it is being produced from the asthenosphere. The excessive heat is dissipated towards the surface. The convection currents are classified into two rising and falling with divergence and convergence actions respectively. The plate boundaries are classified into three types viz., (i) Divergent, (ii) Convergent, and (iii) Transform boundaries.

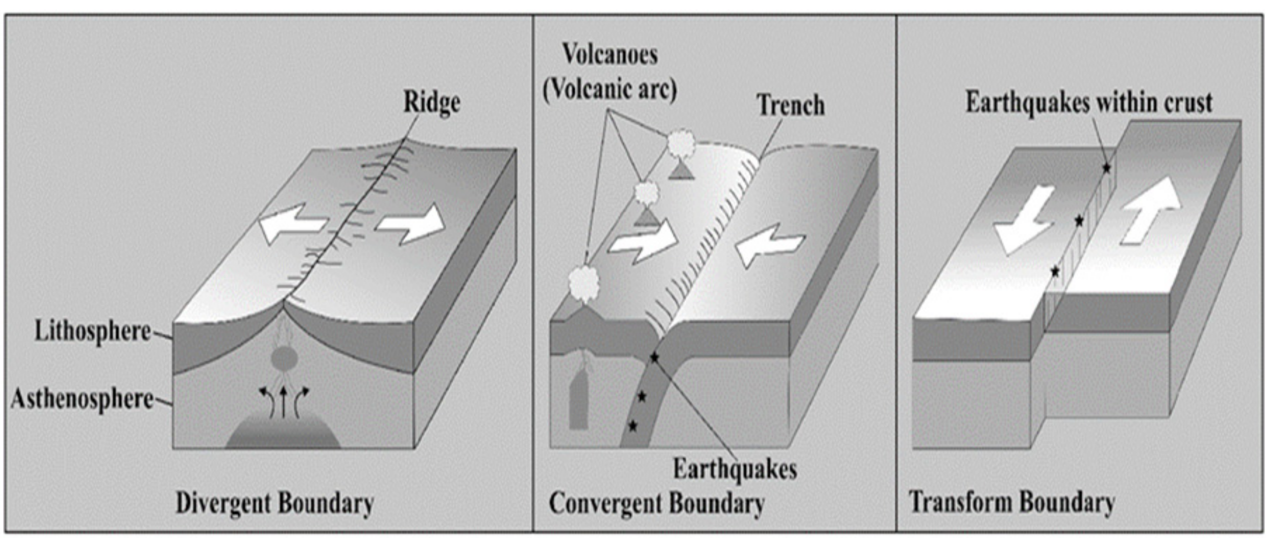

Fig. 3.12 Three types of plate boundaries

1) Divergent Plate Boundaries:

i. Those plates that move away from each other consistently are called Divergent Plate Boundaries.

ii. This type of interaction results in the formation of mid-ocean ridges (such as the Mid-Atlantic Ridge).

iii. The basaltic magma erupts and separates here (seafloor spreading).

iv. The East African Rift Valley, produced by the divergence of the African and Somali plates, is the most important geomorphological feature on the continent.

v. Divergent edges are places where the earth crust is formed (hence the name constructive edge), and volcanic earth formations are common along them.

vi. Along diverging margins, earthquakes (with a shallow focal) are prevalent.

2) Convergent Plate Boundaries:

i. When continental and oceanic plates collide, the oceanic plate, which is thinner and denser, is pushed aside by the continental plate, which is thicker and less dense.

ii. In a process known as "subduction," the oceanic plate is driven down into the mantle.

iii. The oceanic plate is thrust into higher temperature environments as it lowers.

iv. Materials in the subducting plate begin to approach their melting temperatures at a depth of about 100 miles (160 kilometres), and partial melting begins.

v. The most active example of continental convergent plate boundaries is the Himalayan Mountain Range.

vi. Around 55 million years ago, India and Asia collided, forming the Himalayas, the world's largest mountain range. The Indian and Eurasian plates are colliding right now.

3) Transform Plate Boundaries:

i. Two plates slide past each other in this type of interaction, and no new landforms are created or destroyed; only the present landform is deformed.

ii. Transform faults are planes of separation in the oceans that are often perpendicular to the mid-oceanic ridges.

iii. The best example of a transcurrent edge on continents is the San Andreas Fault (Silicon Valley sits dangerously close to the faultline) on the western coast of the United States.

Plate tectonics is a grand unifying geoscience theory that explains how continents move. Most significant characteristics on Earth's surface, such as mountain construction, development of new lithosphere, consumption of old lithosphere, and mid-ocean ridges, are caused by earthquakes and volcanism.

(i) Define continental drift?

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(ii) What are the major crustal plates?

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3.6 SUMMERY

Our earth is undergoing deformations imperceptibly but inexorably. These deformations are caused by the movements generated by various factors. The interaction of matter and temperature generates these forces or movements inside the earth's crust. The earth Endogenic movements are mainly of two types: diastrophism and the sudden movements. The Exogenetic forces involve two stages - firstly; the landforms (in form of rocks) weaken, break up, rot and disintegrate. The rocks undergo various types of changes in their own location under the pro- cess of weathering. The rocks become weak due to the impact of the weather elements - temperature, moisture, frost etc. They develop cracks and disintegrate into small boulders, pebbles or fine fragments. This is called mechanical weathering. This type of weathering is more pronounced in areas of hot and dry or very cold climates. Rock minerals undergo chemical changes due to the effect of water and gases as a result of oxidation, carbonation, hydration and solution. This is called chemical weathering. This type of weathering is more important in areas of warm and humid climates. Plants, animals, insects and men are the agents of biotic weathering and they contribute to both mechanical and chemical weathering.

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. Therefore, his ideas of continental drift was denounced inspite of his strong unfutile and testifying evidences. According to plate tectonic theory, the earth surface is made up of several broken blocks of enormous size with great depth considered to be a plate. There are seven bigger size plates and several smaller size plates.

3.7 Check Your Progress – model answers

(i) Movements caused by internal or endogenetic forces affecting the earth's crust are known as Earth Movements. On the basis of time taken by such movements, they are divided into: (I) Endogenic Movements and (II) Exogenic Movements.

(ii) Folds are that surface of the earth which are wavy and rippling. Folds are of different types based on the appearance of the folds and their angle. They are symmetrical fold., Asymmetrical fold, and overthrusting fold.

(iii) On the basis of eruption frequency, volcanoes are of three types: active, dormant and extinct volcanoes.

(iv) The process by which exposed rocks are broken down and decomposed in situ, or in their natural location, is known as weathering.

(v) Chemical weathering is the process by which rocks break down chemically with the aid of water and gases from the atmosphere**.** This process involves carbonation, oxidation, hydration and solution.

(vi) The movement of continents across the ocean bed is known as continental drift. This drifting takes millions of years to complete this process.

(vii) There are seven major plates in the earth crust. They are North American plate, South American plate, Pacific plate (Largest plate), Antarctica and the surrounding oceanic plate, Eurasia and the adjacent oceanic plate), Africa with the eastern Atlantic floor plate, and India-Australia-New Zealand plate

3.8 Terminal Questions

Essay questions

1. Briefly describe the diastrophic movements?
2. Describe the different types of rock weathering?
3. Examine the continental drift theory?
4. Give a detailed account on plate tectonic theory?

Short questions

5. Explain the types of faults?
6. Explain about earthquakes?

7. Describe the concept of isostasy?

8. What are the types of plate boundaries? Explain anyone.

Very short questions

9. Define earth movements?

10. What are orogenic movements?

11. What do you mean by folds?

12. What are volcanoes?

13. What are the types of lava?

14. Define isostasy?

15. What are divergent plate boundaries?

3.9 Further Reading

- Alka Gautham (2015), Geomorphology, Sharada Pustak Bhavan, Allahabad.
- Geography, Senior Secondary Course, NIOS, Noida, India.

  Physical Geography Text Book, NCERT, India

Chapter - 4

WORKS OF RIVER, UNDERGROUND WATER, GLACIERS, WINDS AND SEA WAVES

Contents

4.0 Introduction

4.1 Objectives

4.2 Work of River

4.3 Work of Underground water

4.4 Work of Glacier

4.5 Work of Winds

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4.7 Summary

4.8 Check Your Progress – model answers

4.9 Terminal Questions

4.10 Further readings

4.0 Introduction

A river has three basic functions: erosion, transportation and deposition. It is the combination of these three processes that lead to the formation of various landforms by the action of a river. These agents produce various relief features over the course of time. Amongst all the agents of gradation, the work of running water (rivers) is by far the most extensive. In this lesson we will study how running water and underground water act as agents of gradation and help in the formation of different relief features. Underground water can be defined as the rainwater or snowmelt that neither runs off along the surface nor evaporates but sinks into the ground. The part of rain or snow- melt water which accumulates in the rocks after seeping through the surface is called underground water. moving ice, wind and sea-waves too are powerful agents of gradation. These three agents too perform the threefold function of erosion, transportation and deposition. In other words, they are removing the weathered material, transporting it from the elevated ground and are depositing the same into low lying areas. This process also tends to ‘grade’ or ‘level off’ all irregularities on the surface of the earth in the areas of their operation.

Davis suggested that a glacial topography is a climatic accident that happens to normal cycle of erosion. Climate gets very cold and the river freezes, instead of rivers water there are rivers ice, called glaciers. In this lesson we will study how running water and underground water glacier winds and sea waves act as agents of gradation and help in the formation of different relief features.

4.1 Objectives

- explain the three functions of running water viz erosion, transportation and deposition, in the different parts of the river’s course;
- explain with the help of diagrams the formation of various relief features formed by underground water;
- define glacier, snow-line, snowfield, continental and valley glaciers;
- explain with the help of diagrams the formation of main erosional and depositional Features produced by glaciers;
- explain the features formed by the wind with the help of diagrams;
- explain with the help of diagrams the various relief features formed by sea waves;

4.2 WORK OF RIVER

The landforms created as a result of **degradational action (erosion and transportation)** *or* **aggradational works (deposition) of running water are** *called fluvial landforms.* In fluvial topography rivers performs three actions namely, (i) erosion (ii) transportation and (iii) deposition. Throughout its course a river displays all the three activities to some extent.

(1) Erosion:

it occurs when overland flow moves soil particles downslope. The cutting and removal of rock debris by the river is called river erosion. The work of river erosion is skilled in four different ways, all of which operate together. These four ways are: **(a) Corrasion or Abrasion:** When rock particles bounce, scrape and drag along the bottom and sides of the river, they break off additional rock fragments. this erosion is called corrasion. **(b) Corrosion or Solutions:** This is a kind of chemical action of water on soluble or partly soluble rocks with which the river water comes in contact. For example, when calcium carbonate comes in contact with water, it is easily dissolved and removed in solution. **(c) Hydraulic Action:** In this process mechanical loosening and sweeping away of material occurs due to sheer force of running water. During the flow water splashes against the river banks and enters into cracks and crevices. Then it picks up the loose fragments from its bank and bed and transports them away. **(d) Attrition:** *River load particles striking, colliding against each other and breaking down in the process*. In the process the coarser boulders are broken down into smaller pieces. The angular edges are smoothened and rounded to form pebbles.

(2) Transportation

River carries rock particles from one place to another. This activity is known as transportation of load by a river. The load is transported in four ways- (a) Traction (b) Saltation (c) Suspension (d) Solution actions as discussed in previous lesson. It helps in transporting various types of sediments and debris load from one place to other by running water.

(a) Traction: The heavier and larger rock fragments like gravel, pebbles etc. are forced by the flow of river to roll along its bed. These fragments can be seen rolling, slipping, bumping and being dragged. This process is known as traction and the load is called traction load. **(b) Saltation:** Some of the fragments of the rocks move along the bed of a stream by jumping or bouncing continuously. This process is called saltation. **(c) Suspension:** The holding-up of small particles like sand, silt and mud by the water as the stream flows is called suspension. And **(d) Solution**: Some parts of rock fragments are dissolved in the river water and are thus transported see (fig 4.1).

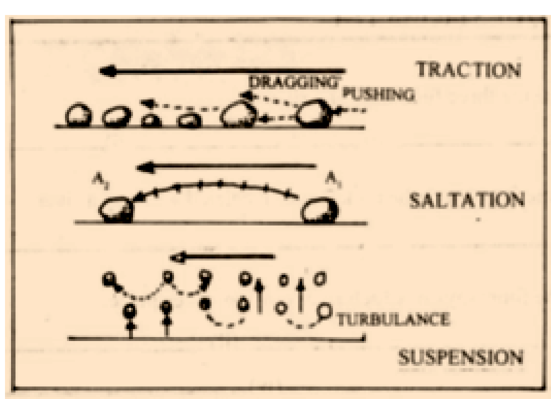

Fig. 4.1 Traction, Saltation and Suspension

(3) Deposition

As the river channels come down from hills to a plain area, the surface slope becomes gentle. The decrease in energy hampers transportation; as a result, part of its load starts settling on its own. This activity is known as deposition. Deposition takes place either due to decrease in slope or due to fall in the volume or velocity of river water. Deposition takes place usually in plains and low-lying areas. When the river joins a lake or sea, the whole of its load is deposited.

4.2.1 COURSES OF A RIVER QUESTIONS 5.1

The starting point of a river is called as 'source of river' which lies in a mountainous region and the place where the river meets the sea or lake is called as 'mouth of river'. The whole path or route in which river flows from its source to mouth is called as river course or its valley. The course of a river is divided into three sections:

(i) The upper course or the stage of youth

(ii) The middle course or the stage of maturity

(iii) The lower course or the stage of old age. (See Fig. 4.2)

(i) The upper course:

This is also called youth stage of river. the upper or mountain course begins from source of the river in hilly or mountainous areas. The river tumbles down the steep slopes and as a result its velocity and eroding power are at their maximum. Consequently, valley deepening assumes its greatest importance at this stage. Normally, weathering also plays its part on the new surfaces exposed along the banks of the stream. The weathered rock material is carried into the stream partly through the action of gravity and partly by rain water flowing into the river. Weathering helps in widening a valley at the top giving it a typical 'V' shaped cross section. Such valleys are known as 'V' shaped valleys.

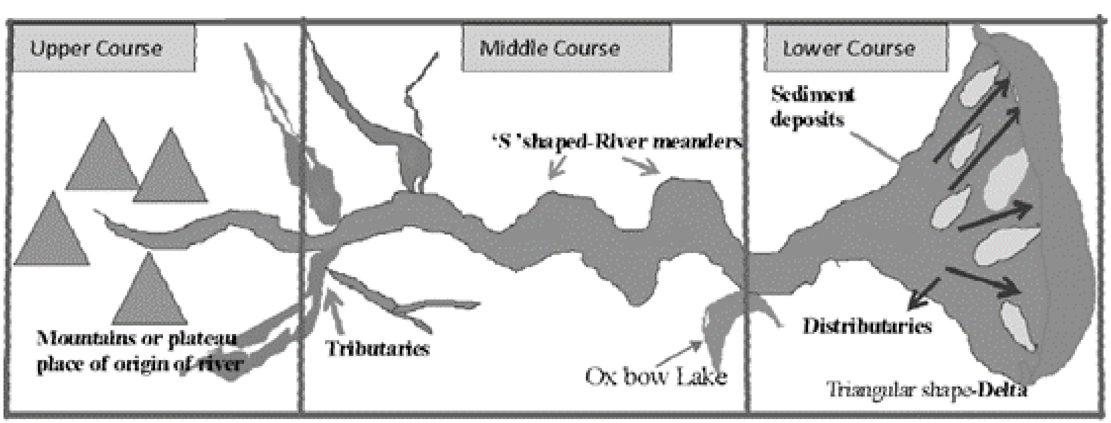

Fig. 4.2 (a) The Upper, Middle and Lower Courses of River

If the bed rock is hard and resistant, the widening of the valley at its top may not take place and the down cutting process of a vigorous river may lead to the formation of a gorge i.e. a river valley with almost vertical sides. In India, deep gorges have been cut by the Brahmaputra and the Indus in the Himalayas. Deep gorges also develop in limestone regions and in rocks lying in dry climates. The narrow and very deep gorge or the canyon with vertical walls is also known as 'I' shaped valley. A canyon is 'very deep gorge with steep sides running for hundreds of kilometers, e.g. Grand Canyon of the river Colorado in U.S.A. Some of the more outstanding features that are developed in the upper course of a river include rapids, cataracts, cascades and waterfalls.

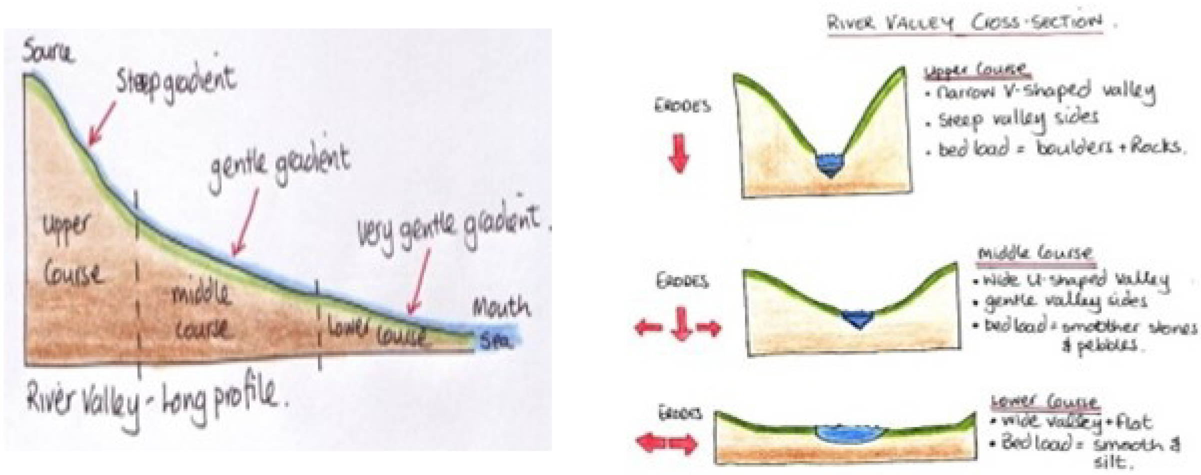

Fig. 4.2 (b) The Graded Long Profile and Cross-section of a River Valley from Source to Mouth

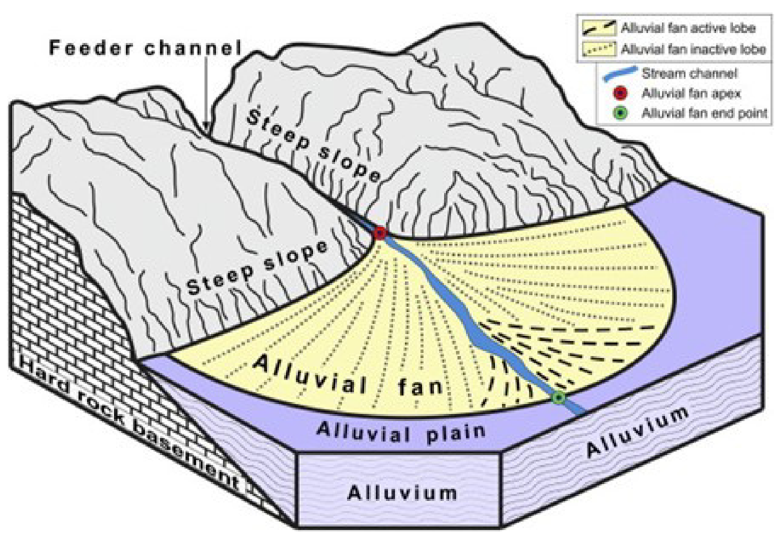

Fig. 4.3 Alluvial Fans

(ii) The middle course:

This is also called mature stage**.** In the middle course, lateral corrasion tends to replace vertical corrasion. Active erosion of the banks widens the 'V' shaped valley. The volume of water increases with the confluence of many tributaries and this increases the river's load. Thus work of the river is predominantly transportation with some deposition. Rivers which sweep down from steep mountain valleys to a comparatively level land drop their-loads of coarse sand and gravels as there is sudden decrease in velocity. The load deposited generally assumes a fan like shape, hence it is called an alluvial fan (See Fig. 4.3).

Sometimes several fans made by neighbouring streams often unite to form a continuous plain known as a piedmont alluvial plain, so called because it lies at the foot of the mountain. In this section even minor obstacles force a river to swing in loops to go round the obstacles. These loops are called meanders, a term derived from the winding River Meanderes in Turkey.

(iii) The lower course:

this is old stage**.** The river moving downstream across a broad, level plain is heavy with debris brought down from the upper and middle courses. Vertical corrasion has almost ceased, the lateral corrasion still goes on to erode its banks further. The work of the river is mainly deposition, building up its bed and forming an extensive flood plain. Many tributaries join the river and the volume of water increases, coarse materials are dropped and the fine silt is carried down towards the mouth of the river. Large sheets of material are deposited on the level bed and the river splits into a maze of channels. Such a stream is called a braided stream.

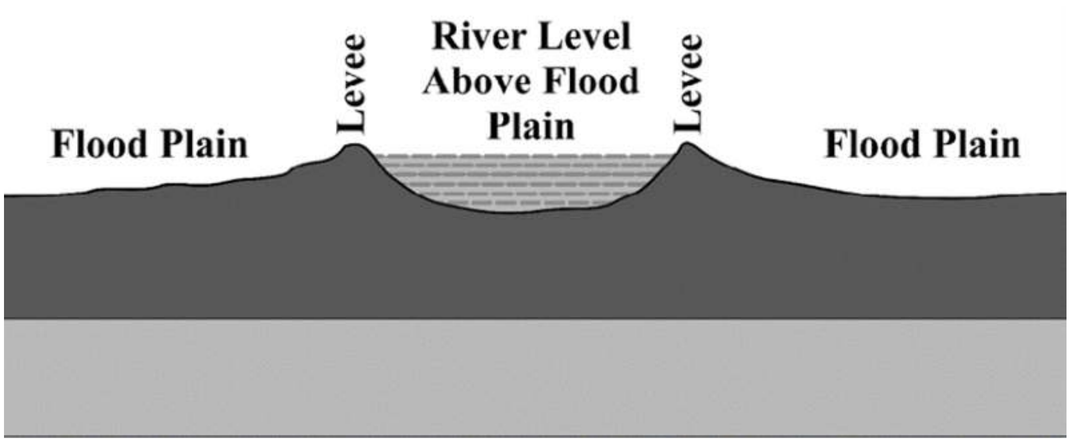

Fig. 4.4 Flood Plain and Levees

During annual floods large quantities of sediments are spread over the low lying adjacent areas. A layer of sediments is thus deposited during each flood gradually building up a fertile flood plain. A raised ridge of coarse material is formed along each bank of the river. Such ridges are called levees. (See Fig. 4.4)

In the lower course of the river, meanders become much more pronounced. The outer bank or concave bank is so rapidly eroded that the meander becomes almost a complete circle. A time comes when the river cuts through the narrow neck of the loop. The meander, now cut of from the main stream, takes the form of an oxbow lake (See Fig. 4.5).

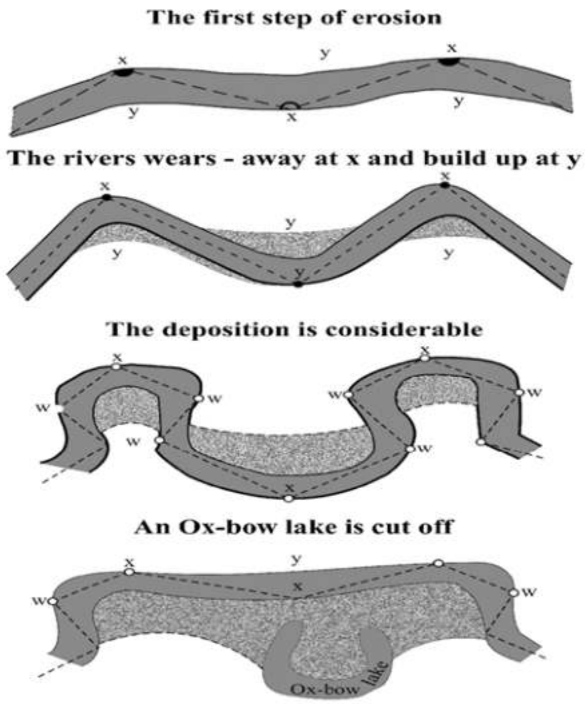

Fig. 4.5 Stages in the Formation of a Oxbow lake

This lake gradually, turning into swamps disappears in course of time. Numerous such partially or fully filled oxbow lakes are marked at short distance from the present course of river like the Ganga. Upon entering a lake or a sea, the river deposits all the load at its mouth giving rise to the formation of a delta (See Fig. 4.7). Delta is a triangular relief features with its apex pointing up stream and is marked as a fan-shaped area of fine alluvium. The Greek letter (“) pronounced delta closely resembles the triangular delta of the river Nile. Some deltas are extremely large. The Ganga-Brahmaputra Delta is the largest delta in the world.

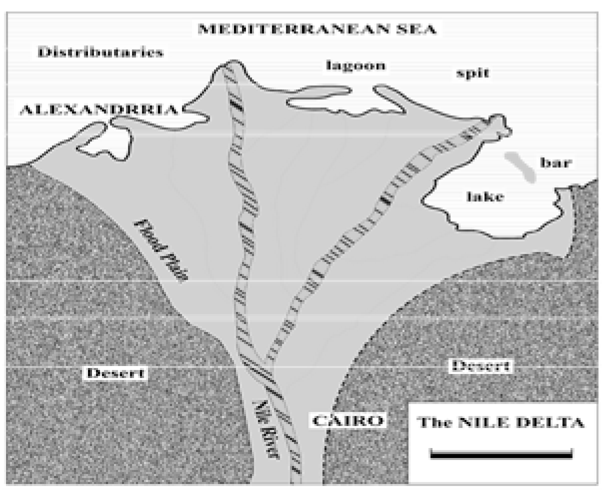

Fig. 4.6 Formation of a Delta

The following conditions favour the formation of deltas:

(1) active vertical and lateral erosion in the upper course of the river to supply large amount of sediments;

(2) tideless, sheltered coast;

(3) shallow sea, adjoining the delta and

(4) no strong current at the river mouth which may wash away the sediments. Due to the obstruction caused by the deposited alluvium, the river discharge its water through several channels which are called distributaries. Some rivers emptying into sea have no deltas but instead they have the shape of a gradually widening mouth cutting deep inland. Such a mouth is called estuary. The formation of estuaries is due to the scouring action of tides and currents. But in most of the cases the original cause is the subsidence of the earth's crust in the area of the outlet. The two west flowing rivers of India, the Narmada and the Tapi do not form deltas. They form estuaries when they join the Arabian Sea.

In the lower course land features produced by river are meanders, flood plains, braided steam, oxbow lakes, deltas and estuaries.

4.3 WORK OF UNDERGROUND WATER

Seepage and water-holding capacity of the rock depend upon its space. If the rock is porous like sandstone, it will allow water to easily pass through it. Such rocks are called permeable rocks. On the other 'hand, if the rocks are not porous and do not allow water to pass through them, they are called impermeable rocks. However, if there are any cracks or joints in such rocks, water may pass through them.

Although the amount of underground water varies from one place to another, its role in shaping the surface features of the earth is quite important. Most of its work is confined to subsurface areas though it plays an important role on surface also.

4.3.1 Water table: WATER TABLE

The water table marks the upper surface of the saturated zone of the ground water, where pores are completely full of water. The zones or horizons of permeable and porous rocks which are fully filled with water are called the zones of saturation. The upper level of this zone, below which the rocks are completely saturated with water is called the underground water level or the water table.

4.3.2 Types of water table: OF WATER TABLE

The level of the ground water table always fluctuates. It is never the same in any area. The level of the water table is controlled by the nature of land surface, variation in the amount of rainfall and the character of the underlying rocks. Water table is generally higher in areas of high precipitation and also in areas bordering rivers and lakes. Water-table changes according to seasons. It is higher in rainy season and lower during summers. On the basis of the variability, the water-table is of two type: (a) The permanent water table and (b) The temporary water table.

(a) Permanent Water Table

When the water table is stable or static and never falls below a particular level, it is called the permanent water-table. It is not affected by seasonal change. Wells dug upto this depth provide water in all seasons. They are perennial wells.

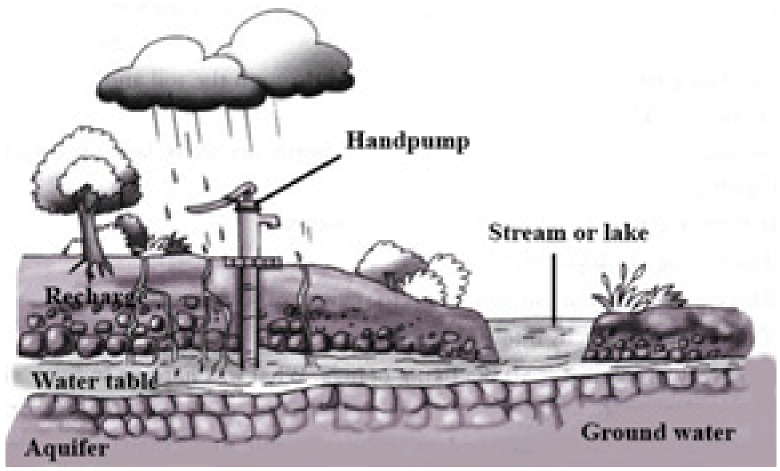

Fig. 4.7 Water Table

(b) Temporary Water Table

This is also known as seasonal water table. The level at which the water-table is not stable, keeps changing with season is called temporary water table. It means that during the wet season, the water table will be higher than it is during the dry season. It is the water table of the wet season that is temporary. Wells dug upto this level are not perennial. They dry up during the summer season. (See Fig. 4.7). You might have seen wells drying up during the summer season and becoming filled with water during the rainy season. It is because such wells are dug upto the temporary water-table.

Wells, Tube wells, and Artesian wells QUESTIONS 5.3

You must have seen wells and tubewells. They are man-made holes dug into the earth's surface through which underground water is drawn for drinking purpose and for irrigation. They are either bored mechanically as in the (case of tubewells) or are dug by man (as in the case of wells) to reach a permanent water table.

A special type of well in which water rises automatically under its own pressure to the surface, either through a natural or a man-made hole is called an artesian well. The name artesian has been derived from the province of Artoi in France, where the first well of this type was dug. Certain conditions are prerequisite of an artesian well.

(a) Arrangement of Rocks :

For an artesian well, there should be layer of permeable rock lying between two impermeable rock layers. In such case, water present in the permeable rock does not escape. (See fig. 4.8)

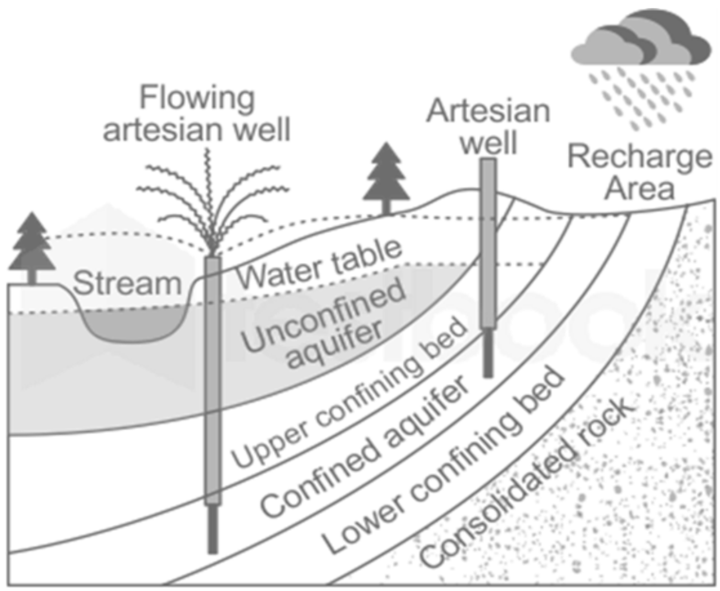

Fig 4.8 Artesian Well

(b) Structure of Rock Strata:

Second condition for the occurrence of artesian wells is that the rock must have a synclinal or tilted structure.

(c) Intake Area of the Rock:

It is necessary that the permeable rock should be exposed at the ground surface, so that rock can soak rainwater. This intake area should be sufficiently high so that enough hydraulic pressure will be developed to force the water upward in the well.

(d) Availability of Water:

There should be sufficient amount of precipitation of infiltration of water in the area where the permeable rock is exposed at the surface.

Springs and Geysers:

Springs are surface outflow of ground water through an opening in a rock under hydraulic pressure. In such cases the aquifer is either exposed at the surface or it underlies an impermeable rocks. The amount of water in the aquifer depends upon the amount of rainfall in that area, landform characteristic and the size of the aquifer. (See fig. 4.8)

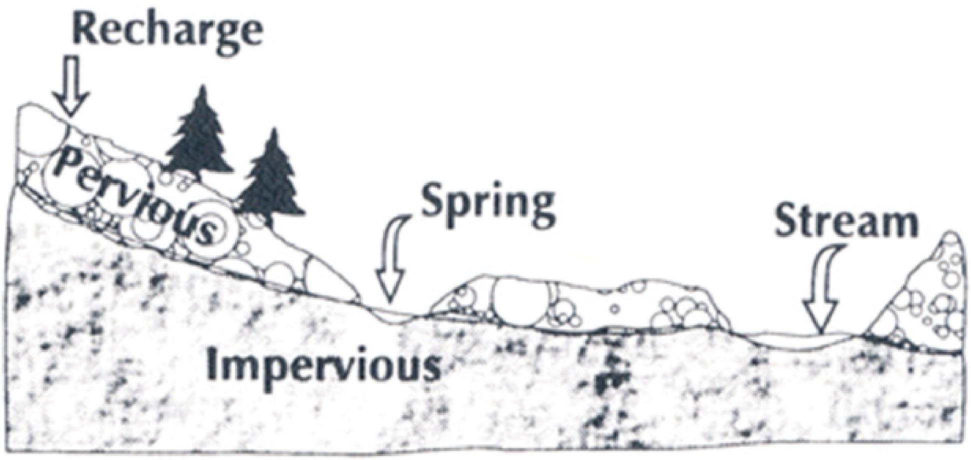

Fig. 4.9 Formation of Spring

(a) Hot Spring

Sometimes the water that flows out of the spring is hot. Such springs are called hot springs. They generally occurs in areas of active or recent vulcanism. In volcanic regions the underground water gets heated up by coming in contact with hot rocks or steam. Hot springs are found in many parts of India, especially in the Himalaya in Jammu and Kashmir and Himachal Pradesh. They also occur in Uttarakhand, Jharkhand, Haryana and Assam. Manikaran in Kulu Valley, Tatapani near Shimla, Jwalamukhi in Kangra, Sohna in Haryana, Rajgir and Sitakund in Jharkhand and Badrinath in Uttarakhand have hot springs (see fig 4.9).

(b) Geyser

Springs emitting hot water and steam in forms of fountains or jets at regular intervals are called geysers. The term geyser has been derived from Icelandic word geyser. In case of a geyser, hot water is ejected violently because of the pressure created by steam. The water does not come out continuously but it flows out intermittently. The period between two emissions is sometimes regular. The best example of geysers working at a regular interval is the Old Faithful in the Yellowstone National Park of U.S.A which is situated in the Rocky Mountain region. Its regularity is so accurate that tourists correct their watches by it. Geysers are found in Iceland, Yellowstone National Park of U.S.A and the northern part of New Zealand (See Fig. 4.10).

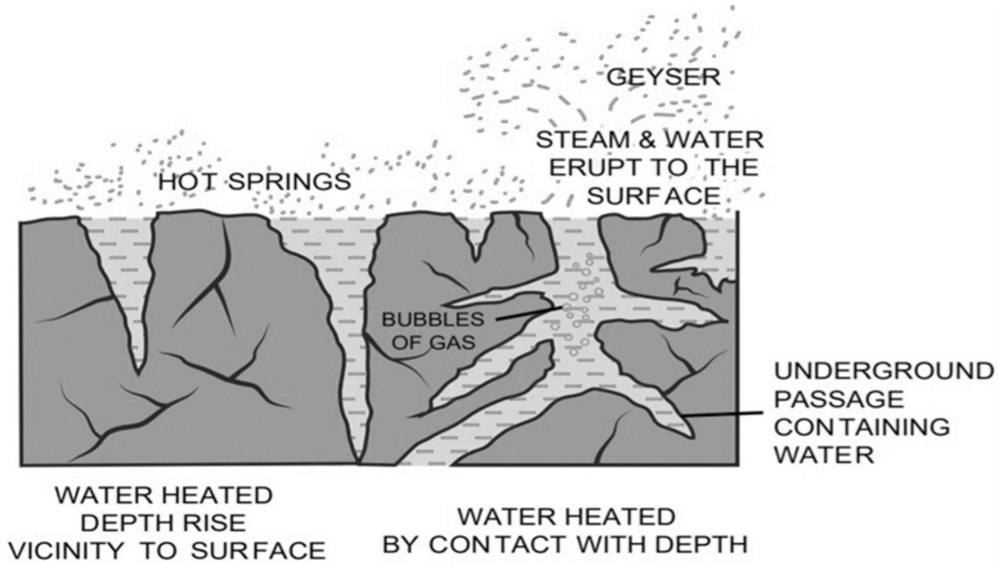

Fig. 4.10 Geyser.

4.3.3 Landforms Produced by Underground water:

Underground water is also an agent of gradation like surface water. It also does the work of erosion, transportation and deposition, which results in formation of a number of picturesque topographical features. Topographical features formed by underground water can be seen particularly, in an highland composed of limestone on a large scale. This distinctive topography formed due to the action of underground water in limestone region is known as Karst topography. 'Karst' word comes from the Karst region of Adriatic Sea coast in Croatia (Yugosalvia) where such formations are noticeable. This region is made up of limestone rocks, where underground water is the most active agent of gradation.

The topographical features created by the work of underground water on limestone are of two types.

(a) Topographical features formed on the surface, like sink holes and swallow holes.

(b) Topographical features formed underground like caverns, stalactites and stalgmites.

(i) Sink Holes

A sinkhole is a surface depression in a region of limestone or chalk terrain. Some sinkholes are filled with soil washed from nearby hillsides, while others are steepsided, dugholes. They develop where the limestone is more susceptible to solution, weathering or where an underground cover near the surface has collapsed.

(ii) Swallow Holes

They are cylindrical in shape lying underneath the sinkholes at some depth. In limestone regions, the surface streams often enter the sinkholes and then disappear underground through swallow holes. It is so, because these holes are connected to the underground caverns on their other side.

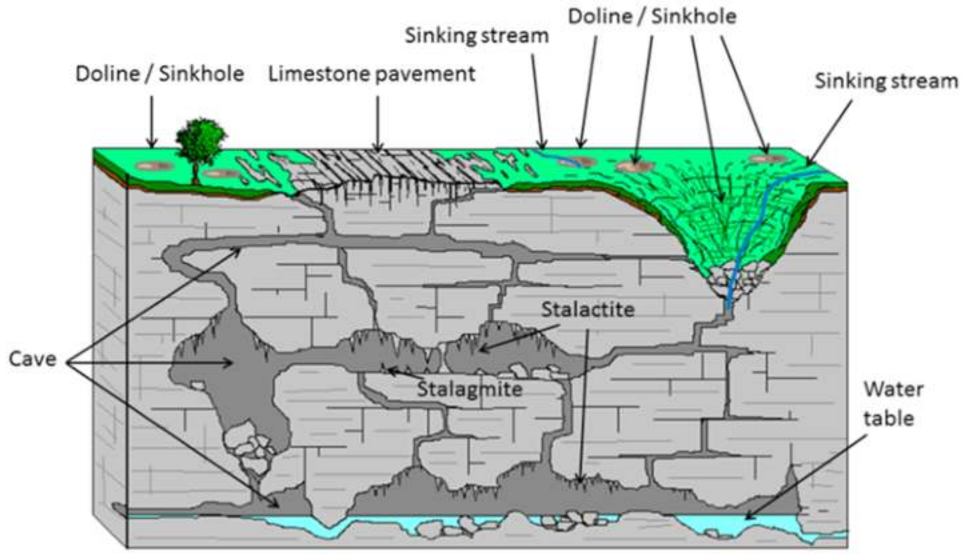

Fig. 4.11 Sinkholes, Stalactites and Stalagmites

(iii) Caverns

Caverns are interconnected subterranean cavities in bedrock formed by the corrosions action of circulating underground water on limestone. They are found near Dehradun in Uttarakhand and in Almora in Kumaon Himalayas. The caves of Kotamsar in the tribal district of Bastar in Chhattisgarh are famous caverns of India

(iv) Stalactites and Stalagmites

They are the major depositional features formed in the caverns in limestone regions. The water containing limestone in solution, seeps through the roofs of the caverns in the form of a continuous chain of drops. A portion of the water dropping from the ceiling gets evaporated and a small deposit of limestone is left behind on the roof. This process continues and deposit of limestone grows downwards like pillars. These beautiful forms are called stalactites.

818 × 490When the remain in portion of the water dropping from the roof of the cavern falls on the floor, a part of it is again evaporated and a small deposit of limestone is left behind. This deposit grows upward from the floor of the cavern. These type of depositional features are called stalagmites. As the process grows, both stalactite and stalagmite often join together to form vertical columns in the caverns.

Check Your Progress

(i) What are the works of River?

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(ii) What are the types of water table?

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4.4 WORK OF GLACIERS

A glacier is a moving mass of ice at speeds averaging a few meters a day. In region experiencing snowfall, the snow keeps on accumulating in layers one above the other. Its overlying pressure is applied to the underlying snow. It is so great that snow in lower layers becomes granular, hard and compact. The pressure also quickens the melting of some of the snow, which on refreezing starts turning into a granular ice. Again it is the pressure of the overlying layers which makes this solid mass of ice mobile. This great mass of ice moving more under its own weight is called a glacier. Its velocity is very low and it moves from a few centimetres to a few metres in a day.

4.4.1 Types of Glaciers

On the basis of their location or area of origin, glaciers are divided into two types:

(i) continental glaciers and (ii) valley glaciers.

(i) Continental Glaciers

A thick ice sheet covering vast area of land is called a continental glacier. The thickness of ice in such regions goes upto thousands of metres. Glaciers of this type build up at the centre and move outward in all directions. Continental glaciers of today are found mainly in Antarctica and Greenland. The precipitation in these regions occurs in the form of snow. It gets accumulated year by year because of relatively slower rate of its melting.

(ii) Valley Glaciers

When a mass of ice from the high mountainous regions starts moving down into the pre-existing valleys, it is called a valley glacier or a mountain glacier. The shape of the valley glaciers depends on the valley it occupies. Where the valley is broad, the glacier spreads outwards and where the valley is narrow, the glacier contracts. The longest glacier in India is the Siachen Glacier in Karakoram range which is 72 kilometres long. Gangotri Glacier in Uttarakhand is 25.5 kilometres long. There are many smaller glaciers in other parts of the Himalaya. Their length varies from 5 to 10 kilometres. The two important rivers of India, the Ganga and Yamuna, originate from Gangotri and Yamunotri glaciers respectively

4.4.2 Landforms Produced by Glaciers: PRODUCED BY GLACIER

Like running water and underground water, glacier also does the work of erosion, transportation and deposition. Although the zone of action of glaciers is rather limited, topographical features made by them are frequently found spread over even in areas once affected by glacial action. .

(A) Erosional work of glacier

As a glacier moves over the land, it drags rock fragments, gravel and sand along with it. These rock fragments become efficient erosive tools. With their help glacier scrapes and scours the surface rocks with which it comes in contact. This action of glacier leaves behind scratches and grooves on rocks.

The landforms created by glacial erosion are:

(i) Cirque (or Corrie)

Snow collects at the upper end in a bowl shaped depression, is called cirque. Layers of snow in the process of compaction and recrystallization are called firn. Sometimes the deepest parts of these hollows are occupied by accumulated-water, to form Corrie Lake (or Tarn).

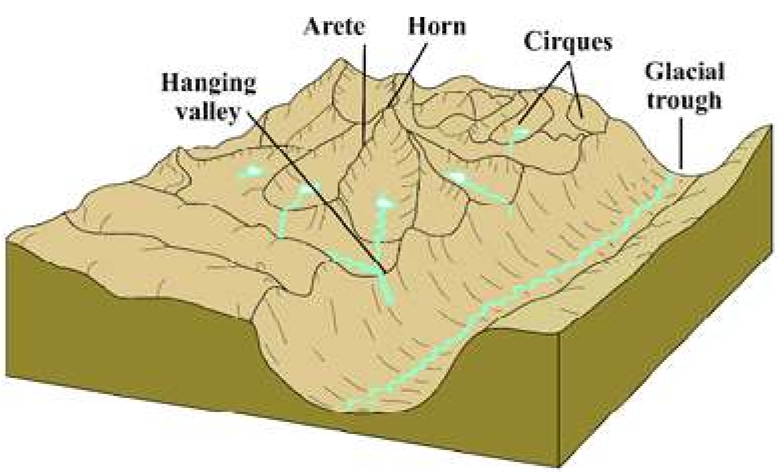

Fig. 4.12 Formation of glacier erosional landforms

(ii) ‘U’ - shaped Valley

The glacier does not carve a new valley like a river but deepens and widens a preexisting valley by smoothening away the irregularities. In this process the glacier broadens the sides of the valley. The shape of the valley formed in this manner resembles the letter ‘U’. It is therefore called a ‘U’ - shaped valley. (See Fig. 4.12). Such a valley is relatively straight, has a flat floor and nearly vertical sides.

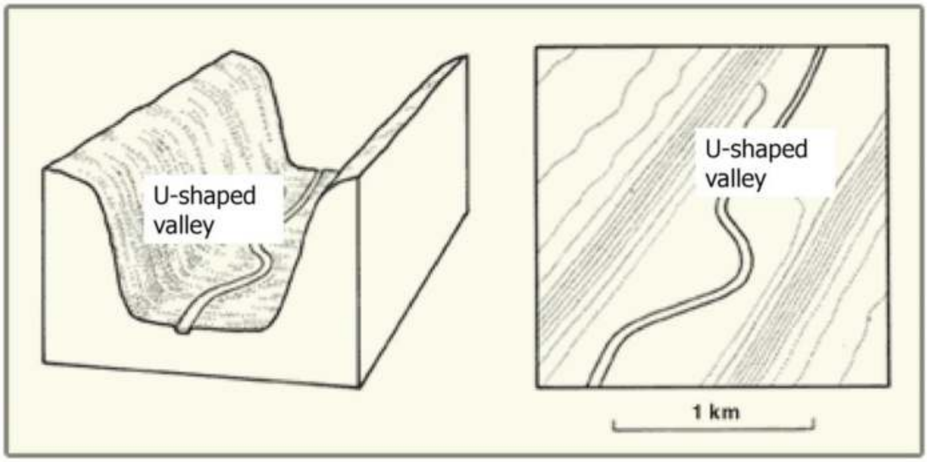

Fig. 4.13 U-shaped Valley

(iii) Hanging Valley

Just like tributary streams of river, there are tributary glaciers also which join the main glacier after moving over their mountainous path. These tributary glaciers like the main glaciers carve U - shaped valleys. However, they have less volume of ice than the main glaciers and thus their rate of erosion is less rapid. As a result their val1eys are smaller and not as deep as that of the main glacier. Due to this difference in deepening; the valley of the tributary glacier is left at a higher level than that of the main glacier. The val1ey of the tributary glacier just looks like hanging downwards at the point of its confluence with the main valley. This type of a topographical feature is cal1ed a hanging val1ey. This feature is visible when ice has melted in both the val1eys. (See Fig.4.12 and 4.13). When the ice in the hanging valley melts, a waterfall is formed at the point of confluence of this stream with the main river.

(B) Transportational work of Glacier

Although the glacier moves very slowly, it drags with it large boulders and rock fragments. Glacier gets this material from the mountain slopes, valley sides, valley bottom and from air. This material is called the load of glacier.

(C) Depositional work of Glacier

When the glacier melts or retreats, it deposits its load in different parts. The debris thus deposited are called moraines. Depending upon their location in the valley. moraines are of four types:- (i) terminal moraine, (ii) lateral moraine, (iii) medial moraine and (iv) ground moraine. (See fig. 4.14)

(i) Terminal Moraine : When the glacier melts, the debris are deposited at the end of the valley glacier in the form of a ridge. It is called terminal moraine. Morainic material ranges from fine clay to large angular boulders.

(ii) Lateral moraine: The moraine which is deposited on either side of a glacier is called lateral moraine.

(iii) Medial moraine: When two glaciers join each other their lateral moraines also join. Moraines thus formed on the confluence of two glaciers are called medial moraines.

(iv) Ground moraine: It consists of deposits left behind in areas once covered by glaciers. It is seen only after the glacial ice has disappeared by melting.

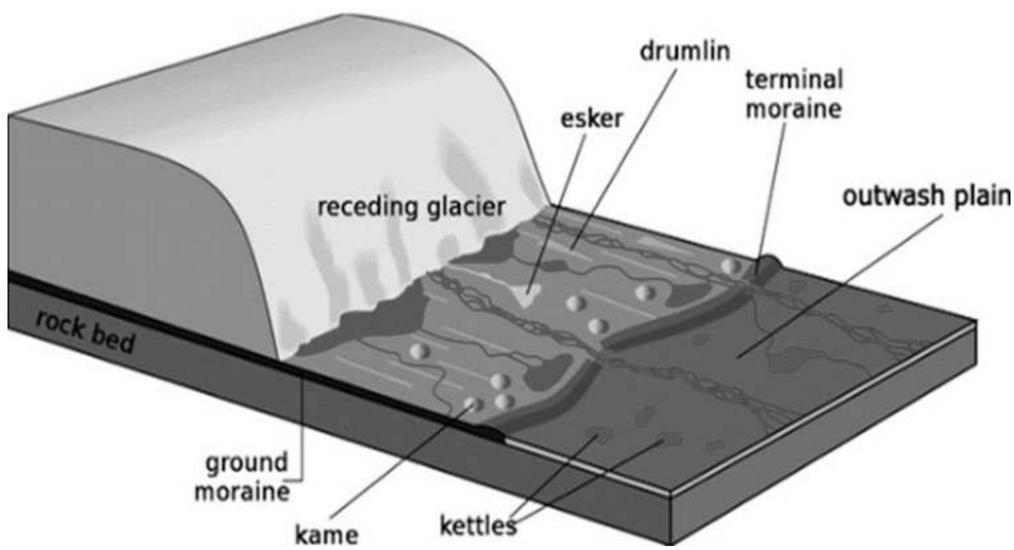

Fig. 4.14 A Glacier with Small Tributaries (showing moraines)

4.5 WORK OF WINDS

Wind is a powerful geological agent to create and destroy landforms. Wind is capable of eroding, transporting and depositing the surface materials. Aeolian landforms are features of the Earth's surface produced by either the erosive or constructive action of the wind. The word "Aeolian" is derived from "Aeolus", in Greek meaning, the god of the winds. In deserts, semi-arid and along sandy shorelines areas of the world where wind action moves sand and mineral particles when they are dry and the areas are without much vegetation or barriers.

4.5.1 Landforms produced by the Wind PRODUCED BY THE WIND

Circulation of air over the earth's surface cause the wind to blow. Wind action moves mineral particles when they are in a dry state and unprotected by a vegetation cover. These conditions are found in deserts and semiarid regions of the world, as well as on sandy shorelines.

(A) Wind Erosion

Wind performs three kinds of erosional work abrasion, attrition and deflation. Loose particles laying on ground surface may be lifted into the air or rolled along the ground by wind action. In the process of wind abrasion, wind drives sand and dust particles against an exposed rock or soil surface. When the wind borne material strike against each other, they are reduced in smaller particles. This process is known as attrition. The removal of loose particles from the ground is termed "deflation".

Landforms Produced by Wind Erosion

Some of the topographical features made by wind erosion are as follows:

(i) **Mushroom Rocks (Or Rock Pedestals):** When rocks, consisting of alternate hard and soft layers are subjected to wind abrasion, differential erosion results. The soft layers are easily eroded but the hard layer's resist erosion. As a result of undercutting near the base (due to greater amount of sand and rock particles being transported close to the ground), the resulting feature resembles a rock pillar shaped like a mushroom, It is aptly called rock pedestal or mushroom rock, Such formations are common in the Sahara Desert, and are also seen near Jodhpur. (See fig. 4.15)

Fig. 4.15 Mushroom Rock

(ii) Wind Eroded Basins: A land form produced by deflation is a shallow depression called a "blowout". The Quattara depression in Egypt is perhaps the finest example of such a hollow.

Fig. 4.16 Wind Eroded Basin

(iii) Yardangs: Yardangs are elongated ridges formed wind oriented with the prevailing winds. Yardangs are larger hill-sized features sculpted by the wind. Yardangs are composed of cohesive silts and clays, sandstone, or limestone. They develop in regions with strong unidirectional winds.

(B) Wind Transportation

Wind is an important agent of transportation in the arid region. The transported material is sometimes deposited in areas very far away from the place from where the dust particles have been picked. Winds blowing from Gobi Desert carry dust to the northern parts of China. In our country also winds blowing from Thar Desert bring dust particles to western Uttar Pradesh and the adjoining parts of Haryana & Punjab. This transported material is deposited in the fertile plains of Uttar Pradesh.

(C) Wind Deposition

Under certain conditions, the material transported by wind starts getting deposited at a particular site along its running track. The conditions favouring it are: (i) When the amount of dust particles present in the air exceed its carrying capacity, a part of the material being transported is deposited. This is the material which is in excess of the transportation capacity of the wind. (ii) When the speed of the wind is reduced, its carrying capacity is also reduced. The material in suspension is thus deposited. (iii) When an obstruction comes in the path of the wind, air has to rise above this obstruction. When it rises, the velocity of the wind is reduced and it starts dropping its load. This material is deposited in the form of a mound at the foot of the obstruction.

Some of the topographical features made by wind deposition are as follows:

(i) Sand Dunes

Sand dunes are a special feature of the desert regions. They are of different types and have a variety of shapes. The major factors affecting their formation are (a) amount of sand available (b) direction and force of wind, (c) an obstruction in the path of the wind e.g. a bush, a stone or a dead animal. As long as the wind is strong enough to carry the sand, the sand dunes are mobile and they keep on shifting from one place to another. If vegetation or a line of trees starts growing on the dunes they become fixed. They also become stationary when they are blocked by a hillock. In case there is no such obstruction, sand dunes may bury agricultural land, plains and settlements. There are two main types of sand dunes:

Types of Sand dunes

Some of the major types of sand dunes are;

a. **Barchan -** They are crescent (half-moon) or arc-shaped, appear convex in shape and are primarily formed by wind from one direction. Most common type of sand dune and found in sandy deserts all over the world. Two "horns" face downwind on this type of dune, with the steeper slope known as the slip face facing away from the wind.

b. **Transverse dunes-**Transverse dunes are asymmetrical in shape, and from where light to moderate winds blow from a constant direction. These dunes take the shape of a series of crests and troughs whose peaks are perpendicular to the direction of prevailing winds. These dunes appear like sea waves.

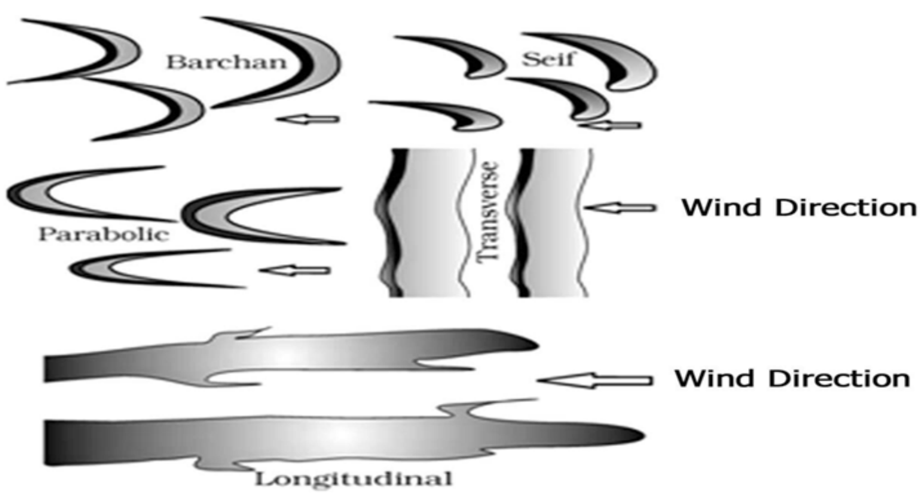

Fig. 4.17 Wind deposition landforms

c. **Seif or longitudinal dunes-** They are long narrow ridges that are parallel to the direction of prevailing winds. The winds come from different directions. The winds blow straight along the corridors between the lines of sand dunes and sweep the corridors clear of sand. Narrow rows elongated which could be many hundred kms long but their troughs the lower portion is almost without sand and some can reach height up to 100 mts. Such types are commonly seen in the Sahara Desert, North Africa, Arabia and can also be seen in western part of the Thar desert of India.

d. **Loess:** In several large areas of the world, the surface is covered by deposits of wind transported silt that has settled out from dust storms over many thousands of years. This material is known as loess. Loess tends to break away along vertical cliffs whenever it is exposed by the cutting of a stream or grading of a roadway. It is also very easily eroded by running water and is subject to rapid gullying when the vegetation cover that protects it is broken. The thickest deposits of loess are in northeast china, where a layer over 30m deep is common and a maximum thickness of 100m has been measured. Besides China, deposits of loess occur in Mississippi Valley of North America and north of Central European Upland in Germany, Belgium and France. Loess deposits are found in Austalia also.

(i) What are the types of glaciers?

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(ii) Mention the different types of sand dunes made by wind deposion?

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4.6 WORK OF SEA WAVES

The coastal zone is the part of the land surface influenced by marine processes and formed by the sea waves near by the sea. It extends from the landward limit of tides, waves, and windblown coastal dunes, and seaward to the point at which waves interact significantly with the seabed.

4.6.1 Landforms produced by Sea waves5 Landforms Produced by Sea Waves

We are aware of the fact that the water in the oceans is never at rest. The tides, waves and ocean currents contribute to the restlessness of ocean. Their continuous effect on coast creates a number of relief features. The work of sea waves as an agent of gradation includes erosion, transportation and deposition. A number of topographical features are made through these actions of waves. Such features are found in the coastal regions. Let us study the work of sea waves in some more details.

(A) Sea waves Erosion

Sea waves have a great erosive force. In their role of an erosional agent they perform four functions. When the sea water loaded with rock fragments and sand attack the coastal rocks it is called *abrasion*. The rock particles present in the water hit against each other and break into progressively smaller particles.

This process is called *attrition*. Thirdly the broadening of cracks and crevices in the cliffs along the coast due to the attack of the sea waves is called the hydraulic action. The rocks made up of limestone are subjected to *solution action* by the sea waves. All these processes help in formation of new features on the coastal margins.

Landforms Produced by sea Wave Erosion

Waves, like streams erode the coastal rocks with the help of rock fragments present in the water. Due to the continued erosion by waves, the coastline keeps retreating and a number of topographical features are formed in the process. Some of the important features made through sea wave erosion are mentioned here:

(i) **Sea Cliff:** The maximum impact of the sea waves is observed on the lower part of the coastal rocks and consequently the lower part of the rocks is eroded more rapidly than the upper part. This results in the formation of a hollow under the rock and with the passage of time this excavation in the lower part of the rock keeps on becoming larger.

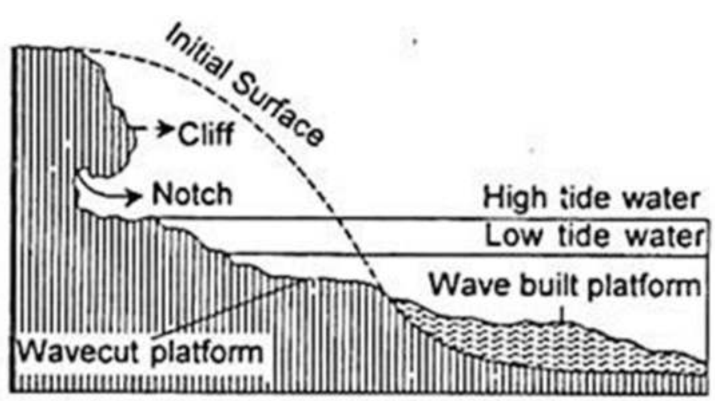

Fig. 4.18 A Sea Cliff

The upper part of the rock is thus left projecting out towards the sea. After sometime, this projecting part fall into the sea under its own weight. As a result a vertical wall is left. This vertical wall is called a cliff. In India a number of sea cliffs are found along the Konkan Coast of India.

(ii) Sea Caves: When the upper part of the coastal rock is hard and the lower part is soft, the erosion is not uniform. The lower part of the rock in such circumstances is eroded much faster than the upper part. Due to differential erosion a hollow is created in the lower part of the rock. When the waves pound against this hollow, air present in the hollow gets compressed. When the wave comes out of the hollow, the pressure on air is also released and it expands. Due to continuous compression of the air in the hollow, the rocks are subjected to a great pressure and they break. In this process, the hollows in the lower part of the rock keep on enlarging. With ***Changing face of the*** passage of time they attain the form of caves and are known as sea caves. Forma- ***Earth*** tion of caves depends upon the nature of the coastline and the force of the waves.

(iii) Sea Arches: When a part of coast extends to some distance into the sea, sea waves working from opposite directions cut a passage through the soft rocks. In the initial stages, this passage is a narrow hole but it enlarges into a broad arch. These broad doorlike features are called sea arches or natural bridges.

(iv) Sea Stacks: When the roof of an arch is broken by erosion or under its own weight or due to any other reason a part of the original rock remains standing as a solitary mass. It may be the rock forming the side of the arch. This type of a feature is called a seastack. Stacks are of a number of types depending upon their shape and the nature of the rocks. Sometimes they take the shape of islands but such islands are not permanent. Small underwater stacks are known as stumps (see fig 4.19).

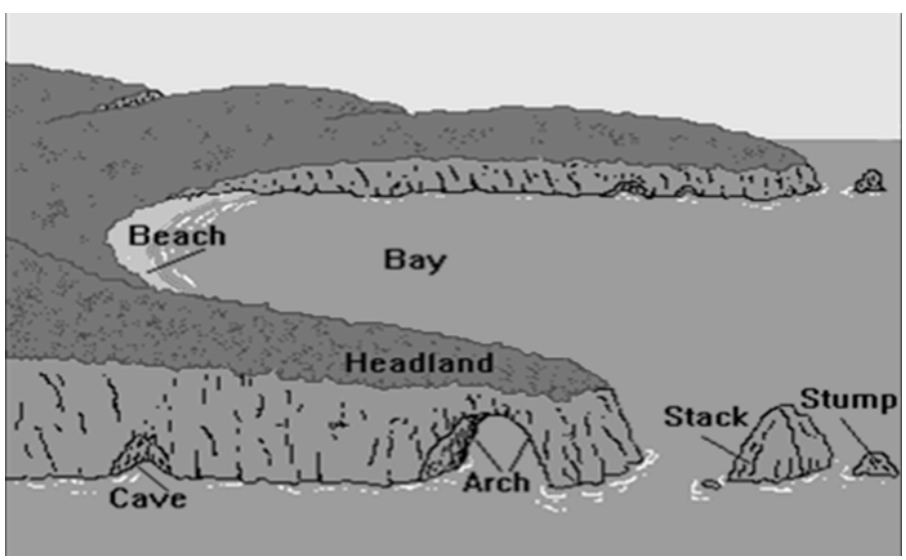

Fig. 4.19 Topographical features made through wave erosion

(B) Sea Waves Transportation

Sea waves, currents and tides are the main agents of transportation of eroded material in the coastal regions. However, the role of waves is more important in connection with the formation of coastal relief features. The material deposited on the coasts by the rivers and glaciers etc. is removed and transported by the waves. Transportation by sea waves is carried out in two ways: (i) Removal and transportation, towards the sea, of the material deposited by river etc. on the coast. (ii) Carrying of material found in the sea to the coastal areas. During this process, the oceanic materials like pearls, conches and other shells are brought to the coast.

(C) Sea Waves Deposition

Sea waves are helpful in the deposition of the material eroded from the coastal areas. Oceanic current are also helpful in deposition of the transported material. Deposition of the material along the coast is selective. The larger particles are deposited first therefore they are found near the coast. On the other hand, the finest particles are deposited last and they are deposited generally away from the coast. This selective deposition is sometimes altered or affected by a change in the intensity or force of the waves. Thus it is sometimes possible to find very fine particles deposited near the coast where generally larger particles are deposited. A number of topographical features are formed due to deposition by waves and currents. Some of these topographical features are discussed here:

(i) **Beach:** Most of the material eroded and picked up by the waves is deposited near the coast. Due to this deposition, the sea becomes shallow and a part of the coastal area is raised above the water level. This raised portion is almost like a flat plain of a platform formed of gravel and sand. This type of depositional features along the coast is called a beach. Beaches are centres of tourist attraction. Marina Beach of Chennai and Kovalam Beach of Thiruvananthapuram are the famous beaches of India.

(ii) **Sand Bar:** Sometimes the deposits of sand and gravel laid down by waves and currents form embankment, separating shoreline from the sea. They thus form barriers between the sea and the mainland. Such deposits are called sand bars. They sometime pose difficulties in navigating.

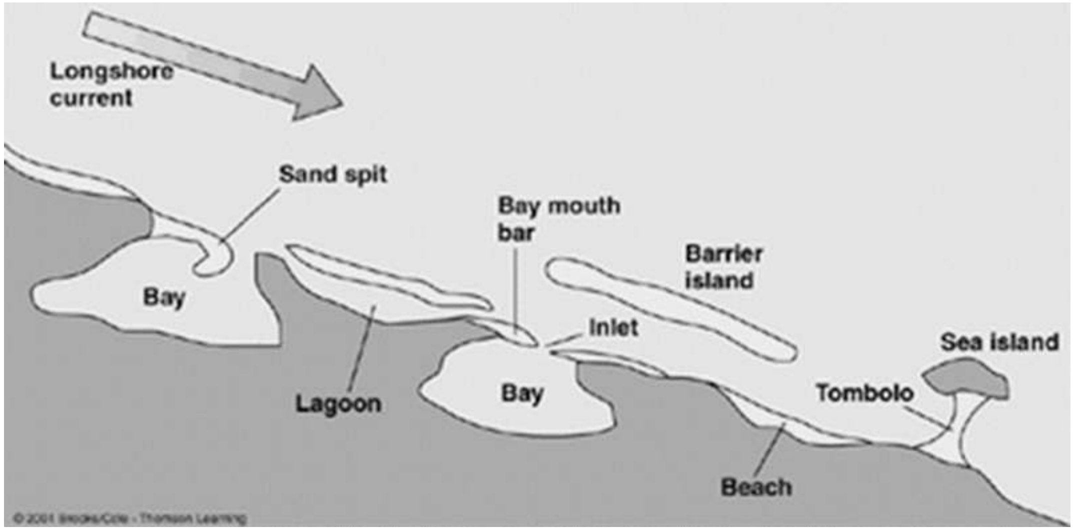

Fig 4.20 Sand Bar and Spit

(iii) Spit *Earth:* When one end of a bar is attached to the coast and other extends into the sea, it is called a spit. These spits are formed by the accumulation of materials brought by waves like sand and gravel.

(iv) Lagoon: Sometimes due to deposition of waves and currents both the ends of the bar join to enclose a part of the sea water between the coast and the bar. This enclosed part of the sea forms a lake of saline water. This saline water lake is called a lagoon (sea fig 4.20).

Sometimes the lagoons are formed due to wave erosion also. A lagoon is generally connected with the sea through a narrow passage. The Chilka and Pulicate lakes on the north-eastern coast and lake Vembanad on Kerala coast are examples of lagoon lakes in India.

(i) What are the works of sea waves?

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(ii) Bring out the various depositional landforms made by sea waves?

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4.7 Summary

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 land features produced by river erosion are gorges, canyons, rapids, waterfalls. The middle course lies at the junction of mountain and plains. The water which percolates inside the earth is called underground water. The upper limit of underground water is called water-table. Underground water comes to the surface through wells, tubewells and springs Sometimes the water flows out of springs is hot, such springs are called hot springs.

The areas with permanent snow cover are called snow-fields. Snow-fields are found always above the snowline. Snowline is that line above which the snow never melts completely. Moving ice is called a glacier. They are of two types- continental glaciers and valley glaciers. Glaciers do the work of erosion, transportation and deposition through which a number of topographical features are formed. The major topographical features of glacial erosion are the 'U' -shaped valleys and hanging valleys. Wind like running water, moving ice and underground water, is an important agent of gradation. Action of wind is more effective in arid and semi-arid regions. Wind erodes the rocks, transports the broken material and deposits it in different areas. These three actions of wind are known as erosion, transportation and deposition The most important agent shaping coastal landform is wave action. The important ***Earth*** works of waves are the breaking up of the rocks, removal of broken material and laying down of this material in different parts of the coastal areas. These three actions of waves are called erosion, transportation and deposition. The landforms in coastal areas are sea cliff, sea caves, arches and stacks, sand bars, tombolo, lagoons etc.

4.8 Check Your Progress – model answers

(i) Rivers performs three actions. They are erosion, transportation and deposition.

(ii) On the basis of the variability, the water-table is of two type: (a) The permanent water table and (b) The temporary water table.

(iii) On the basis of their location or area of origin, glaciers are divided into two types: (a) continental glaciers and (b) valley glaciers.

(iv) Types of sand dunes include barchans, seifs, traverse dunes, loess etc.

(v) Works of sea waves in coastal regions are erosion, transportation and deposition.

(vi) Depositional land forms of sea waves in coastal regions are beach, sand bar, spit, lagoon etc.

4.9 Terminal Questions

1. Which are the three functions of a river?
2. What name is given to the rock material carried away by a river?
3. In which province of France was the first artesian well dug?
4. In which country is Old Faithful geyser located?
5. In which country is "Karst" region located.?
6. What is the name given to a moving mass of ice and snow?
7. How many types of glaciers?
8. In which region is the work of wind more effective?

4.10 Further readings

- Alka Gautum (2015), Geomorphology, Sharada Pustak Bhavan, Allahabad, Uttar Pradesh, India.
- Geography, Senior Secondary Course, NIOS, Noida, India.
- Geography Text Book, NCERT, India

Chapter - 5

ELEMENTS OF WEATHER AND CLIMATE

Contents

5.0 Introduction

5.1 Objectives

5.2 Weather and Climate

5.3 Factors affecting the Climate

5.4 Elements of Weather and Climate

5.5 Summary

5.6 Check Your Progress – Model answers

5.7 Terminal Questions

5.8 Further readings

5.0 Introduction

Elements of weather have an important effect on our lives. houses, clothes and the food mainly depend on weather and climatic conditions.

5.1 Objectives

After studying this lesson, you will be able to:

- name the various elements of weather and climate;
- differentiate among weather, season and climate;
- explain the need for forecasting weather in advance;
- explain with specific example the various factors affecting the climate of a place or region;

5.2 Weather and Climate

5.2.1 Weather

Temperature, pressure, wind, humidity and precipitation, interact with each other. They influence the atmospheric conditions like the direction and velocity of wind, amount of insolation, cloud-cover and the amount of precipitation. These are known as the elements of both weather and climate. The influence of these elements differs from place to place and time to time. It may be restricted to a small area and for a short duration of time. We very often describe this influence in the name of weather as sunny, hot, warm, cold, fine, etc depending upon the dominant element of weather at a place and at a point of time.

Weather Forecast

It is important to know by some means the coming weather in advance. You may be planning to go on a hike without knowing that the particular day may be rainy. Farmers, sailors, aviators, tourists and many others are interested to know the weather conditions in advance for their own benefits. Now, better weather forecasts are available with the use of weather satellites.

The weather office collects data on temperature, wind, cloud cover, rainfall and other atmospheric phenomena through its numerous observation centres. These centres are scattered all over the country. Similar information is also received from the ships sailing in the high seas. The analysis of these data thus collected, helps in forecasting weather conditions for the next 48 hours or even for a week.

Season

A year is divided into seasons depending upon variations in atmospheric conditions. They are specified periods in a year which have similar weather conditions. Season is a period of the year characterized by a particular set of weather conditions resulting from the inclination of the earth's axis and the revolution of the earth round the sun. The same cycle of season is repeated year after year. Four seasons, each of three months duration have been recognized in temperate regions. They are spring, summer, autumn and winter. In our country, we have three distinct seasons which are summer, winter and rainy.

The Indian Meteorological Department has recognized four main seasons. They are:

(1) Cold weather season (December to February.)

(2) Hot weather seasons (March to May)

(3) Advancing monsoon season or rainy season (June to September.) and.

(4) Retreating monsoon season (October to November.)

Traditionally there are six seasons in north India. They are

(1) Basant Ritu (Chaitra- Vaisakh or March-April),

(2) Greeshm Ritu (JaysthaAsharh or May-June),

(3) Varsha Ritu (Shravan-Bhadrapad or JulyAug.),

(4) Sharad Ritu (Aswina-Kartika or Sept - Oct.),

(5) Hemant Ritu (Margashirsh-Posh or Nov-Dec.) and

(6) Shishir Ritu (MaghFalgun or Jan-Feb.)

The rays of the sun are more or less direct on the equator throughout the year. Hence, equatorial regions experience the same temperature all the year round. Therefore, seasons are insignificant on or near the equator. Near the coast, the oceanic influence reduces the seasonal variations. In the Polar Regions, there are only two seasons i.e. long winter and short summer.

5.2.2 Climate

The average weather conditions, prevalent from one season to another in the course of a year, over a large area is known as climate. The average of these weather conditions is calculated from the data collected for several year (about 35 years) for a larger area. Rajasthan, for example, experiences hot and arid climate, Kerala has tropical rainy climate, Greenland has cold desert climate and the climate of Central Asia is temperate continental. Climate of a region is considered more or less permanent.

- ❖ Weather is the atmospheric condition of any place for a short period of time with respect to its one or more elements such as temperature, pressure, wind, humidity, precipitation, sunshine, cloud cover etc.
- ❖ The periods of the year which are characterised by particular set of weather conditions are mainly caused by the inclination of the earth's axis and the revolution of the earth around the sun, are known as seasons.
- ❖ The average weather condition of a large area for the past several years is known as its climate persisting more or less permanent.

The difference between weather and climate can be tabulated as under

Weather	Climate
(1) Weather is the study of atmospheric conditions for short duration of a limited area.	(1) Climate is the study of the average weather conditions observed over a long period of time for a larger area.
(2) Weather is influenced by anyone of its predominant elements i.e., temperature, rainfall or humidity.	(2) Climate is the collective effect of all its elements.
(3) The weather changes very often	(3) It is more or less permanent.
(4) It is experienced over small areas of a country.	(4) It is experienced over large area of the continent.
(5) A place can experience different types of weather conditions in a year.	(5) A place can experience only one type of climate.

5.3 FACTORS AFFECTING CLIMATE

Different regions of the world have differences in temperature, humidity and precipitation. These differences influence the lifestyle of the people living under different climatic conditions. To understand different climatic conditions, let us discuss the factors which cause the variations in the climate of a place or a region.

1. Latitude or Distance from the Equator

The places near the equator are warmer than the places which are far away from it. This is because the rays of the sun fall vertical on the equator and slanting in the temperate and polar regions.

2. Altitude or the Height from the mean sea level

We all know that mountains are cooler than the plains. Shimla situated on a higher altitude is cooler than Jalandhar, although both are almost on the same latitude. The temperature decreases with the height of a place. For a vertical rise of 165 metres there is an average decrease in temperature at the rate of 1°C.

3. Continentally or the Distance from the Sea

The water is a bad conductor of heat i.e. it takes longer time to heat and longer time to cool. Due to this moderating effect of the sea, places near the coast have low range of temperature and high humidity. The places in the interior of the continent do not experience moderating effect of the sea. These places have extreme temperatures. The places far from the sea have higher range of diurnal (daily) and annual temperatures.

4. Nature of the Prevailing Winds

The on-shore winds bring the moisture from the sea and cause rainfall on the area through which they pass. The off-shore winds coming from the land are dry and help in evaporation. In India, the on-shore summer monsoon winds bring rains while off-shore winter monsoon winds are generally dry.

5. Cloud Cover

In areas generally of cloudless sky as in deserts, temperature even under shade are very high because of the hot day time sunshine. At night this heat radiates back from the ground very rapidly. It results in a large diurnal range in temperature.

6. Ocean Currents

Ocean waters move from one place to another partly as an attempt to equalize temperature and density of water. Ocean currents are large movements of water usually from a place of warm temperature to one of cooler temperature or vice-versa.

7. Direction of Mountain Chains

The mountain chains act as natural barrier for the wind. The on-shore moisture laden winds are forced to rise after striking against the mountain; and give heavy rainfall on the windward side. These winds descending on the leeward side cause very low rainfall.

8. Slope and the Aspect

The concentration of heat being more on the gentler slope raises the temperature of air above them. Its lesser concentration along steeper slopes lowers the temperature. At the same time, mountain slopes facing the sun are warmer than the slopes which are away from the sun's rays. The southern slopes of Himalaya are warmer than the northern slopes.

9. The Nature of the Soil and Vegetation Cover

The nature of soil depends upon its texture, structure and composition. These, qualities vary from soil to soil. Stony or sandy soils are good conductor of heat while black clay soils absorb the heat of the sun's rays quickly. The bare surface reradiates the heat easily. The deserts are hot in the day and cold in the night. The forest areas have lower range of temperature throughout the year in contrast to non-forested areas.

The factors which affect the climate of a place or region are latitude or the distance from the equator, altitude or the height from the mean sea level, continentality or the distance from the sea, nature of the prevailing winds, ocean currents, direction of mountain chain, slope and its aspect, nature of soil and the vegetation cover.

The varied effect of the major weather elements in different parts of the world and also the varied nature of the earth's surface give every location a distinct climate.

Check Your Progress

(i) What is weather?

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(ii) Difference between weather and climate?

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5.4 Elements of Weather and Climate

Weather is nothing more than the different elements it is composed of, as well as the way they interact with each to create different atmospheric conditions or weather events. We first need to identify what the elements are that make up the weather. Eight primary elements/factors drive all weather:

1. **Temperature:** Temperature is a measurement of the amount of kinetic energy present in the air, which manifests itself physically through the experience of heat or cold. It is because we are so sensitive to temperature and quickly become aware of feeling cold or hot.

2. **Air (Atmospheric) Pressure**: Air Pressure is the result of the pressure created by the weight of the air in the Earth's atmosphere. It comes to creating or changing atmospheric conditions. It is also one of the critical variables used to make accurate weather forecasts.

3. **Wind (Speed & Direction)**: Wind is the large-scale movement of air from an area of high to an area of low pressure in the atmosphere. The majority of major and even extreme weather events like cold & warm fronts, clouds, thunderstorms, and hurricanes are all driven by wind.

4. **Humidity:** Humidity is the amount of water vapour that is present in the atmosphere at any specific time. It not only plays a big part in weather formation but also directly influence our physical comfort levels.

5. **Precipitation:** Precipitation is water in all its different states, which formed after condensation turned water vapour into its solid form, which falls to the ground after it becomes too heavy to stay suspended in the air. Precipitation can take the form of rain, snow, hail, or graupel. Humans, animals, and plants need water to grow or stay alive, and precipitation is the only way to replenish the dams, rivers, reservoirs, and groundwater on which we rely.

6. **Visibility:** Visibility is the measurement of the degree through which an object can be observed over a certain distance. Visibility may seem like a very unlikely element of weather, but is especially important when discussing and measuring weather conditions like fog, mist, freezing drizzle, and smog.

7. **Clouds (Type & Cover) :** Clouds are water droplets or water in different states (like ice and snow crystals), which formed after water vapor reached condensation level and could no longer remain in gaseous form. Clouds are one of the quickest ways to determine current and future weather conditions. Studying them in more detail with scientific equipment is very valuable to make very accurate assessments of present and feature atmospheric conditions.

8. **Sunshine Duration:** Sunshine duration is the length of time the Earth's surface is directly exposed to solar radiation. The amount of sunshine the Earth receives (which is a characteristic of solar radiation) greatly influence other elements of the weather like ambient temperature, and more indirectly humidity and air pressure.

Check Your Progress

(iii) Mention the elements of weather?

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(iv) Define sunshine duration?

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5.5 Summery

The difference among weather, season and climate is that of duration, extent and permanency. Weather is the atmospheric condition of a place for a short period of time with respect to one or more of its elements. It is not permanent. Season is the period of a year which is characterized by a particular set of weather condition. It is mainly caused by the inclination of the earth's axis and revolution of the earth round the sun. Its cycle is repeated year after year. Climate is the average weather conditions of a large area for the past several years. It is more or less permanent. Climate of any place or region is affected by several factors, such as distance from the equator, ocean currents, and direction of mountains. Slope and aspect, soil and vegetation cover etc.

5.6 Check Your Progress- Model answers

(i) Weather is the atmospheric condition of any place for a short period of time with respect to its one or more elements such as temperature, pressure, wind, humidity, precipitation, sunshine, cloud cover etc.

(ii) The average weather conditions, prevalent from one season to another in the course of a year, over a large area is known as climate. The average of these weather conditions is calculated from the data collected for several year (about 35 years) for a larger area.

(iii) Weather is nothing more than the different elements it is composed of Temperature, Air Presure, Wind direction, Humidity, Prespitation, Visibility, Clouds, Sunshine duration

(iv) Sunshine duration is the length of time the Earth's surface is directly exposed to solar radiation. The amount of sunshine the Earth receives (which is a characteristic of solar radiation) greatly influence other elements of the weather like ambient temperature, and more indirectly humidity and air pressure.

5.7 TERMINAL QUESTIONS

Long Questions

1. Differentiate between weather and climate?
2. What are the factors that affect the climate of a region?
3. What are the elements of weather and climate? Explain.

Short Questions

4. Definition of Climate and weather.
5. Mention main seasons of India?
6. What are the six traditional seasons of India?

Very Short questions:

7. Weather forecast
8. Seasons
9. Precipitation

5.8 Further Readings

- Fundamentals of Physical Geography, Class XI NCERT Geography text book
- https://diksha.gov.in/nios

  Physical Geography B.A. Text Book by Telugu Academy, Hyderabad

Chapter - 6

COMPOSITION AND STRUCTURE OF ATMOSPHERE

Contents

6.0 Introduction

6.1 Objectives

6.2 Atmosphere

6.3 Composition of Atmosphere

6.4 Structure of Atmosphere

6.5 Summery

6.6 Check Your Progress – Model Answers

6.7 Terminal Questions

6.8 Further Readings

6.0 Introduction

Earth is the only known planet in the universe where life exists due to the presence of air and water. Both have noteworthy effects on our survival as they have different characteristics.

6.1 Objectives

After studying this lesson, you will be able to:

- Understand the composition of atmosphere
- Study the structure of atmosphere
- Explain the characteristics of atmospheric layers

6.2 ATMOSPHERE

Before discussing composition and structure of the atmosphere, let us know more about the atmosphere in general. We know that life is only possible on the Earth's surface. The main reason for this is the presence of air. Without any horizontal movement we can't feel the presence of air. The earth is surrounded by a gaseous envelope which acts like an air blanket on the earth 's surface. It is attached due to the gravitational force of the earth. This is known as the atmosphere. Earth is a green planet only due to its atmosphere, without this existence of water bodies, clouds and sound are not possible.

Atmosphere protects the earth from harmful solar energy such as ultraviolet radiation. It is a very important part of our fragile earth system which controls our various human activities by different processes. Earth receives solar energy through the atmosphere. The climatic phenomena such as temperature, air pressure, winds, moisture, clouds, precipitation, fog, frost etc. are occurring in lower atmosphere. Atmosphere plays a fundamental role in the distribution or redistribution of energy over the planet earth through energy exchange to each other.

In recent years, the changing environment of the earth's surface has contributed to changes in atmospheric composition in the form of undesirable concentration of carbon dioxide, high pollution levels, ozone depletion and global warming. Among all, global warming is a major cause of concern. However, all these problems are also a matter of atmospheric dynamics.

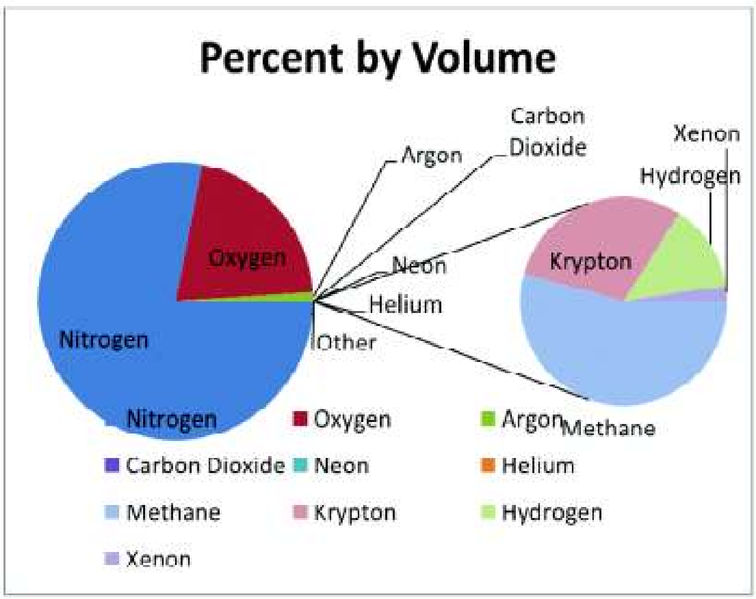
Among all of them global warming is major of concern in present scenario. Global warming is the result of greenhouse effect. It means the gradual increase in world-wide atmospheric warming due to accumulation of heat in lower atmosphere through the greenhouse gases like carbon dioxide (CO_2), Methene (CH_4), Chlorofluorocarbons (CFCs), Nitrous Oxide (N_2O), Ozone (O_3), water vapour. These phenomena are changing the composition of the atmosphere. We can better understand atmosphere, by knowing its composition.

6.3 COMPOSITION OF ATMOSPHERE

The atmosphere is made up of various gases, dust particles and water vapour. These are neither static nor spread uniformly in the atmosphere. We can find variation in their distribution according to altitude, latitude and seasons. The characteristics of three basic constituents' namely, gases, liquids and solids are as follows:

A. Gases Components

Gases of atmosphere are, broadly, divided into two groups i.e. permanent and variable gases. Nitrogen, Oxygen, Argon, Neon, Helium, Hydrogen, and Xenon are permanent gases and Carbon dioxide, Methane, Nitrous oxide, Ozone and Chlorofluorocarbons (CFCs) are variable gases. We can see their amount of concentration by percentages in the given figure. It shows Nitrogen and Oxygen are found in large amounts.



Gases	Percent by Volume
Nitrogen	78.08
Oxygen	20.95
Argon	0.93
Carbon Dioxide	0.0314
Neon	0.0018
Helium	0.0005
Methane	0.0002
Krypton	0.00011
Hydrogen	0.00006
Xenon	0.000009

Fig. 1 Composition of atmosphere

i. Nitrogen:

Nitrogen is very important for all life forms in the biosphere because it is an essential part of amino acids which makes up proteins. It helps in controlling combustion by diluting oxygen and also indirectly helps in oxidation.

ii. Oxygen:

Oxygen is a very active gas which combines with the majority of elements in the biosphere. Through the process of photosynthesis and respiration, it is exchanged between atmosphere and living organisms.

iii. Carbon Dioxide:

The role of this gas is very important in atmospheric processes because of its ability to absorb radiant heat. It is a vital greenhouse gas that taps earth's outgoing radiation and is causing global warming. Its percentage is increasing in the atmosphere due to increasing burning of fossil fuels such as wood, coal, natural gas, gasoline and oil etc.

iv. Ozone:

It is unevenly distributed and lies in between 20 km to 25 km of altitude. Ozone has a protective role in the atmosphere as it's essential for maintaining habitability of earth. It blocks the harmful ultraviolet radiation from the sun.

v. Methane:

Methane is a second most abundant greenhouse gas which is emitted from both anthropogenic (landfills, agricultural activities, coal mining, stationary and mobile combustion) and natural sources. Methane absorbs earth radiation quite efficiently. Its presence in the atmosphere affects the temperature and climate system of earth.

B. Liquid components

Water vapour is water in gaseous instead of liquid form. It is also the most important gas in the atmosphere. Some important facts about water vapour are as follows:

- Hydrosphere is the source of atmospheric water vapour.
- It changes their state from vapours (gas) into liquid (water) and liquid into solid (ice).
- Amount of water vapour varies in different regions. Maximum amount of water vapour present in the atmosphere is up to 4%.
- All forms of precipitation whether in liquid or solid are possible only by conversion of water vapour into the other forms.
- It also absorbs long-wave terrestrial radiation. Water vapour plays an important role in heat energy balance.

C. Solid components

Dust particles are made of fine particles of solid matter. It is found in the atmosphere. Its main significance is that they help in the formation of clouds, which in turn is important for precipitation and rainfall on earth.

Check your progress

(i) What do you mean by Atmosphere?

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(ii) Discuss about the Gases components?

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6.4 STRUCTURE OFTHE ATMOSPHERE

Atmosphere is multi-layer gases and it is a component of the Earth-environment system. The atmosphere can be divided into various vertical layers. These layers are distinguished from one another by temperature, chemical composition and related phenomena.

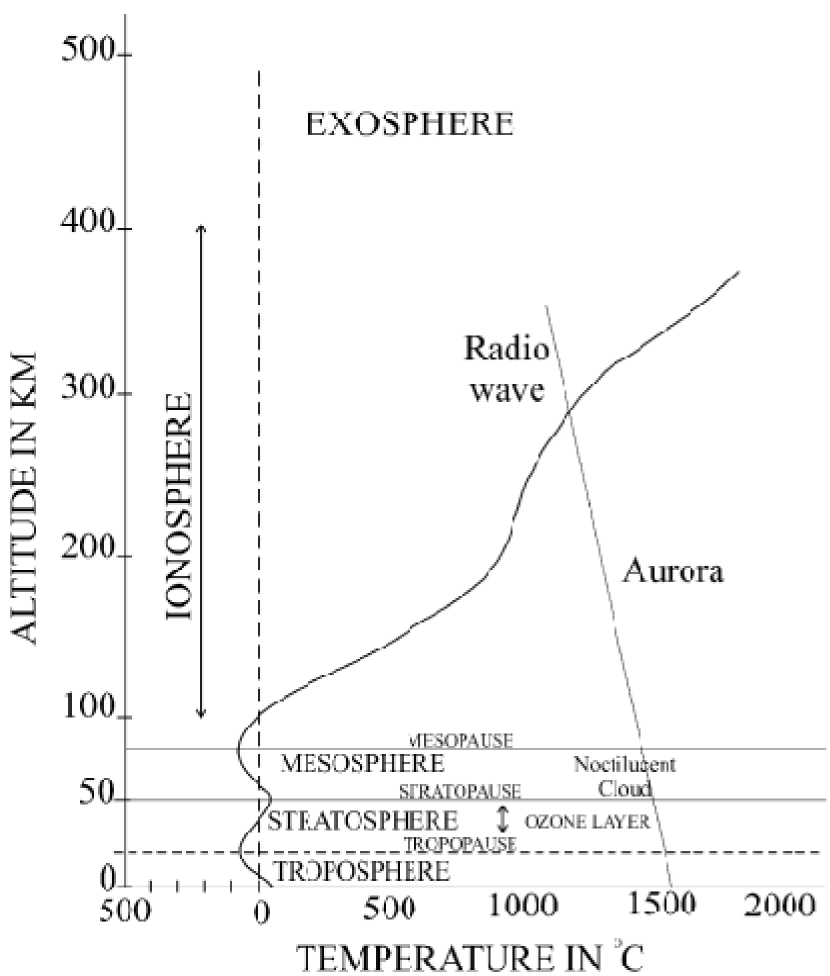

Fig. 2 Vertical Layer of Atmosphere

1. Troposphere

The Troposphere is the first and lowermost layer of the atmosphere. This layer contains about 75% of gaseous mass along with the concentration of pollutants. The average height of this layer is around 12 kms., which varies with latitude. The height of the troposphere is not constant as it is 16 kms. on the equator, whereas 8 kms. on the poles. On the equator, height of this layer is determined by the presence of conventional hot currents. The lowest temperature is observed in this layer with increasing height. Moreover, all types of climatic and weather phenomena take place within the troposphere. A gradual decrease in the temperature with height is 6.5°C per thousand metres. This phenomenon is known as "Normal lapse rate". As the gradual decrease in temperature stops, tropopause starts.

2. Stratosphere

The stratosphere extends from tropopause to a height of 50 kms. Thermal conditions of the lower part of the stratosphere are stable due to nonexistence of dust particles, water vapours and conventional current. It is known as an isothermal zone. This layer is considered ideal for flying aeroplanes because weather events do not take place. The Stratosphere covers about 24 % of the total air mass. As height increases, the temperature in the stratosphere increases due to the presence of ozone gas in the upper part of the layer. Without the Ozone layers, all living things could not exist on earth's surface. It protects us from the harmful effects of ultraviolet solar radiation.

3. Mesosphere

Mesosphere is the third layer of the atmosphere which extends up to 80 kms. The temperature in the mesosphere continuously decreases with increasing height. The layer records the lowest temperature in the atmosphere i.e. -100° Celsius. Meteors occur in the mesosphere and "Noctilucent" clouds are formed by the process of condensation in association with meteoric dusts.

4. Ionosphere

The fourth layer, the Ionosphere, is located above the mesosphere up to the height of 400 kms. Due to the high concentration of ions particles, this layer is known as the ionosphere. Temperature rises with increasing height in this layer. The Ionosphere plays a significant role in radio communications. From this layer, radio waves are reflected back on the earth and due to this radio broadcasting has become possible. The phenomenon known as "Aurora" has also been observed in this layer.

5. Exosphere

This is the last and uppermost layer of the atmosphere. Exosphere is located above 400 kms of height after the ionosphere. Gases are very sparse in this layer because of the lack of gravitational forces. Hydrogen and Helium gases are predominant in this layer. They are very light in nature. Therefore, the density of this layer is very low.

Check your progress

(i) Explain about Stratosphere?

____

____

(ii) Write about exosphere briefly?

____

____

6.5 Summery

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.

6.6 Check Your Progress – Model answers

i) The earth is surrounded by a gaseous envelope which acts like an air blanket on the earth ‘s surface. It is attached due to the gravitational force of the earth. This is known as the atmosphere.

ii) Gases of atmosphere are, broadly, divided into two groups i.e. permanent and variable gases. Nitrogen, Oxygen, Argon, Neon, Helium, Hydrogen, and Xenon are permanent gases and Carbon dioxide, Methane, Nitrous oxide, Ozone and Chlorofluorocarbons (CFCs) are variable gases.

iii) The stratosphere extends from tropopause to a height of 50 kms. Thermal conditions of the lower part of the stratosphere are stable due to nonexistence of dust particles, water vapours and conventional current. It is known as an isothermal zone. This layer is considered ideal for flying aeroplanes because weather events do not take place. The Stratosphere covers about 24 % of the total air mass. As height increases, the temperature in the stratosphere increases due to the presence of ozone gas in the upper part of the layer.

iv) This is the last and uppermost layer of the atmosphere. Exosphere is located above 400 kms of height after the ionosphere. Gases are very sparse in this layer because of the lack of gravitational forces. Hydrogen and Helium gases are predominant in this layer. They are very light in nature. Therefore, the density of this layer is very low.

6.7 TERMINAL QUESTIONS

Long Questions

1. Write an account of Atmospheric Composition
2. Explain different layers of the atmosphere with the help of a diagram.

Short Questions

3. Name the layer which is related to “Normal lapse rate” ?
4. Which gas protects us from ultraviolet solar radiation and where is it located?
5. What is the importance of the ionosphere?
6. Name the Layer where density is very low?

Very short questions

7. Water vapour
8. Troposphere
9. Ozone

6.7 Further Readings

- Fundamentals of Physical Geography, Class XI NCERT Geography text book
- https://diksha.gov.in/nios
- Physical Geography B.A. Text Book by Telugu Academy, Hyderabad

Chapter - 7

INSOLATION AND TEMPERATURE

Contents

7.0 Introduction

7.1 Objectives

7.2 Insolation

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7.4 Global warming

7.5 Temperature and it’s distribution

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7.0 Introduction

In the previous lesson we have studied that the air surrounding the earth is called the atmosphere. The atmosphere is made up different types of gasses water vapour and dust particles. Atmosphere is essential for survival of plant and animal life. They also required optimum temperature to keep themselves warm and grow. Have you ever thought what is the source of heat and energy received on the surface the Earth? Why does earth surface get warm during the day and cool down during the night? Let us find answer to all these and other related question in this lesson.

7.1 Objectives

After studying this lesson, you will be able to

- Explain the importance of isolation and establish relationship between angle of incidence of sun's rays and the intensity of heat received from them at place.
- Explain the different processes involved in heating and cooling of the atmosphere (conduction, convention, radiation and advection.
- Explain the heat budget with the help of a diagram.
- Differential but seen solar radiation and terrestrial radiation.
- Explain the causes of global warming and its effect.
- Explain the various factors effecting the horizontal distribution of temperature.
- Explain with the help of map the main characteristics of temperature distribution in the world. In month of January and July.
- Explain the condition in which inversion of temperature occurred.

7.2 Insolation

The core of the sun acts like a gigantic nuclear reactor and converts huge quantity of hydrogen in to helium in this process of fusion. The sun releases tremendous. energy in all direction the sun is the primary source of energy on the earth. This energy (Both heat & light) is radiated in all directions in to space through short ways. This is now as Solar Radiation 1 in 2000000000 parts of the sun's tremendous energy is received by the earth this small property of solar radiation is of great importance as it is the only major source of energy on the earth for most the physical and biological phenomena.

Incoming solar radiation through short waves is termed as insolation the amount of insolation received on the earth's surface is for less than that is radiated from the sun because of the small size of the earth and its distance from the sun. More over water vapour, dust particles ozone and other gases present in the atmosphere. Observe a small account of insolation.

- The Sun is the primary source on earth
- Insolation is the incoming solar radiation

A) Factors influencing insolation

The amount of insolation received on the earth surface is not uniform energyIt varies from place to place and from time to time the tropical zones receive the maximum annual insolation it gradually decreases towards the poles insolation is more in summer's and less in winters.

The following factors influence the amount of insolation received.

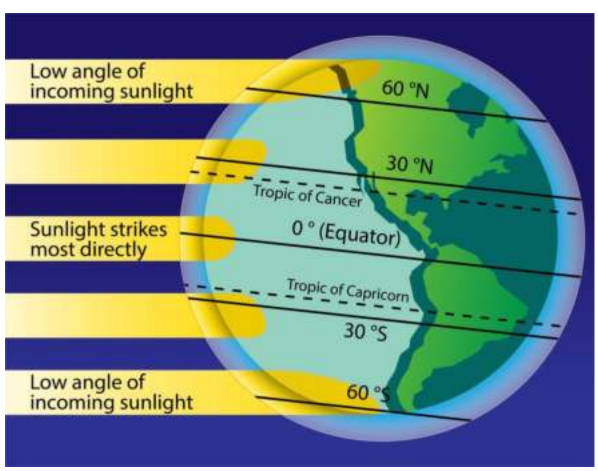
i) The angle of incidence.

ii) Duration of the day (daily sunlight period)

iii) Transparency of the atmosphere

i) The angle of incidence.

Since the earth is round the sun's rays strike the surface at different angles, at different places. The angle formed by the sun's rays with the target of the earth's circle at a point is called angle of **incidence**. The angle of incidence influences the insolation in two ways. First when the sun is almost our head the rays of the sun or vertical. The angle of incidence is large hence they are concentrated in a smaller area, giving more amount of insolation at the place. If the sun's rays are oblique angle of incidence is small and sun's rays have to heat up a greater area resulting in less amount of insolation received their. Secondly the sun's rays with small angle traverse more of the atmosphere then rays striking at a large angle, longer the path of sun's rays greater in the amount of reflection and observation of heat by atmosphere. As a result, the intensity of insolation at a place is less



(fig 7.2).

ii) The Duration of the day (daily sunlight period)

Duration of the varies from place to place and season to season. It decides the amount of insolation received on earth's surface. The longer (A the equator) The duration of the day the greater is the amount of insolation received. Conversely shorter the duration (towards the poles) of the day leads to receipt of less insolation.

iii) Transparency of the atmosphere:

Transparency of the atmosphere here also determined. The amount of insolation reaching the earth's surface. The transparency depends up on cloud cover its thickness, dust particles and water vapour, as they reflect absorb or transmit insolation. Thick clouds, hinder the insolation to reach the earth, while clear sky helps it to reach the surface water vapour absorb insolation, resulting in less amount of insolation reading the surface.

> - Amount of insolation at a place depends upon angle of incidence, duration of the day and transparency of the atmosphere.

B) Heating and cooling of the atmosphere.

The sun is the ultimate source of atmosphere heat and energy, but it's effect I not direct. For example, as we climb a mountain or ascend in the atmosphere, temperature become steadily lower, rather than brighter, as we might expect. This is because the mechanism of heating the atmosphere in not simple. There are four heating processes directly responsible for heating the atmosphere. They are i) Radiation ii) conduction, iii) convection and iv) advection. In this process heat travels through the empty space**.**

I. **Radiation:** Solar radiation is the only primary source of heat and light for the Earth. Radiation is the process by which solar energy reaches the earth is in the form of radiation. Temperature and wave length are inversely related. Hotter the object shorter is the length of the wave. Insolation reaches the earth's surface in short waves and heat is radiated from the earth long waves. Hence energy leaving the earths surface i.e terrestrial radiation heat up the atmosphere more than the incoming solar radiation i.e insolation.

The sun's energy absorbed by the earth's surface and radiation out in to space is called Terrestrial radiation. The sun's heat energy is absorbed by the earth and its atmosphere during the day. At night this heat which is absorbed by the earth and its atmosphere is radiated out by the earth and its atmosphere. In other words the insolation radiation our by the earth is called terrestrial radiation it is in the form of long waves. These long waves are more reading absorbed by the molecules of gases in the atmosphere. The following facts about radiation ate worth nothing.

i. All objects whether hot or cold emit radiant energy continuously

ii. Hotter objects radiate more energy per unit area than colder objects.

iii. Temperature of an objects determines the waves the waves length of radiation. Temperature and wave length are inversely ratated. Hotter the object shorter is the length of the waves.

iv. Insolation reaches the earth's surface in short waves and heat is radiated from the earth in long waves.

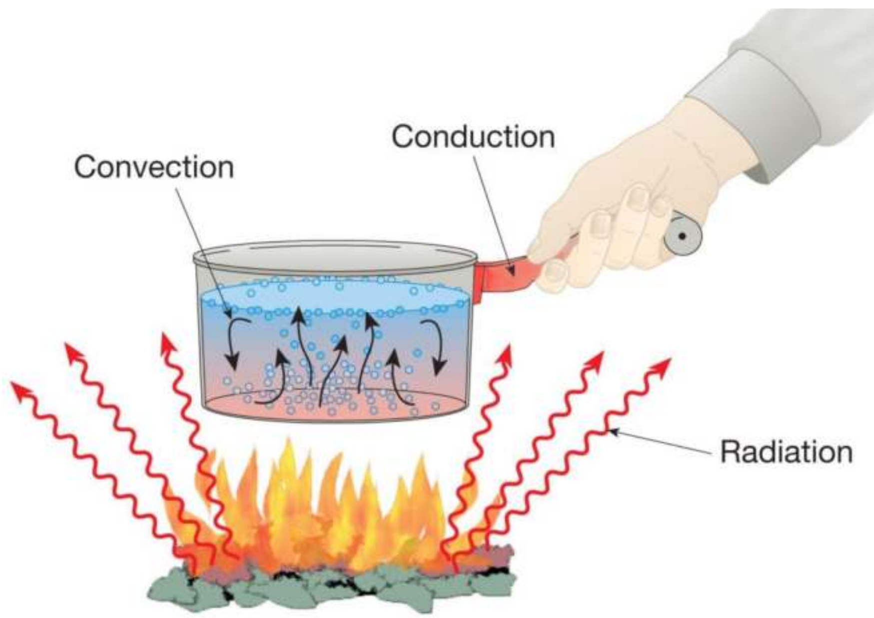


Fig. 7.3

Insolation	Terrestrial Radiation
It is the incoming solar energy (51Units) reaching the earth 14 units out of the 100 units of energy coming from the sun are absorbed by gages in the atmosphere. i.e 14%	It is the insolation (51units) radiated out by the earth. 34 units out of 51 units of energy radiating from the earth are absorbed by gages in the atmosphere. i.e 85%.

From the above it is clear that the atmosphere is heated more by terrestrial radiation given by the earth those by the incoming insolation.

II. **Conduction**: when two objects of unequal temperature come in contact with each other, heat energy flow from the warmer object to the colder object and this process of heat transfer is knows at conduction. The flow continues till temperature of both the objects becomes equal of the contact is broken. The conduction in the atmosphere occurse at zone of contact between the atmosphere and the earth's surface. Conduction is important in heating the lower layers of the atmosphere. However, this is a minor method of hear transfer in terms of warming the atmosphere since it only effects the air close to the earth's surface.

III. **Convection:** Transfer of hear by movement of mass or substance from one place to another, generally vertical is called convection. The air of the lower layers of the atmosphere gets heated either by the earth's radiation or by conduction. The heating of the air leads to its expansion. Its diversity decreases and it moves upwards. Continuous ascent of heated air creates vaccum in the cooler air come down to fill the vaccum, leading to convection. The cyclic movement associated with the lower layers to the upper layers and heats up the atmosphere. The convection transfer of energy is confined only to the troposphere.

IV. **Advection** (Horizontal transfer of heat) Winds carry the temperature of one place to another. the temperature of place will rise if it lies on the path of winds coming from wormer regions. The temperature will fall if the place lies on the path of the blowing from cold regions. This process of horizontal transport of heat by winds is known as advection.

Horizontal movement of the air reactively more important than the vertical movement. In the middle latitudes, most of diurnal (day and night) variations in daily weather are caused by advection alone. In tropical regions particularly in northern India during the summer reason, local winds called Loo is the outcome of advection process.

7.3 Heat Budget

The insolation is made up of energy transmitted directly through the atmosphere and scattered energy. Isolation is the amount of solar radiation that reaches the earth's surface through short waves. The earth also radiates heat energy like all other hot object. This is known as terrestrial radiation. The annual mean temperature on the surface of the earth is always constant. It has been possible because of the balance between insolation and terrestrial radiation. This balance is termed as a heat budget of the earth.

Let us suppose that the total heat (incoming solar radiation) received at the top of the atmosphere is 100 units (see fig 7.4 roughly 35 units of its are reflected back in to space even before reaching the surface of the earth out of these 35 units, 6 units are reflected back to space from the top of the atmosphere 27 units reflected by clouds and 2 units from snow and ice coved surface.

Out of the remaining 65 units (100-35) only 51 units reach the earth's surface and 14 units are absorbed by the various gages , dust particulars and water vapour of the atmosphere

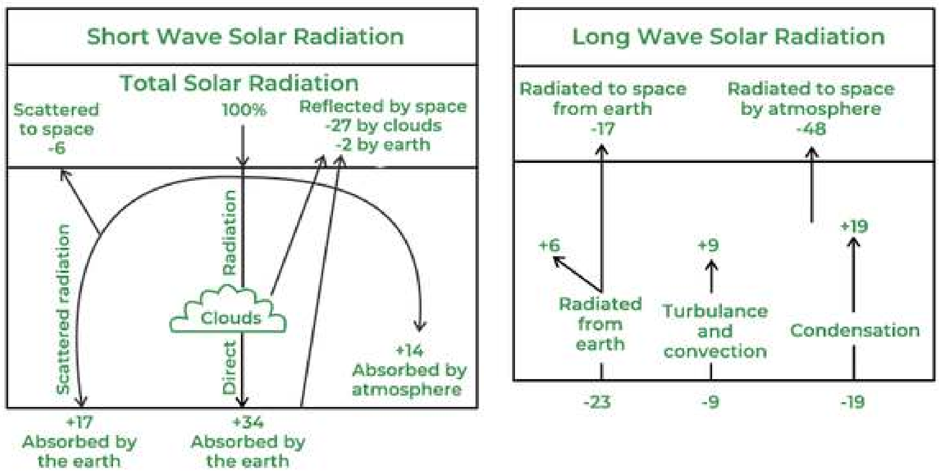


Fig.7.4: Heat budget (Balance between insolation and terrestrial radiation)

The earth in turn radiates back 51 units in the form of terrestrial radiation. Out of these 51 units of terrestrial ration, 34 units ate absorbed by the atmosphere and the remaining 17 units directly go to space. The atmosphere also radiates 48units (14 units of incoming radiation and 34 units of out going radiation absorbed by it) back to space. This 65 units of solar radiation entering the atmosphere are reflected back in to the space. This account of incoming and out going radiation always maintain the balance of heat on the surface of the earth.

- Heat budget is the balance between insolation (incoming solar radiation) and terrestrial radiation.

A through the earth as a whole maintains balance incoming solar radiation and outgoing terrestrial radiation. But this is not true. What we observe at different latitudes. As previously discussed the amount of insolation received is directly related to latitudes. In the tropical region the amount of insolation is higher than the amount of terrestrial radiation. Hence it is a region of surplus heat. In the solar regions the heat gain is less than the heat loss. Hence it is a region of deficit heat. Thus the insolation creates an in balance of heat at different latitudes (See Fig.7.5). This is being nullified to some extend by winds and ocean currents which transfer heat regions. This is commonly known as latitudinal Heat balance.

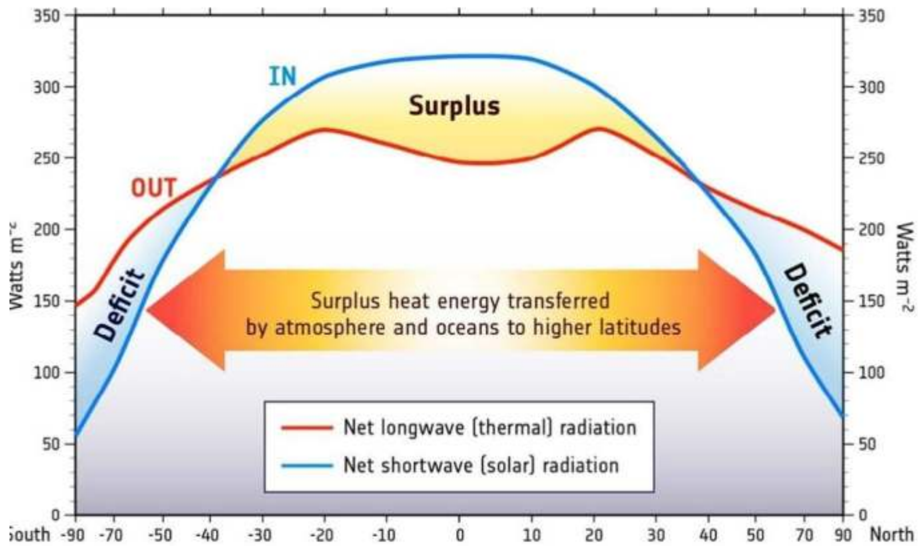


Fig 7.5: Latitudinal Heat Balance

7.4 Global Warming

Global warming is one of the major environmental problem our earth is facing.Scientists see its association with depletion of stratospheric ozone layer and increase in atmospheric carbon dioxide.As you know that the upper portion of the stratosphere contains a layer of ozone gas.

Ozone is capable of absorbing a large amount of sun's ultraviolet radiation thus preventing it from reaching the earth's surface.scientists have realized that the thickness of the ozone layer is reducing.This is disturbing the balance of gases in the atmosphere and increasing the amount of ultraviolet radiation reaching the earth.Ultraviolet radiation is responsible for increasing the global temperature of the earth's surface besides it can severally burn human being's skin,increase the incidence of the skin cancer,destroy certain microscopic forms of life and damage plants.

There is a gradual increase in the **carbon dioxide** content of the atmosphere.It is estimated that the carbon dioxide content of the atmosphere has increased 25% in the last hundred years. Carbon dioxide allows insolation to pass through but,absorbs terrestrial radiation. Increase of carbon dioxide in the atmosphere has the effect of raising the atmospheric temperature.It is estimated that the temperature of atmosphere has increased by about 0.5°C in the last 1000 years .Large scale of de-forestation, fossil fuel burning ,burning of garbages, combustion processes in factories and volcanic eruptions are some of the factors responsible for the increase of carbon dioxide in the atmosphere.

If the depletion of ozone layer and the increase in the carbon dioxide content continue,the time would come when the temperature of the atmosphere will rise to the extent that it would melt polar ice caps,increasing the sea level and causing submergence of coastal regions and islands.The phenomena of world-wide increase of atmospheric temperature due to depletaion of ozone layer and the increase of carbon dioxide content is known as **global warming**.

- Latitudinal heat balance is the transfer of heat from lower to higher latitudes by winds and ocean currents to counter the imbalance created by insolation at different latitudes.
- Global warming is the world-wide increase of atmospheric temperature due to depletion of ozone layer and in the increase of carbon dioxide content.

7.5 Temperature and It's Distribution

Temperature indicates the relative degree of heat of a substance.Heat is the energy which make things or objects hot,while temperature measure the intensity of heat.Although quite distinct from each other,yet heat and temperature are closely related because gain or loss of heat is necessary to raise or lower the temperature.The temperature is measuredin **Celsius** and also in **Fahrenheit** scale.The Celsius scale named after the Swedish Astronomer,**Anders Celsius**.Fahrenheit temperature may be converted to their Celsius equivalent by the formula C=5/9(F-32).

Moreover,difference in temperature determines the direction of flow of heat.This we can understand by studying temperature distribution.Distribution of temperature varies both **horizontal** and **vertically**.Let usstudy it under,

A The Horizontal distribution of temperature

B. The Vertical distribution of temperature

A. Horizontal distribution of temperature

Distribution of temperature across the latitudes over the surface of the earth is called its horizontal distribution. On maps, the horizontal distribution of temperature is commonly shown by the "Isotherms" lines connecting points that have equal temperatures. If you study an 'isotherm map' you will find that the distribution of temperature is uneven.

The factors responsible for uneven distribution of temperature are as follows.

1. Latitude
2. Altitude (Height above sea level
3. Land and sea contrast
4. Winds
5. Ocean currents
6. Relief (Direction of mountain ranges)
7. Vegetation cover
8. Nature of the soil cover and
9. Slop of the land

1. Latitude: The spherical shape of the Earth causes different parts of the earth to be heated to different degree. The regions near the **Equator** gets more direct rays of the sun. The direct rays are concentrated over a small area and so it heat up the earth more.

As we go away from the Equator, due to the curvature of the Earth, the sun's rays strike the Earth's surface at an angle. The slanting rays spread the heat over a large area and so they do not heat to the same extent as the direct rays. Thus, the temperature decreases as we go away from the Equator.

2.**Altitude (Height above sea level:** The Earth's atmosphere is heated by the absorbed by the gas molecules and impurities like dust particles present in the air.

As height increases, the density of air decreases. Thus the amount of heat absorbed decreases with height. This rate of change of temperature varies with time of the day and season of a place. The temperature decreases with increase in height above sea level. The average rate of change of temperature 1°C for every 165 m of height in the atmosphere. For this reason places on hills and mountains are cooler than places in the plains.

Sea level:-The ocean is one continuous body of water. Hence, it's surface is at the same level throughout the world. Therefore the surface of the ocean is used as a base for measuring elevation.

Elevation:-It is the height on the surface of the earth.

Altitude:-It refers to the height in the atmosphere.

3. Land and sea contrast:-If latitude was the only factor affecting the climate of a place, then all places on the same latitude would have the same temperature. For example **New Delhi Canary Islands** lie on almost the same latitude ,but New Delhi is hotter than Canary Islands in summer and colder in winter. But this is not so. This is due to the influence of the sea.

Land and water get heated in different ways. Land is a solid and gets heated by the process of **conduction**. Water (Oceans, lakes)is heated rapidly and to a greater degree than water during sunshine. It is also cools down more rapidly then water during the night. Hence, temperature is relatively higher on land during day time and it is higher in water during night. In the same way there are seasonal contrast in temperature. During summer the air above land has higher temperature than the oceans. But the air above oceans gets higher temperature than landmasses in winter. Land and sea contrast is responsible for the **monsoon** winds.

4. Winds:-The Equator receives more heat from the sun. Hence winds that blow out from here are **warm wind**. The polar regions receives slanting rays and hence less heat. Therefore, winds that blow out from the polar region are **cold.**

The temperature of the wind affects the area it blows into. Warm winds make the place it blows into **warmer**, and cold winds make the place it blows into colder. For example; Western Europe (temperate latitudes)comes under the influence of the **westerlies**. The westerlies are warm winds with blow from the lower latitudes.

5. Ocean Currents:-Ocean currents are river like streams of water. They are caused by the uneven heating of the Earth. Due to uneven heating of the ocean waters, a convectional current is set up.

Ocean currents are of two types; i)**Warm Currents** and ii) **Cold Currents**. Warm currents make the coasts along which they flow warmer, while cold currents reduce the temperature of the coasts along which they flow.

Near the Equator the temperature is higher. The water of the ocean from the equatorial region gets warmer. The warm water from the low latitudes flows towards the poles. This is **warm current**. The water near the polar regions is cooler. The cold water from the polar region flows towards the equatorial region. This is a **cold current**. A cold current will have a cooling effect and a warm current will raise the temperature. For example **the Warm North Atlantic Drift** keeps western Europe much warmer in winter as compared to the east coast of North America, which is also on the same latitude but, washed by **the Cold Labrador Current.**

6. Relief (Direction of Mountain Ranges):-The direction of mountain ranges greatly influences the temperature of a place. If the mountain range a **against** the direction of the wind, it can act as a barrier to the movement of winds, i.e, it will prevent the wind from passing through. It can protect a region from cold winds and

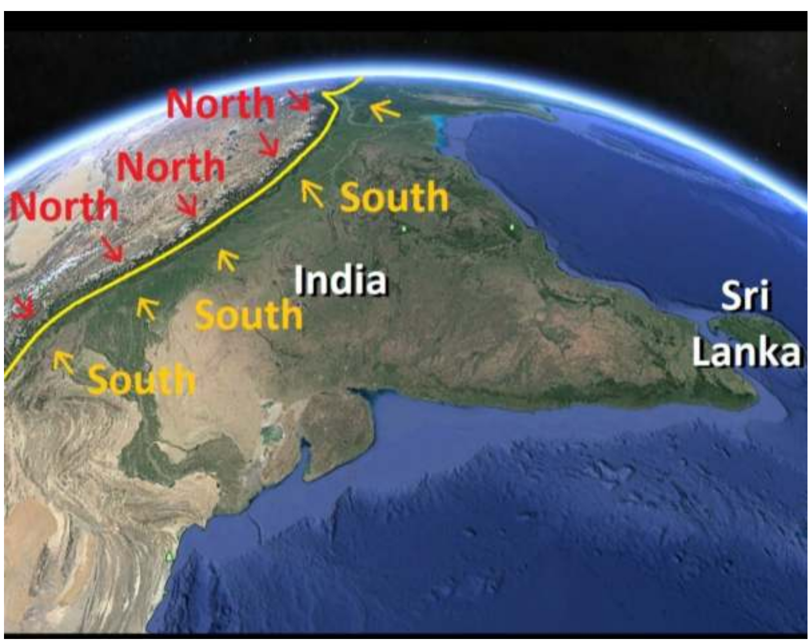


Fig.7.7

thus keep it warmer. If the direction of the mountain range is in the **same direction** as the wind, then the mountain range will not block the wind. The mountain range will not have much effect on the temperature of that region.

The **Himalayan ranges** prevent cold wind of Central Asia from entering India, during winter. Because of this **Kolkata** is not as cold as **Canton** (Guangzhou)China in winter though both are situated almost on the same latitude.

7. Vegetation Cover:-The plant life of a region is collectively known as **vegetation**. It helps to retain moisture in the soil. The roots bind the soil and present the drainage of water.

Plants reduce temperatures by releasing moisture into the atmosphere. For this reason it is cooler in parks and gardens. Tree provide valuable shade which cuts off much of the heat received by the earth. That is why it is cooler in jungles and forests.

In cities and towns where natural vegetation has been removed, temperatures can be several degrees higher than they are in the surrounding countryside.

8. Nature of Soil Cover:-Depending on the kind of soil found in a region ,the temperature of a place is affected. **Soi**l is a layer of mineral and organic material that covers most of the earth's land surface. Different types of soils are found in different parts of the earth.

Colour, texture and structure of soils modify temperature to a great degree. Black, yellow and clayey soils absorb more heat than sandy soils. Likewise heat radiates more rapidly from sandy soils than from black, yellow and clayey soil areas than those of sandy soils.

9. Slop of the land:-Angle of the slope and its direction control the receipt of insolation. The angle of incidence of sun's rays is greater along a gentler slope and smaller along a steeper slop. The ray in both the cases carry an equal amount of solar energy. Greater concentration of solar energy per unit area along gentler slope raises the temperature while its lesser concentration along steeper slopes lowers the temperature .Fore such reasons, the southern slopes of the Himalayas are warmer than the northern ones.

B. Vertical distribution of temperature

The permanent snow on high mountains, even in the tropics, indicates the decrease of temperature with **altitude**. Observations reveals that there is a fairly regular decrease in temperature with an increase in altitude. The average rate of temperature decrease upward in the troposphere is about 6°C per km, extending to the tropopause. This vertical gradient of temperature is commonly referred to as the stand and atmosphere or normal laps rate, but is varies with height, season, latitude and other factors. In deed the actual lapse rate of temperature does not always show a decrease with altitude

C. Inversion of temperature

'The phenomena on in which temperature increases with increasing altitude temporarily and locally under certain (Long winter night, clear sky, dry air and absence of winds) conditions is known as **inversion of temperature**. This is especially observed in intermountain valleys. During winters the mountain slopes cool very rapidly due to quick radiation of heat. The air rising above them also becomes cold and its density increases. Hence, it moves down the slopes and settles down in the valleys. This air pushes the comparatively warmer air of valleys upwards and leads to the phenomenon of inversion of temperature. Sometimes the temperature falls below freezing point in the valleys leading even to the occurrence of frost. In contrast, the higher slopes remain comparatively warmer. That is why mulberry planters of the **Suwa Basin** of Japan and the apple growers of **Himachal Pradesh** avoid the lower slopes of the mountains to escape winters frost. If you have been to any hill station you would have seen that most of the holiday reports and the houses of affluent persons are built on the upper slopes.

- Temperature usually decreases with increasing altitude.
- The normal lapse rate is 6°C per 1000 metres ascend.
- The phenomenon in which temperature increases with increasing altitude temporarily and locally und certain conditions is known as inversion of temperature.

7.6 Summary

The Sun is the primary source of energy on the earth. Sun's energy reaching the earth in short waves is called **insolation**. The amount of insolation depends upon angle of incidence, duration of the day and transparency of the atmosphere. The processes involved in the heating and cooling of the atmosphere are radiation, conduction, convection and advection. Radiation predominates other three processes. Terrestrial radiation is the amount of heat radiated back from the earth. There is a balance between the receipt of insolation and the terrestrial radiation on earth's surface. It is known as **heat budget**. **Global warming** is the world wide increase in atmospheric temperature due to depletion of ozone layer and increase in caron dioxide.

Temperature measures the intensity of heat. Distribution of temperature varies both horizontally and vertically. Certain factors control its distribution. They are latitude, land and water contrast, winds, ocean currents, altitude and aspect of slope. Horizontal distribution of temperature is shown on a map with the help of isotherms, the imaginary lines joining places of equal temperature.

Temperature also decreases with increasing altitude. The rate at which it decreases in normal conditions is known as normal lapse of temperature occurs when temperature increases with increase in height. It is generally local and temporary in character

7.7 TERMINAL QUESTIONS

1. Answer the following questions at the most in one sentence:

   (a) What is meant by normal lapse rate?

   (b) What is insolation?

   (c) Define terrestrial radiation

   (d) At which rate does temperature decrease with increase in altitude?

2. Write in about 50 words on each of the following

   (a) Heat Budget

   (b) Latitudinal heat balance.

3. Describe the factors that influence the horizontal distribution of temperature.

4. Draw a diagram to explain the heat budget of the earth.

7.8 FURTHER READINGS

- A Text Book for Intermediate first Year Geography, Telugu Akademi, Hyderabad.
- Oxford Dictionary of Geography, Susan Mayhew
- Geomorphology for B.sc ,B.A, Telugu Akademi by Dr.S.Padmaja
- B.A & B.Sc World Geography, Telugu Akademi, Hyderabad by Pof.S.Padmaja
- Elements of Practical Geography by R.L.Singh
- A Text Books of Geography Class VI, IX and X by Rita Rajan.
- Geography, Senior Secondary Course, NIOS, Noida, India.
- Geography Text Book, NCERT, India

  https://www.geo.fu-berlin.de/en/v/geolearning

Chapter - 8

ATMOSPHERIC PRESSURE AND TYPES OF WINDS

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8.2 Measurement of Air pressure

8.3 Factors Affecting Air Pressure

8.4 Pressure belts of the World

8.5 Shifting of Pressure Belts

8.6 Winds

8.7 Factors affecting Direction and Velocity of Winds

8.8 Types of Winds

8.9 Summary

8.10 Terminal Questions

8.11 Further Readings

8.0 Introduction

Air is a physical substance. It is a mixture of many gases that are present in the atmosphere. Air has its own weight and it exerts pressure on the Earth's surface. The weight of the air on a unit area of the earth is called *Air Pressure*. For example: The bubbles of soap are spherical because the air pressure inside the bubble is equal to the atmospheric pressure. Similarly, the balloon expands as we fill air into it. The air pressure inside the balloon is equal to the atmospheric pressure. Similarly, the air around us exerts pressure. But we do not feel the weight of the atmosphere because we have air inside us which exerts an equal outward pressure that balances the inward pressure of the atmosphere. Atmospheric pressure is important to us because it is related to winds and it helps to determined, weather conditions of a place. In this lesson you will study air pressure, its distribution, winds, and their typesAtmospheric pressure also called as Barometric Pressure refers to the force per unit area exerted against a surface by the weight of the air above that surface. The typical Pressure at sea level is 1013.25 millibars or 14.7 pounds per square inch. A millibar is a unit that is used to report the Atmospheric Pressure (the height of the column of the mercury in the barometer at sea level).

8.1 Learning Objectives:

- To understand that air has a mass and exerts pressure.
- To contrast high and low pressure.
- To be able to explain, why winds are created and the factors that affect the wind.
- Explore how the interaction between high- and low-pressure systems affect the speed and direction of wind.
- Simulate given weather and wind patterns, understanding that wind has direction and speed.
- Investigate how pressure systems affect weather conditions.
- Draw conclusions of wind speed and direction based on observations.

8.2 MEASUREMENT OF AIR PRESSURE

Atmospheric Pressure is normally measured in millibars. The variation in pressure is shown on a map by means of isobars. These are lines joining places having same barometric pressure. Atmospheric pressure can be measured with a mercury barometer (hence the commonly used synonym barometric pressure), which indicates the height of a column of mercury that exactly balances the weight of the column of atmosphere over the barometer. Atmospheric pressure is also measured using an aneroid barometer, in which the sensing element is one or more hollow, partially evacuated, corrugated metal disks supported against collapse by an inside or outside spring; the change in the shape of the disk with changing pressure can be recorded using a pen arm and a clock-driven revolving drum.

Atmospheric pressure is expressed in several different systems of units: millimetres (or inches) of mercury, pounds per square inch (psi), dynes per square centimetre, millibars (mb), standard atmospheres, or kilopascals. Standard sea-level pressure, by definition, equals 760 mm (29.92 inches) of mercury, 14.70 pounds per square inch, 1,013.25 millibars, one standard atmosphere, or 101.325 kilopascals. Variations about these values are quite small; for example, the highest and lowest sea-level pressures ever recorded are 32.01 inches (in the middle of Siberia) and 25.90 inches (in a typhoon in the South Pacific). The atmospheric pressure is not equal across regions.

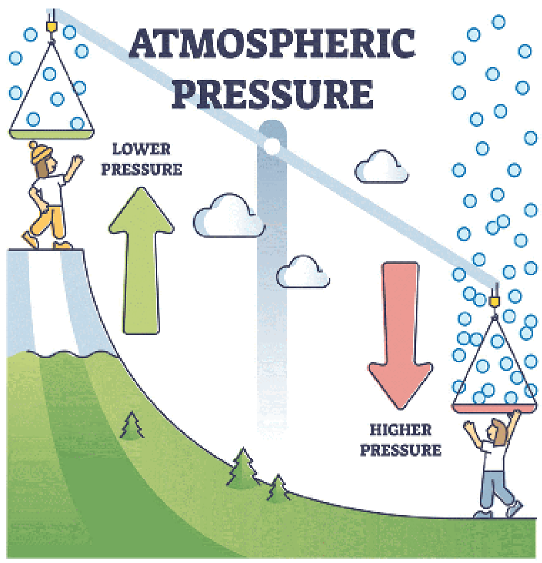


Fig 8.1 Atmospheric Pressure of Layers of Air

8.3 FACTORS AFFECTING AIR PRESSURE

There are various factors responsible that affect distribution of air pressure are as the following:

1. Altitude: The Atmospheric Pressure decreases with height or altitude. The decrease in pressure is about one centimetre of mercury for every 110 metres of ascent. The atmospheric pressure is high at sea level. This is because at higher altitudes the air is thinner or less dense than the air at the sea level. The maximum air density is at the Earth's surface; air density decreases with height (because the pull off the earth's gravity is less). The fewer number of gas molecules at higher altitudes mean fewer molecular collisions and a decrease in air pressure. since the atmosphere is highly compressible the overlying layers exert pressure on low lying layers.

As the pressure decreases the amount of oxygen available to breathe also decreases. At high altitudes atmospheric pressure and available oxygen get so low that people feel breathlessness. Mountain climbers use bottled oxygen when they accent very high peaks. They also take time to get used to the altitude because quickly moving from high pressure to low pressure can cause decompression sickness. Aircraft create artificial pressure in the cabin so passengers remain comfortable while flying.

2. Temperature: Atmospheric Pressure decreases with increase in temperature. This is because when temperature rises, air expands. The molecules of air move far apart (become less dense) and hence exert less pressure. On the contrary with decrease in temperature, the air gets compressed and space between molecules decreases (becomes denser) and exerts more pressure on the region. That is why the Equatorial region has a low-pressure belt, whereas the polar regions have high pressure belts.

3. Water vapour: water vapour concentration affects atmospheric pressure because the molecular weight of water 18 grams per mole is less than the average molecular weight of air (about 29 grams /mol). When water evaporates and enters the atmosphere as a gas, the water vapour molecules take the place of other gas molecules in the air. So, a volume of wet (or humid) air weighs less than an equal volume of dry air. Therefore, humid air is less dense and exerts less pressure than dry air.

4. Rotation of the Earth: Due to the rotation of the earth, bulk of air at the poles is thrown away towards the Equator. Since Equatorial region receives great amount of heat throughout the year, the air becomes warm and light and therefore it rises and creates low pressure. At the poles the cold heavy air sinks down and creates high pressure. In fact, temperature and rotation of the earth together contribute to the formation of *world pressure belts.*

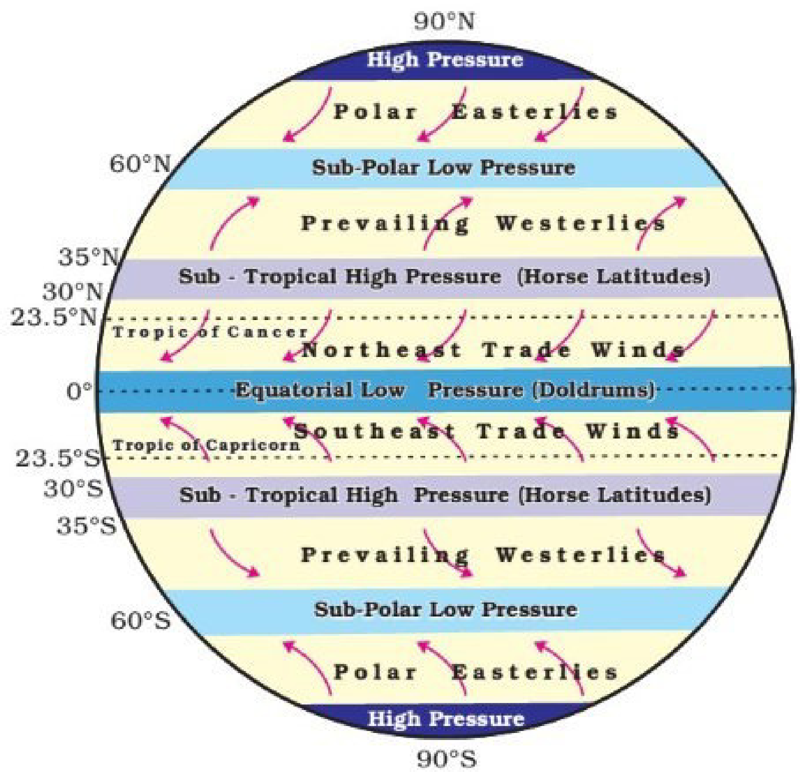
These factors make air pressure an important parameter in predicting weather in general weather .In general weather becomes stormy when air pressure falls(generally due to warmer humid air and/or convergence of air masses at the surface of the earth which cause convention and rising air) and becomes fair when air pressure rises(generally due to prior colder air or divergence of air masses).When a low pressure system moves into an area, it usually leads to cloudiness, wind and precipitation .high pressure systems usually lead to fair and calm weather.

8.4 World Pressure Belts

Distribution of atmospheric pressure across the latitude is termed global horizontal distribution of pressure. Its main feature is its zonal character known as pressure belts. On the earth surface there are in all 7 pressure belts. They are Equatorial low, the two subtropical high-pressure belts, the two subpolar lows and the two polar high-pressure belts. Except the Equatorial low the others form matching pairs in the northern and southern hemispheres.

There is a pattern of alternate high- and low-pressure belts over the earth. This is due to the spherical shape of the earth- different parts of the earth are heated unequally. The Equatorial regions receive great amount of heat throughout the year. Warm air being light, the air at the equator rises creating a low pressure.

At the poles the cold heavy air causes high pressure to be formed. It is also due to the rotation of the earth. In sub polar regions around the latitude 60 degree to 65 degree North and South of the equator, the rotation of the earth pushes up the bulk of the air towards the equator creating a low-pressure belt in this region.



Major Pressure Belts and Wind System

Fig 8.2 Pressure Belts of the World

(i) Equatorial Low-Pressure Belt: This low-pressure belt extends from 0^0 to 5^0 North and South of the equator. Due to the vertical rays of the sun here, there is intense heating. The air therefore, expands and rises as convection current causing a low pressure to develop here. This low-pressure belt is also called as doldrums, because it is a zone of total calm. that is without any breeze.

(ii) The Sub-tropical High Pressure Belts The sub-tropical high-pressure belts extend from the tropics to about 35^0 latitudes in both the Hemispheres. In the northern hemisphere it is called as the North sub-tropical high-pressure belt and in the southern hemisphere it is known as the South sub-tropical high-pressure belt. The existence of these pressure belts is due to the fact that the uprising air of the equatorial region is deflected towards poles due to the earth's rotation. After becoming cold and heavy, it descends in these regions and get piled up. This results in high pressure. Calm conditions with feeble and variable winds are found here. In olden days vessels with cargo of horses passing through these belts found difficulty in sailing under these calm conditions. They used to throw the horses in the sea in order to make the vessels lighter. Henceforth these belts are referred to as Horse latitudes.

(iii) Circum-Polar Low- Pressure Belts

These belts located between 60^0 and 70^0 each hemisphere is known as circum-polar low-pressure belts. In the sub-tropical region, the descending air gets divided into two parts. one-part blows towards the Equatorial low pressure belt the other part blows towards the circum- polar low-pressure belt. This zone is marked by ascent of warm sub-tropical air or cold polar air blowing from poles due to Earth's rotation. The wind surrounding the polar region blow towards the equator. Centrifugal forces operating in this region create the low-pressure belt appropriately called circum- polar low-pressure belt. This region is marked by violent storms in in winter.

(iv) Polar High- Pressure Belts

At the North and South poles between 70^0 to 90^0 North and South of the equator, the temperatures are always extremely low. The cold descending air gives rise to high pressure over the poles. These areas of polar high- pressure are known as the Polar Highs. These regions are characterised by permanent ice caps.

8. 5 Shifting of Pressure Belts

If the earth had not been inclined towards the sun, the pressure belts, as described above, would have been as they are. But it is not so, because the earth is inclined 23.5^0 towards the sun. On account of this inclination, differences in heating of the continents, oceans and pressure conditions in January and July vary greatly. January represents winter season and July, summer season in the northern hemisphere. Opposite condition prevails in the southern hemisphere.

When the sun is overhead on the Tropic of cancer the pressure belts shift 5^0 northward and when it shines vertically overhead on Tropic of Capricorn, they shift 5^0 southward from their original position. The shifting of the pressure belts causes seasonal changes in the climate especially between latitudes 30^0 and 40^0 in both hemispheres. In this region the Mediterranean type of climate is experienced because of shifting of permanent belt southward and northwards with the overhead position of the sun. During winters Westerlies prevail and causes rainfall. During summers dry Trade winds blow offshore and are unable to give rainfall in these regions. When the sun shines vertically over the Equator on the 21st March and 23rd September the pressure belts remain balanced in both the hemispheres

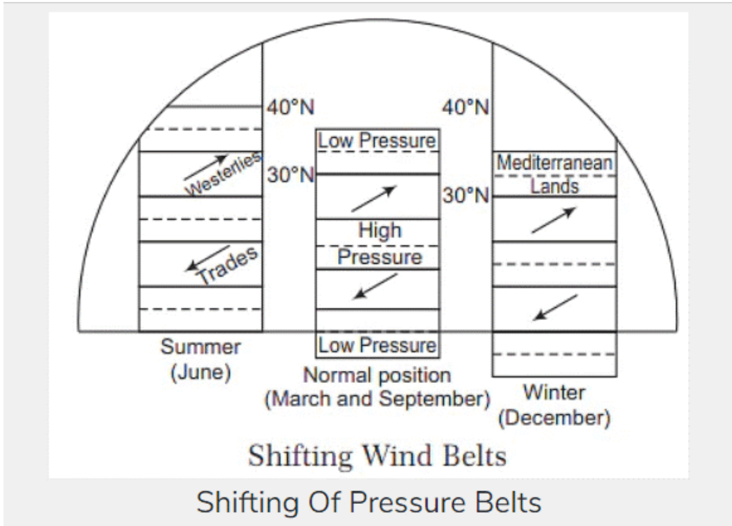


Fig 8.3 Shifting of Pressure Belts

Check your Progress

(i) What do you mean by the term 'Atmospheric Pressure?

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(ii) What are the factors affecting the atmospheric pressure of a region?

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(iii) Mention the atmospheric pressure belts of the world?

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8. 6 Winds

Air flow from areas of high pressure to areas of low pressure. Horizontal movement of the air is called wind. It is nature's attempt to balance inequalities in air pressure. The vertical or nearly vertical movement of air is referred to as the air current. Winds and air currents manage the system of circulation in the atmosphere.

Factors affecting direction and velocity of wind

Direction and speed of wind are controlled by a combination of factors. These are the pressure gradient the corioli's force, altitude, latitude, rotation of the earth, centripetal acceleration, and friction.

1. **Pressure gradient:** We have already studied about the pressure gradient the greater the difference in the pressure between 2 points is taper is the pressure gradient and higher is the wind speed. Since winds blow from higher to lower pressure areas and perpendicular to the isobars, please wind blow are parallel to the gradient and at right angles to the isobar

2. **Coriolis effect:** The earth rotates on inclined axis. If it did not, winds would follow the direction of the pressure gradient. But the rotation produces another force other than the pressure force. It is called the Coriolis effect or corioli's force which deflects the air

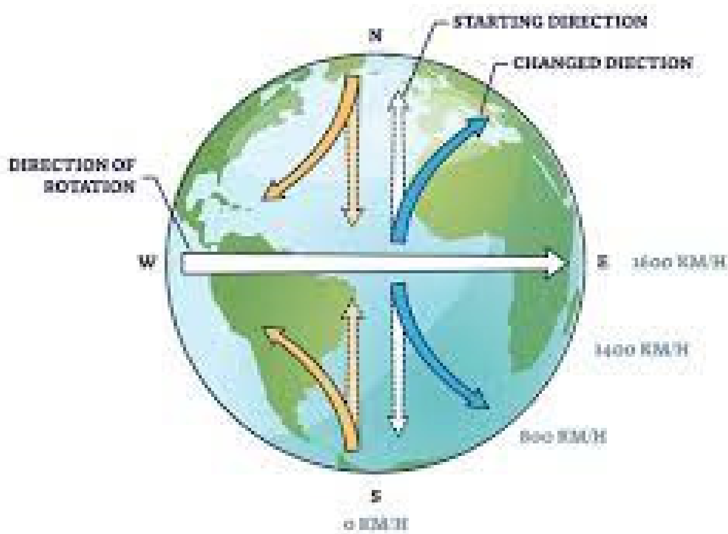

Fig 8.3 Coriolis effect

The deflection is the least at the equator and greater at the poles. This tends to turn the flow of air by changing its direction from its original straight path. The wind starts deflecting to its right in the northern hemisphere. In the southern hemisphere, it starts deflecting to its left from its path. Thus, a wind blowing from north becomes north-easterly in northern hemisphere. A wind blowing from South becomes South- easterly in the southern hemisphere. Example North East trade winds. This is due to maximum speed of rotation at the equator, hence the deflection is less

8.7 Types of winds

There are some winds which blow throughout the year from one latitude to other in the response to the latitudinal differences in air pressure. These are known as permanent or prevailing or planetary winds. Certain winds reverse their direction periodically with season and are called periodic winds. There are certain winds in different parts of the world which blow in comparatively small areas and have special characters. These are called local winds.

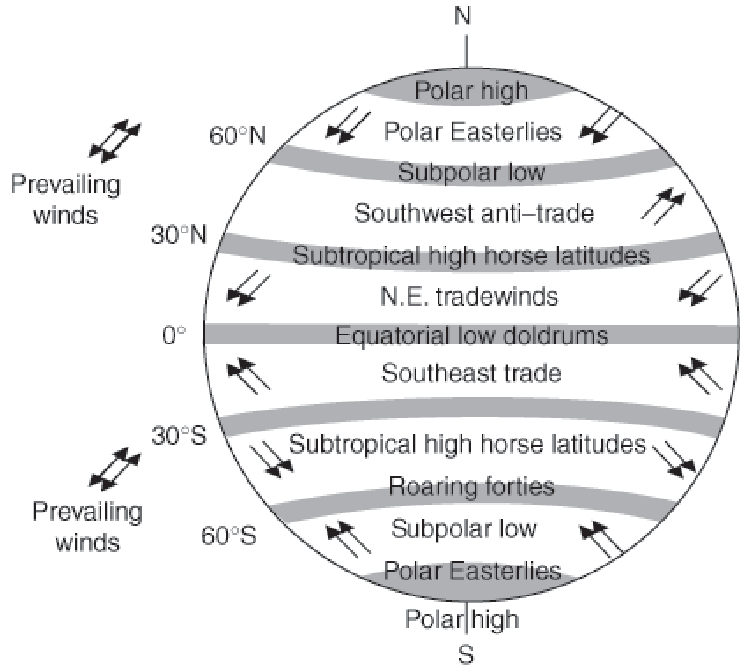

Fig 8.4 major pressure belts and wind system

Permanent winds/ Prevailing winds:

These winds are permanent and blow from high pressure to low pressure belts throughout the year.

The Trade winds

The winds blowing from the subtropical High- Pressure area (30^0 N&S) towards the Equatorial Low-Pressure belt or the extremely steady winds known as the Trade winds.

The name Trade comes from the German word trade meaning 'Track' to blow Trade' means to blow steadily in the same direction and in a constant course.'

North and South of the Equatorial belt are the trade winds in the zone lying between 5^0 and 30^0 North and South. In other words, they cover almost the entire area between 30^0 north and 30^0 South latitude and both side of the equator These trade winds are result of pressure gradient from Sub-Tropical belt of high pressure to Equatorial belt of low pressure.

In the northern hemisphere the wind moving towards the equator, is deflected by the Earth's rotation to the blow south-westward. Thus, the prevailing winds blow from the north-east and it has been named as North East Trade. In the southern hemisphere, deflection of the wind is towards the left, this causes the South-East Trades.'

Trade winds bring heavy rainfall to the eastern coast of continents lying within the Tropics. On the western coasts of the continents, these winds do not bring any rainfall. It is because here there are offshore winds or winds blowing just parallel to the shores. Therefore, the western areas within the within the Tropics suffering from aridity. The great deserts of the Sahara. Kalahari. Atacama and great Australian desert all lie on the western margins of the continents within the Tropical latitudes

Characteristics of Trade winds:

- They blow from Sub-Tropical High- Pressure to Equatorial low- Pressure
- Since they are warm winds, they pick up moisture and are responsible for heavy rainfall on Eastern side of the tropical lands.
- They are called North- East Trades in Northern Hemisphere and South- East Trades in Southern Hemisphere. The winds and pressure belts move a few degrees North and South along with the movement of the overhead sun.
- They have fixed velocity and are regular.
- They are permanent or prevailing winds.

The westerlies

The westerlies or the Prevailing westerly winds below between 30^0 and 60^0 North and South latitudes from Sub-Tropical High-Pressure Belts towards the Sub-Polar Low-Pressure Belts.

In the northern hemisphere the westerlies generally blow from south-west north-east and in southern hemisphere from north-west to south-east. There are onshore winds on the West Coast and offshore winds on their East Coast. The onshore winds bring rainfall while the offshore winds do not bring rainfall.

Characteristics of westerlies

- Develop from sub-tropical high pressure to sub-polar low.
- They are very strong winds and often blow from western side of the landmass.

The Polar Easterlies

The winds that originate in the North and South polar regions and blow towards, polar low-pressure zones are known as polar winds. They start from polar high-pressure zone and originate from ice-capped landmass. In the northern hemisphere, they blow from North- East and are called the North East polar winds and in southern hemisphere they blow from south-east and are called south-east polar winds.

Characteristics of Polar winds

- They are very cold winds.
- When they blow over oceans, they become warm.

They are also called as Polar Easterlies from the directions in which they blow.

Periodic Winds

Periodic winds blow at regular intervals in regular cycle. These winds occur due to temperature and pressure differences. Land and sea breeze are best examples of Periodic winds.

Land and sea breeze. They are caused by differential rate of heating of the land and sea.

During the day land gets heated faster than the adjoining sea. This creates low pressure zone on the land and high-pressure zone over the sea. Thus, the winds blow from sea to land and are called Sea Breezes. At night reverse of this happens and winds blow from land to sea and are called Land Breezes.

Monsoons are periodic seasonal winds blowing in the regions of South East Asia and northern Australia. The word monsoon is derived from the Arabic word 'Mausam' meaning; season.' They develop because of differences in heating conditions of the continent and the oceans. They are divided into 2 wind systems- the summer monsoon and the winter monsoon.

Summer monsoon

In Summer, the land gets more heated than the sea. Hence, there develops centre of low pressure on the land. Over the adjoining sea the air is comparatively cool and the high pressure develops there. This causes the wind to blow from sea to land. It is the summer monsoon.

In May, June, and July the plains of India and China are heated by the vertical rays of the sun. The intense heat develops and continental low pressure. During these months over the Indian Ocean high pressure area developed. So, the winds blow from the Indian Ocean northward and North West wards into Asia. The summer monsoon winds blow from the sea to the land they bring heavy rainfall to South East Asia. The summer monsoon winds blow south-west so they are known as southwest summer monsoons.

Winter monsoons

During the winter season, the conditions are just reverse of those summers. High pressure develops over a big landmass stretching from central Asia up to the north to the west Indian plain. At the same time low pressure zone develops in the Indian ocean. As the winds blow from the land to sea, they bring cold dry weather. They are incapable of producing rainfall.

when these winds blow over seas and pass over the adjoining land, they bring some rainfall to the southern coromandel coast Tamil Nadu in India and Vietnamese coast in the West Coast of Japan gets rain from winter monsoon. The winter monsoon winds blow north-east. So, the monsoon is known as in north-east winter monsoon.

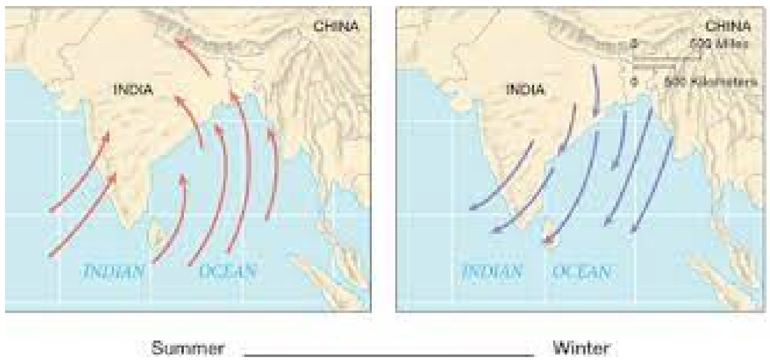

FIG 8.5 SUMMER AND WINTER MONSOON

Local Winds

Till now we were discussing the major winds of the earth's surface, which are vital for understanding the climatic regions. But we are all aware that there are winds that affect local weather. Local winds usually affect small areas and are confined to the lower levels of the troposphere. Some of the local winds are given below:

1.The Mountain and Valley Breezes

Another combination of local winds that undergoes a daily reversal consists of the mountain and valley breezes. On a warm sunny day, the mountain slopes are heated more than the valley floor. Hence, the pressure is low over the slopes while it is comparatively high in the valleys below. As a result, gentle wind begins to blow from valley towards slopes and it assumes the name of valley breeze. After sunset, the rapid radiation takes place on the mountain slopes. Here, high pressure develops more rapidly than on the valley floor. Cold arid heavy air of mountain slopes starts moving down towards the valley floor. This is known as the mountain breeze.

Hot Winds such as Loo, Foehn and Chinook are important hot winds of local category.

(1) Loo Loo are hot and dry winds, which blow very strongly over the northern plains of India and Pakistan in the months of May and June. Their direction is from west to east and they are usually experienced in the afternoons. Their temperature varies between 45°C to 50°C.

(2) Foehn: Foehn is strong, dusty, dry, and warm local wind which develops on the leeward

side of the Alps Mountain ranges. Regional pressure gradient forces the air to ascend and cross the barrier. Ascending air sometimes causes precipitation on the windward side of the mountains. After crossing the mountain crest, the Foehn winds starts descending on the leeward side or northern slopes of the mountain as warm and dry wind. The temperature of the winds varies from 15°C to 20°C which help in melting snow. Thus making pasture land ready for animal grazing and help the grapes to ripe early.

(3) Chinook: Chinook is the name of hot and dry local wind which moves down the eastern slopes of the Rockies in U.S.A. and Canada. The literal meaning of chinook is 'snow eater' as they help in melting the snow earlier. They keep the grasslands clear of snow. Hence, they are very helpful to ranchers.

(iv) Cold Winds The local cold winds originate in the snow-capped mountains during winter and move down the slopes towards the valleys. They are known by different names in different areas.

(1) Mistral Mistrals are most common local cold winds. They originate on the Alps and move over France towards the Mediterranean Sea through the Rhone valley. They are very cold, dry, and high velocity winds. They bring down temperature below freezing point in areas of their influence. People in these areas protect their orchards and gardens by growing thick hedges and build their houses facing the Mediterranean Sea.

Variable winds

These winds are related to pressure systems and blow in small areas. They are called variable because they do not blow in any different direction and their direction varies with the movement of the pressure system. Their speed also depends on the intensity of the depressions. They last only for a few days. Two chief types of variable winds are cyclones and Anticyclones.

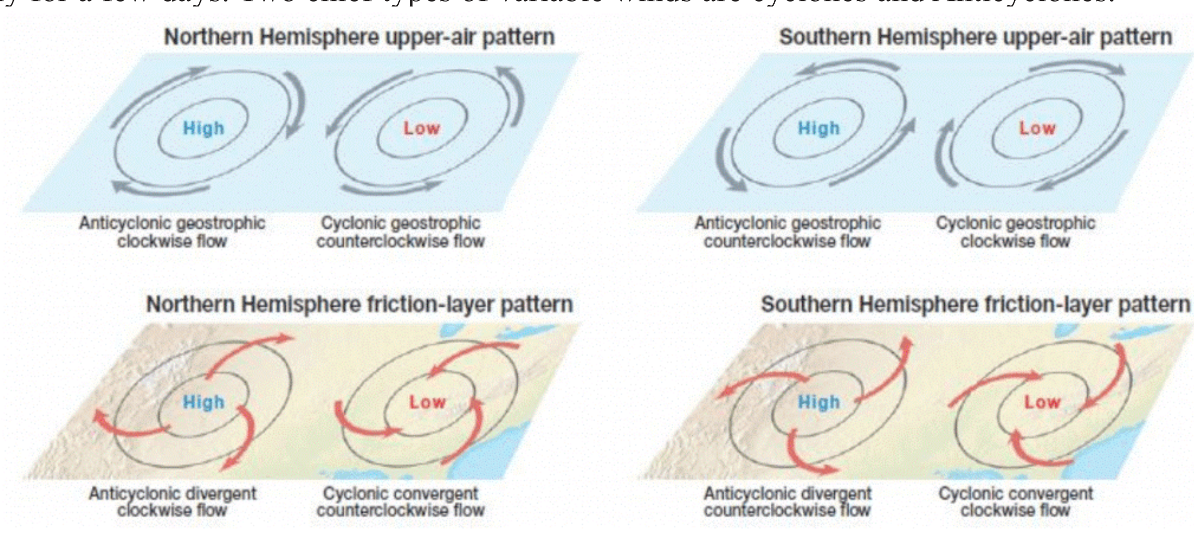

FIG 8.6 cyclone and anticyclone

Cyclones

In low latitudes and interest depression with the low-pressure centre is known as tropical cyclone in the Indian Ocean area. As hurricanes in the Caribbean, typhoons and in China and Willis in Australia.

A Cyclone is a portion of the atmosphere in which the pressure is lowest in the centre. The wind blow inward in the opposite direction. i.e from the South or south-west in front of the cyclone and from north to northwest in its rear. when a cyclone approaches, the reading on barometer falls because of low pressure, but the thermometer rises due to the warm South or South West winds. The rising moisture laden air of such a cyclone result in heavy rain in the centre of depression. cyclones on account of the corioli's force blow in anticlockwise direction in the northern hemisphere and clockwise in the southern hemisphere. Cyclones are associated with turbulent weather conditions thick cloud cover strong winds and rainfall.

Tropical cyclone

Tropical cyclones thus, cause heavy damage to the property and loss of human lives. The cyclone generally originates in the tropical region between 8 ^{0} and 20 ^{0} north and south. They are more frequent in summer because of of the movement of the doldrum belt away from the Equator. Most often they originate in the South China Sea and cause a lot of damage to life and property in the countries bordering that region. In the Bay of Bengal and Arabian Sea they cause great damage as they are strong winds even though they range is small.

The Central part of a cyclone is a calm region and is known as the eye of the cyclone surrounded by a turbulent vortex. The force of winds depends on the intensity of low-pressure centre and surrounding high pressure. The greater the difference the stronger is the wind.

Temperate Cyclones

Temperate cyclones are formed along a front in mid-latitudes between 35° and 65° N and S. They blow from west to east and are more pronounced in winter season. Atlantic Ocean and North West Europe are major regions of temperate cyclones. They are generally extensive having a thickness of 9 to11 kilometres and with 1040-1920 km short and long diameters respectively. Each such cyclone alternates with a high-pressure anticyclone. The weather associated with the cyclone is drizzling rain and of cloudy nature for number of days. The anticyclone weather is sunny, calm and of cold waves.

Anticyclones

An anticyclone is a fine atmospheric condition. There is a high pressure in the core our centre and low pressure around it. Winds blow gently outwards. These winds are clockwise in northern hemisphere and anticlockwise in southern hemisphere. They are centres of high pressure. They are found in regions of descending air currents.

Jet streams

Jet streams refer to the concentrated bands of rapid air movement found at the tropopause and in the stratosphere, located at 10 to 15 kilometres above the surface of the earth. They are found near boundaries of adjacent air masses with significant differences in temperature such as polar region and the warmer air to the South. They are associated with latitudes where the poleward temperature gradient is particularly strong. Two such zones occur at about 30^0 latitude and other in the polar front zone in each hemisphere. The major jet stream are westerly winds flowing west to east in northern hemisphere during the summer, easterly jets are formed in tropical regions, typically in a region where dry air encounters more humid air at high altitudes. Low level jets can form wherever low-level winds are squeezed together, typically between and oncoming front and a high-pressure cell.

Importance of jet streams

most weather systems do not just sit over an area, they are instead moved forward with the jet stream. The position and strength of the judge stream then helps meteorologists forecast future weather events.

The airline industry consistently uses the jet stream for its flights. By flying commercial aircraft within jet stream, the flight time gets reduced. The reduced flight time and aid of the strong winds lead to reduction in fuel consumption.

Whatever the position of a jet stream it has a significant impact on the world's weather pattern and severe weather events like floods and droughts. It is therefore essential that meteorologist understand as much as possible about the jet streams and continue to track its movement to monitor weather conditions around the world.

Check your Progress

(i) What are trade winds? How are they caused?

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(ii) What are Westerlies?

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(iii) **What are periodic winds? Give examples?**

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8.8 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. Due to Coriolis force, winds deflect from their original course. In Northern Hemisphere they deflect towards their right and in Southern Hemisphere towards their left. This is known as the Ferrel's law. Winds are grouped under planetary, Periodic and local winds. Planetary winds blow in the same direction throughout the year, while the other types of winds get modified due to certain reasons. 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.

8.9 Check your Progress – Model answers

(i) The weight of the air on a unit area of the earth is called *Air Pressure.*

(ii) There are various factors responsible that affect distribution of air pressure are as the following: altitude, temperature, water vapor, rotation of the earth etc.

(iii) On the earth surface there are in all 7 pressure belts. They are Equatorial low, the two subtropical high-pressure belts, the two subpolar lows and the two polar high-pressure belts. Except the Equatorial low the others form matching pairs in the northern and southern hemispheres.

(iv) The winds blowing from the subtropical High- Pressure area (30^0 N&S) towards the Equatorial Low-Pressure belt or the extremely steady winds known as the Trade winds.

(v) The westerlies or the Prevailing westerly winds below between 30^0 and 60^0 North and South latitudes from Sub-Tropical High-Pressure Belts towards the Sub-Polar Low-Pressure Belts.

(vi) Periodic winds blow at regular intervals in regular cycle. These winds occur due to temperature and pressure differences. Land and sea breeze are best examples of Periodic winds.

8.10 Terminal Questions:

Essay question

1. Explain the factors affecting the distribution of air pressure? Explain.
2. Describe the atmospheric pressure belts of the world with a neat diagram?
3. What are planetary winds? How many types are there? Explain.

Short questions

4. What are Local Winds? Give examples.
5. What are land and sea breezes?
6. Explain a sea breeze with the help of a diagram
7. What are Monsoon Winds? How are they caused?
8. What is a Cyclone? How is it caused?
9. Describe the weather conditions associated with the cyclones.
10. What are Anticyclones? How are they caused?
11. What are Tropical and Temperate Cyclones?

Very short question

12. Define pressure gradient?
13. What are doldrums?

14. What are horse latitudes?

8.11 Further Readings:

- Holden, Joseph. (2004). Introduction to Physical Geography and the Environment. Prentice-Hall, London.
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Chapter - 9

PRECIPITATION FORMS AND TYPES OF RAINFALL

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Earth is known as blue planet. 71% of its surface consists of water, which is essential for continuation of life on the Earth. Water exists on the Earth's surface in solid, liquid, and gaseous states. Latent heat is required for transformation of water from one state to another. This heat is released into the air at the time of condensation, which is referred to as latent heat of condensation. Humidity is the amount of moisture that is present in the air. The proportion of moisture in the air is not same everywhere. It varies from place to place and from time to time. Moisture content is less in arid regions and more in humid regions. It is invisible and can be seen when water vapour is converted into droplets of water or crystals of ice by the process of condensation.

9.1 Learning Objectives

- To distinguish between Absolute and Relative humidity;
- To establish relationship between temperature and Humidity (absolute and relative humidity)
- To distinguish between saturated and unsaturated air;
- To identify the factors affecting the rate of evaporation;
- To explain the latent heat and its importance;
- To discuss the various forms of condensation;
- To explain conditions favourable for precipitation;
- To differentiate between the three types of rainfall with the help of diagrams;
- To describe the salient features of distribution of precipitation in the world with reference to regional and seasonal variations;
- To identify the factors affecting world precipitation distribution.

9.2 Humidity

Humidity is a general term which indicates the amount of moisture or water vapour in the air. There is a close relationship between humidity and the temperature of air. The capacity of the air to contain water vapour depends upon the temperature. The water holding capacity of air increases with increase in temperature. Higher the temperature, higher is the water holding capacity of air.

1. The water vapour present in the rain- bearing clouds is responsible for all kinds of precipitation.

2. Water vapour absorbs radiation both incoming and outgoing. It thus, plays a crucial role in the Earth's heat budget.

3. The amount of water vapour present decides the quantity of latent energy stored up in the atmosphere for the development of storms and cyclones.

4. The amount of moisture in Air effects the rate of cooling of human body.

9.3 Measurement of Humidity

The air is termed as humid when it has large content of water vapour and it is said to be dry when the water vapour is less. Humidity in air is expressed in three ways:

1. Absolute Humidity:

Absolute Humidity is the amount of water vapour which is present in the air. It is expressed in grams of water vapour per cubic metre of air. Absolute Humidity varies with expansion and contraction of air. It changes with change in temperature.

2. Specific Humidity

Specific Humidity is a weight of water vapour, for weight of given mass of air. specific humidity is measured as grams of water vapour per kilogram of air. specific humidity is maximum at equator and minimum at poles. It is expressed as grams of water vapour per kg of moist air mass. The amount of water vapour that air can hold depends upon temperature. Specific humidity at 20°C is 15g per kg. At 30°C, it is 26 g per kg and at -10°C, it is 2 g per kg. Suppose, 1kg of air contains 12 grams of water vapours, then the specific humidity of air is 12 g per kg.

3. Relative Humidity:

Relative humidity is expressed as a ratio between the amount of water vapour present in the air to the amount of water vapour that air can hold, at given temperature. Relative Humidity is also called as saturation humidity. It is expressed in percentage. Relative humidity (RH) is always expressed as percentage. Suppose an air mass of 1kg contains 9 gram of water vapours at a given temperature and constant pressure. But 1kg of an air mass has the capacity to contain 12 gram of water vapours at the same temperature and pressure.

$$\therefore RH = 9/12 \times 100 = 75\%$$

Relative humidity may also be defined as the ratio of actual vapour pressure to that required for saturation at the same temperature. Relative humidity tends to be higher during winter over land, except during monsoon period. Relative humidity is higher over the oceans during summer season.

9.4 Distribution of Water Vapour

Horizontally, the water vapour in air, decreases from the Equator towards the poles, in an irregular fashion, with the horizontal temperature gradient.

The oceanic air may be saturated to the extent of 80%, while the continental air has comparatively less moisture, to about 20%. With increase in altitude the capacity of the air to hold moisture also decreases, as the temperature decreases.

During day Absolute humidity is high in the afternoon, and comes down as the temperature decreases in the evening. The relative humidity is low during early morning.

9.5 Evaporation and Condensation

The amount of moisture present in the atmosphere gets added or withdrawn by the process to evaporation and condensation respectively. The process by which water is transformed from liquid to gaseous state is called evaporation. The main cause for evaporation is Sun's radiant heat. The temperature at which the water starts evaporating is referred to as the latent heat of vaporisation. Hot air has more water absorption and retention capacity. Movement of air replaces the saturated layer with the unsaturated layer. Hence, the greater the movement of air, the greater is the evaporation. The change of state of water vapour(gaseous) into water(liquid) is called condensation. Condensation is caused by the loss of heat. Cooling of moist air continuously, causes the air to reach a level when its capacity to hold water vapour stops. At this stage, the excess water vapour condenses into liquid form. If it directly condenses into solid form, it is referred to as sublimation. With increase in height, temperature decreases, the rate of decrease of temperature with increase in altitude is termed as **lapse rate** which is about $56.5^{0\ \mathrm{Celsius}\ /\mathrm{KM}}$. With decrease in temperature the capacity of the air to hold water vapour decreases. Hence, if relative humidity increases, then air is said to be saturated. The limit at which relative humidity reaches 100%, This point is called ***dew point***.

Condensation takes place when:

- In free air, condensation results from cooling around very small particles termed as hygroscopic condensation nuclei. Particles of smoke, dust and salt from the ocean are particularly good examples as they absorb water.
- Condensation also takes place when the moist air meets some colder object.
- It may also take place when the temperature is close to the dew point.

Condensation, therefore, depends upon the level of cooling and the relative humidity of the air. Condensation is affected by the volume of air, temperature, pressure, and humidity. Nevertheless, the most favourable condition for condensation is the decrease in air temperature.

Forms of Condensation: After condensation the moisture in the atmosphere takes one of the following forms — dew, frost, fog, and clouds. Forms of condensation can be classified based on temperature and location. Condensation takes place when the dew point is lower than the freezing point as well as higher than the freezing point.

Dew: When the moisture in air gets deposited in the form of water droplets on cooler surfaces of the Earth surface's such as stones, grass blades and leaves, it is known as dew. The ideal conditions for its formation of dew are clear skies, calm air, high relative humidity, and colder and long nights. Dew occurs, when the dew point is above the freezing point.

Frost: Frost is formed on cold surfaces, when condensation takes place below 0^0 Celsius, i.e., the dew point is at or lower than the freezing point. The excess moisture present in the air is deposited as minute ice crystals instead of water droplets. The conditions ideal for the formation of white frost and dew are the same, except that the temperature of the air must be at or below 0^0 Celsius (freezing point).

Fog and Mist: When the temperature of the air mass containing a large quantity of moisture decreases suddenly, it leads to condensation within itself on fine dust particles in the lower layers of air. So, the fog is a cloud with its base at or very near to the Earth's surface Fog and mist, reduces the visibility. In urban and industrial areas smoke provides supplies much needed nuclei which help the formation of fog and mist. Such a condition when fog is mixed with smoke, is described as smog. Major difference between the mist and fog is that mist has more moisture compared to the fog. In mist each hygroscopic nuclei contains a denser layer of moisture.

Check your Progress

1. Define Humidity?

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2. What are the four chief forms of condensation?

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9.6 Precipitation

The process through which, water from the atmosphere falls on the earth is called precipitation. In this process, no change of state of water is involved. Precipitation occurs when tiny droplets, joined together into large rain droplets, become heavier and fall to the Earth's surface through the atmosphere.

Forms of Precipitation**:**

The precipitation takes place in many different forms in the regions located in the middle latitudes.

Typical characteristics of various forms of precipitation are explained below:

Rain: Precipitation that reaches the ground in liquid form is called rain. Rain drops are 0.5 millimetres to 6.35 millimetre in diameter. The precipitation in the form of water droplets is called rainfall. Small drops of rain which float in air is known as drizzle.

Drizzle: They are tiny water droplets of size between 0.1 to 0.5 mm which fall with such slow settling rates that they occasionally appear to float.

Snow: when the temperature is lower than the freezing point, precipitation takes place in the form of fine flakes of snow and is called snowfall. Water vapour is released in the form of hexagonal crystals. These crystals form flakes of snow.

Sleet: Besides rain and snow, other forms of precipitation are sleet and hail, though the latter occur very rarely, and are sporadic in both time and space. Frozen raindrops are known sleet and refrozen melted snow-water. When a layer of air with the temperature above freezing point overlies a sub-freezing layer near the Earth's surface, precipitation takes place in the form of sleet.

Hail: Drops of rain, which leave the warm air, encounter the cold air below, solidify and reach the Earth surface as small pellets of ice which are not bigger than the raindrops from which they are formed. At times, raindrops after being released by the clouds solidify into small rounded solid pieces of ice and which reach the surface of the earth are called hailstones. These are formed by the rainwater passing through the colder layers of atmosphere. Hailstones have several concentric layers of ice one over the other.

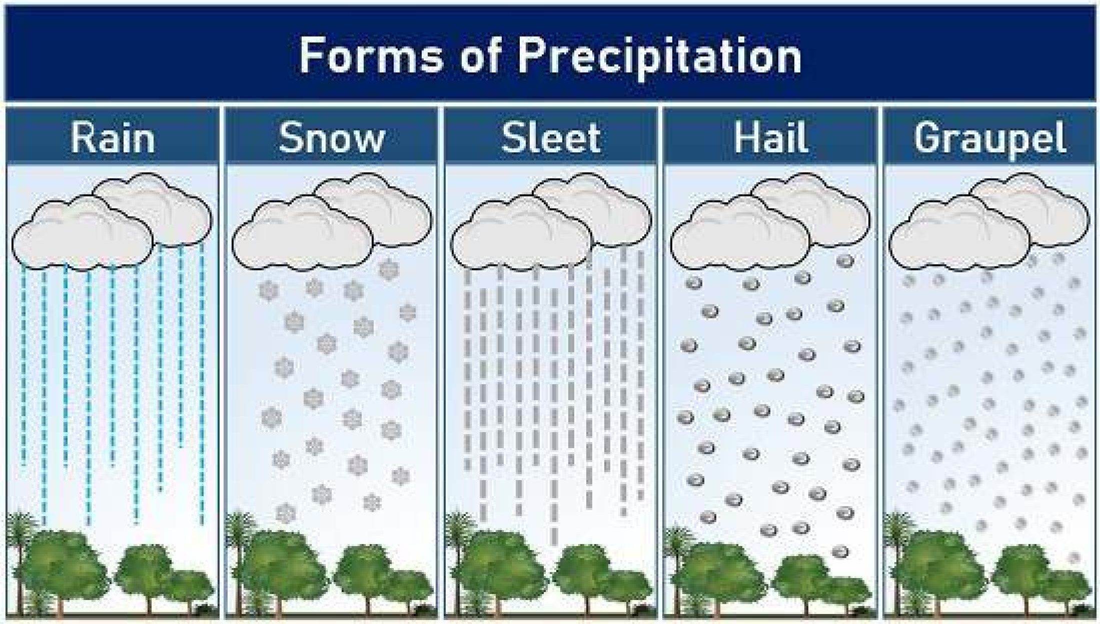

Fig 9.1 Forms of Precipitation

Stages in the Rain Formation:

The first stage is **nucleation.** In this stage water collects on condensation nuclei and forms tiny cloud drops. This type of nucleation occurs in the tropics. Outside the topics, water vapour condenses directly on ice crystals so that they grow bigger and bigger.

In the second stage, the droplets of crystals continue to grow though condensation. If the drops of crystals grow large enough, they start falling.

Factors determining rainfall

The type, and the amount of rainfall is closely related to pressure and wind built. It varies from season to season. The amount of rainfall depends on the moisture content of the air which depends on 3 main factors.

1. Land and sea contrast: More rainfall occurs along coastal regions, since the source of water vapour, the sea, is closer than in the interior of continents.
2. Direction of prevailing winds: winds from sea (Onshore) bring more rainfall than winds blowing from the land (Offshore).
3. Presence of mountains when mountains obstruct moist winds, they are forced to give rain on the windward side. The leeward side remains dry.

The side of the mountain facing the wind is known as the windward side. The side of the mountain facing away from the wind is known as Leeward side. They Leeward side of the mountain is also known as the rain shadow since it receives very little or no rain.

9.8 Types of rainfall

Precipitation is the natural process of conversion of atmospheric vapour into water. The water so formed then falls to the earth in the form of a rainfall. In terms of hydrology rainfall constitutes the third phase of atmospheric division of the hydrologic cycle, "the change of state". The term precipitation is also used for rainfall. Precipitation is however, a general term and includes all forms of falling moisture viz., rainfall, snowfall, sleet, hail etc.

Different types of rainfall can be recognised according to the process by which warm and moist air mass gets lifted and subsequently cooled. Broadly speaking there are three types of rainfall.

(1) Conventional rainfall

The sun warms the earth and air above it. As the heated air rises higher into the atmosphere, it expands and cools. The air eventually becomes saturated and rain occurs**. Convention currents** are normally set up in the atmosphere due to local heating. The current rise at the centre and are drawn up from the side.

The very rapid rising of warm moist air results in the formation of Cumulonimbus Clouds. These clouds give heavy rain, usually accompanied by thunder and lightning, but the rainfall does not last long. These are called **Thunder showers**.

Conventional rainfall is very common in the **Equatorial region,** where it occurs almost every day in the afternoon. Hence, also called the 4:00 o'clock rain.

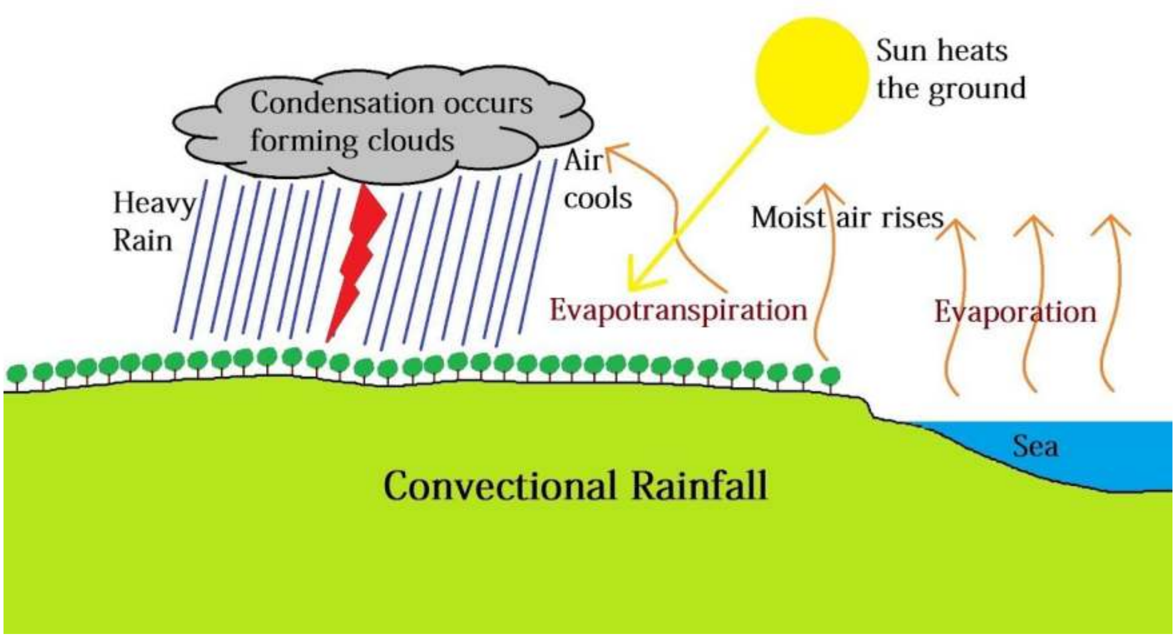

Fig 9.2 Convectional Rainfall

(2) Relief or Orographic Rainfall

This is the most widespread form of rainfall. When moisture bearing wind encounters a mountain barrier, it is forced due to rise. As The Wind rises the mountain, it cools to its saturation point. on further cooling rain occurs.

The windward side of the most mountains receive more rain than the Leeward side. As the wind moves down to the leeward side of the mountain, the amount of rain decreases significantly.

By the time the winds reach the leeward side, they are quite dry. But more importantly, as the air moves down the slope, it warms up again, reducing the chances of rain.

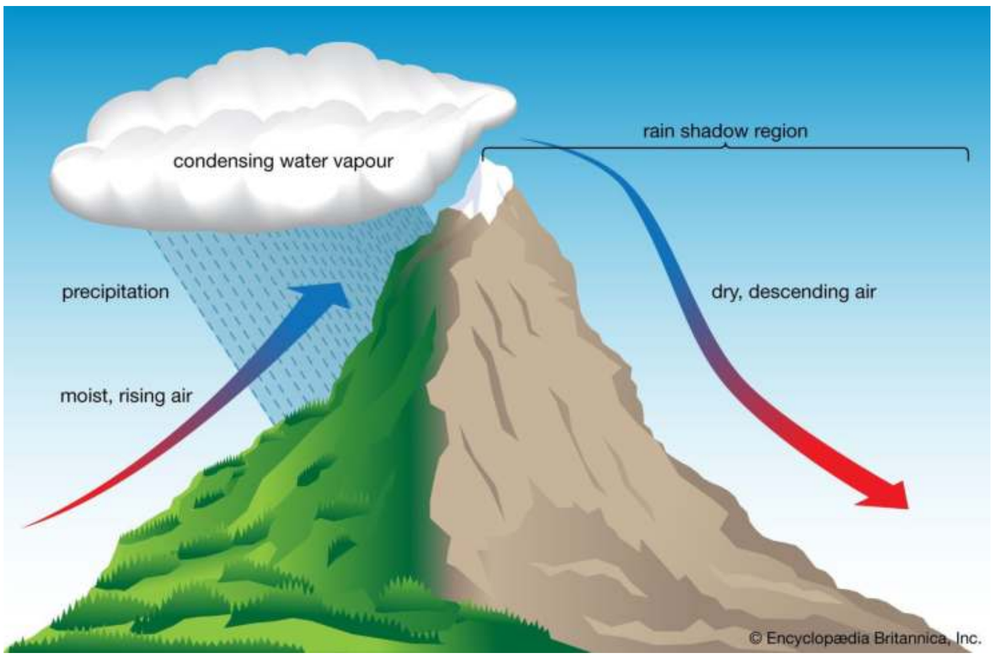

Fig 9.3 Orographic Rainfall

(3) Cyclonic or frontal rainfall

This type can be sub-divided into:

(a) Frontal and

(b) Non-frontal precipitation. This type of rainfall occurs from lifting of air which converges into a low pressure area or cyclone. This type of rainfall generally occurs in plain regions.

(a) Front type of precipitation:

Front is a boundary joining warm moist air mass and cool air mass. When a moving warm moist air mass is obstructed by a stationary cold air mass, the warm air mass rises up as it is lighter than the cold air mass. Sometimes cold moving air mass meets stationary warm air mass with similar results.

The lifted air mass cools down at high altitudes and precipitation occurs. This process continues till the whole warm air mass passes over the cold air mass. A showery type precipitation occurs in case of cold front whereas in case of warm front precipitation continuous rainfall occurs till the warm front passes over the cold air mass.

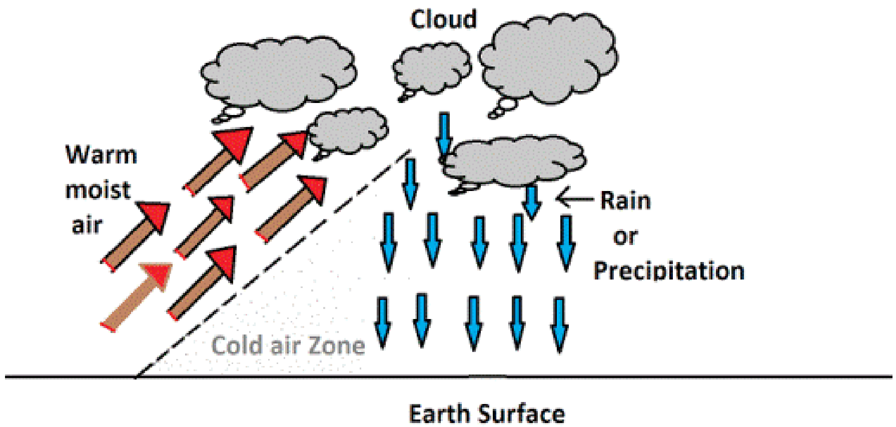

Fig 9.4 Non-frontal Rainfall

(b) Non-frontal precipitation:

This type of rainfall is not related to fronts. When the moving cold air mass meets the warm moist air mass moist and warm air mass gets lifted up being lighter than the cold air mass. When the warm air mass cools down at high altitude precipitation occurs.

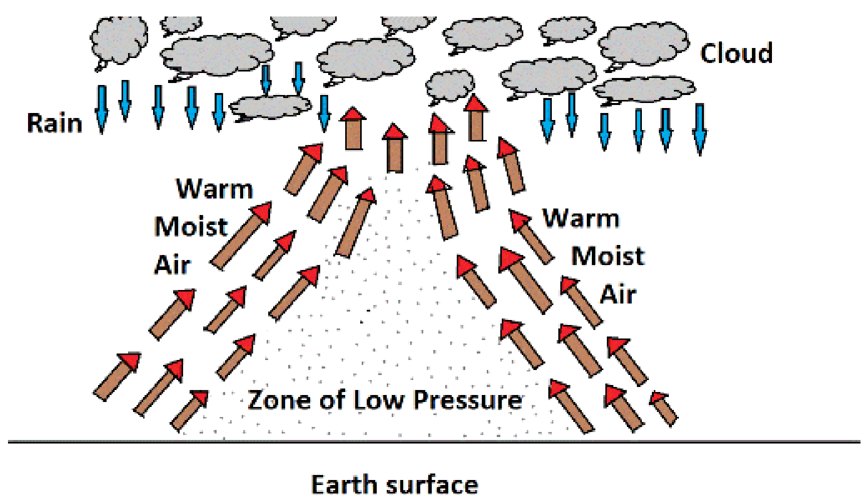

Fig 9.5 Non-frontal Rainfall

9.9 World Distribution of Rainfall

Regions of heavy Rainfall

1. **The Equatorial regions** receives conventional rain through-out the year. The rate of evaporation is high since temperature remaining high through-out the year.

2. **Eastern margins** of continents in the subtropical latitudes come under influence of Trade winds throughout the year. These winds blow from the sea bringing plenty of rainfall to the Eastern margin.

Western margins of continents between latitudes 40^0 and 60^0 come under the influence of the westerlies throughout the year. These winds blow from sea, bringing plenty of rain to Western margins.

Regions of Scanty Rainfall

Polar Regions: These regions receive very little rainfall. Due to the extremely low temperature, there is very little evaporation and precipitation.

Western margins of continents in the Trade wind Belt: since the Trade winds blow from the eastern direction, they shed most of the moisture on the eastern margins of the continents. They are dry by the time they come to the western margins. That is why the Tropical deserts are located on the western margins of continents.

Eastern margins of continents in the westerlies wind Belt: since the westerlies blow from the West margins. they shed their moisture on the western margins of continents. they are dry by the time they come to the eastern margins. This is why temperate deserts are located on eastern margins of continents.

- The total volume of water in the oceans and seas remains constant because all the water that evaporates from the earth's water bodies is eventually returned to it directly by the process of condensation and precipitation, and indirectly by stream and overflow from land surfaces.
- In Equatorial regions the sky often remains overcast with clouds due to excessive heat. The high temperature leads to the rapid heating of air. Such heated air rises in convectional currents, leading to development of clouds at about 10 km height.
- Human comfort depends on humidity because highly humid air is more oppressive. The human body dissipates heat through perspiration and its evaporation. Under conditions of high relative humidity, the rate of evaporation of sweat from the skin decreases and the human being feels warm and uncomfortable.
- Condensation is the reverse process of evaporation as evaporation is the process by which water vapour enters the atmosphere on heating while condensation is the process by which water vapour is converted back to water droplets on cooling.

- Coasts receive more rainfall than the interior of the continents because the humidity in the clouds is high when they are at the coast. When they reach the interior of the continents, they have already shed water in the form of rain, and so, they do not have much humidity left to cause rainfall.
- The windward sides of mountains receive more rainfall than the leeward sides because the sudden ascent of warm moist air on the windward sides causes cooling of air, leading to condensation and precipitation.
- On the contrary, on descending the leeward slope, a decrease in altitude increases both the pressure and the temperature, leading the air to get compressed and warm. Consequently, the relative humidity drops and there is evaporation and little or no precipitation in the rain shadow area.

Clouds: Cloud is an aggregate of minute water droplets or tiny crystals of ice formed by the condensation of the water vapour in free air at considerable altitudes. The clouds are formed at varying height over the surface of the earth; Hence, they take various shapes.

Types of clouds: According to their elevation, expanse, density, and opaqueness clouds are classified under four types: (i) cirrus; (ii) cumulus; (iii) stratus; (iv) nimbus.

- **Cirrus:** Cirrus clouds are formed at higher altitudes between8,000 - 12,000m. They are thin and detached clouds with a feather like appearance. They are almost always white in colour.
- **Cumulus:** Cumulus clouds appear like cotton wool. They are mostly formed at an elevation of 4,000 - 7,000 m. They exist in patches in the sky and can be seen in dispersed pattern. They have a flat base.
- **Stratus**: Stratus refers to layers, these clouds cover large portions of the sky. They are generally formed either due to loss of heat or by the mixing of air masses of different temperatures.
- **Nimbus:** Nimbus clouds appear black or dark grey in colour. They form at lower levels or very near to the surface. They are rain bearing clouds.

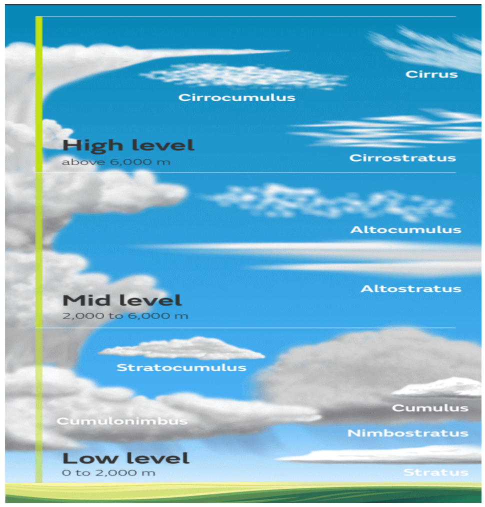

Fig 9.6 Types of Clouds

On the basis of altitude, the cloud can be classified as the following types**. They are:**

(i) **High Altitude clouds:** These are found 20,000ft or higher above the land surface. Cirrus, Cirrostratus, and Cirrocumulus are the cloud types found here.

(ii) **Middle Altitude Clouds:** These are found between 6,500ft to 20,000ft above the land surface. Altostratus and Altocumulus are the cloud types found here.

(iii) **Low Altitude Clouds:** These cloud types can be found from ground level to about 6,500ft above it. They include Stratus, Stratocumulus, and Nimbostratus clouds.

(iv) **Vertical Clouds:** These are clouds that extend from the lower to the higher altitudes of the atmosphere. They form by thermal convection or frontal lifting, sustained by the powerful convectional current that holds and pushes the moisture in the clouds further upward. An example of a vertical cloud is the Cumulonimbus cloud.

Check Your Progress

3. What do you mean by Precipitation?

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4. What are the types of clouds? Explain.

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9.10 Summary

Water vapour in the Air is not constant. It is highly variable. It is the most significant component of atmosphere. Moisture in air is responsible for global heat balance, all atmospheric phenomenon and for sustainability of plant and animal life on our Earth. The moisture present in the atmosphere is called humidity, which is expressed as absolute humidity and relative humidity. The relative humidity of air is the most reliable measure. Water vapour enters 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 water vapour to its full capacity is called saturated air and the temperature at which air gets saturated is termed as dew point. The process of changing of water vapour into liquid or solid state is known as condensation. It occurs when temperature of an air falls below dew point. Condensation happens near the ground as dew, mist, or fog and at higher levels of clouds. Continuous condensation of water vapour in air is called precipitation. Drizzle, rainfall, snowfall, sleet, and hail are various forms of precipitation. The rainfall occurs in three different types conventional, orographic, and cyclonic. The distribution of precipitation across the world shows marked regional and seasonal variation. Some regions receive heavy rainfall while others receive scanty rainfall. There are some regions which receive precipitation throughout the year while others experience only in the winter or summer.

9.11 Check your progress- Model answers

(i) Humidity is a general term which indicates the amount of moisture or water vapour in the air. There is a close relationship between humidity and the temperature of air.

(ii) Forms of Condensation: After condensation the moisture in the atmosphere takes one of the following forms — dew, frost, fog, and clouds.

(iii) The process through which, water from the atmosphere falls on the earth is called precipitation. In this process, no change of state of water is involved.

(iv) Types of clouds: According to their elevation, expanse, density, and opaqueness clouds are classified under four types: (i) cirrus; (ii) cumulus; (iii) stratus; (iv) nimbus.

9.12 Terminal Questions

Essay

1. Distinguish between Absolute Humidity and Relative Humidity.
2. Describe the different forms of precipitation?
3. Define Rainfall? Explain the different types of rainfall?

Short questions

1. What is ‘humidity’? How is humidity measured?
2. Explain the relative humidity?
3. Define the terms ‘fog’ and ‘mist’?
4. Describe the distribution of rainfall?
5. Explain the orographic rainfall with a neat diagram?
6. Explain the types of clouds on the basis of altitude?

Very short questions

7. Define specific humidity?
8. What do you mean by hail?
9. Define the term cloud?
10. Define cirrus clouds

9.13 Further References:

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Chapter - 10

OCEAN AND SUBMARINE RELIEF

Contents

10.0 Introduction

10.1 Objectives

10.2 Ocean basins

10.3 Submarine relief features

10.4 Summary

10.5 Check Your Progress – Model answers

10.6 Terminal questions

10.7 Further Readings

10.0 Introduction:

Water is necessary for living organisms on the earth. All life processes, including cell development, protein synthesis, photosynthesis, and the uptake of substances by plants and animals, depend on water. Despite the fact that some living things can survive without air, but no one organism can survive without water. The hydrosphere is made up of all the water on earth. Water exists in three states, in liquid state, it includes rivers, lakes, wells, springs, seas, and oceans; solid in the form of ice and snow; and gaseous in the form of water vapour, which is a component of the atmosphere but also a part of the hydrosphere. The largest bodies of water in the hydrosphere are oceans. This lesson will cover ocean basins, their relief, the causes and effects of ocean water circulation, and the significance of oceans for humankind.

10.1 Objectives

After learning this lesson, you will be able to:

- Understand importance of water on earth
- Recognise various oceans
- Identify different submarine relief features

10.2 Ocean basins

Our earth is frequently referred to as a "watery planet" because it is the only planet in the solar system which comprises of abundance of water. Water covers about 71% of the earth's surface. Oceans form a single, large, continuous body of water encircling all the landmass of the earth. They make up four-fifth of the Southern Hemisphere and three-fifth of the Northern Hemisphere, respectively. They hold 97.2 percent of the water in the entire world. In the world, there are five major oceans that are primarily distinguished by their geographic locations. The Pacific Ocean, Indian Ocean, Atlantic Ocean, Antarctic Ocean and Arctic Ocean are among them. All the other seas, inland seas or the arms of the oceans, are counted within these four main oceans.

The Pacific Ocean: It is the largest and deepest ocean in the world and it makes up about one-third of the planet's surface. With its apex in the north at the Bering Strait, it has a roughly triangular shape and many marginal seas, bays, and gulfs line its edges. In this vast ocean there are nearly 20,000 islands.

The Atlantic Ocean: The Atlantic Ocean is the second-largest ocean in the world after the Pacific Ocean, and it is roughly half the size of the Pacific Ocean. This ocean resembles 'S' latter in shape. It is the most significant ocean in terms of trade. Several seamounts form islands of the mid-Atlantic. Examples include Pico Island of Azores, Cape Verde Islands, Canary Islands etc.

S. No	Name of Ocean	Area (in million km2)	Average Depth (in metres)
1	Pacific Ocean	168 (46.6%)	3,970
2	Atlantic Ocean	85 (23.5%)	3,646
3	Indian Ocean	70 (19.5%)	3,741
4	Antarctic Ocean	21 (6.1%)	3,270
5	Arctic Ocean	15 (4.3%)	1,205

Indian Ocean: The Indian Ocean is the third largest ocean basin in the world and it is smaller and shallower than the Atlantic Ocean. Its north part resembles 'M' letter in shape. This ocean is named after India. Most of the islands in the Indian Ocean are continental islands. They are present in the north and west parts and they include the Andaman and Nicobar, Sri Lanka, Madagascar and Zanzibar islands etc.

Figure 10.1

Antarctic Ocean: It is the fourth largest ocean in the world. The most southerly of the planet's five oceans is the Antarctic Ocean, also referred to as the Southern Ocean. It connects the southern waters of the Pacific, Indian, and Atlantic oceans and completely envelops the continent of Antarctica.

Arctic Ocean: The Arctic Ocean encircles the North Pole and is found inside the Arctic Circle. This is the smallest among the five oceans in the world. It is connected to the Pacific Ocean by the Bering Strait, a confined area of shallow water. It is encircled by the northern coasts of North America and Eurasia landmasses.

Check Your Progress

(i) Planet Earth is also known as watery planet? Why?

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(ii) Explain about ocean basins in the world?

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10.3 Submarine Relief Features

Oceanic bottom relief or submarine relief features are mostly resultants of various geomorphic process such as tectonic, volcanic, erosional and depositional and their interactions. Oceanic relief regulates the movement of ocean water. The movement of oceanic water in the form of ocean currents, in turn, leads to several changes in both oceans and atmosphere. Submarine relief of oceans also influences navigation and fishing activities. According to the studies the average depth of the oceans is about 3800 m whereas the average height of the lithosphere is 840 m from the mean sea level. These variations in heights and depth zones of the lithosphere and hydrosphere on the earth planet are represented by a hypsometric curve.

A hypsometric curve, also known as Hypsographic Curve, is a histogram or cumulative distribution function of the earth surface and some part thereof. The variations in hypsometric curves between the landforms arise due to various geomorphic process that alter the landscape may be different.

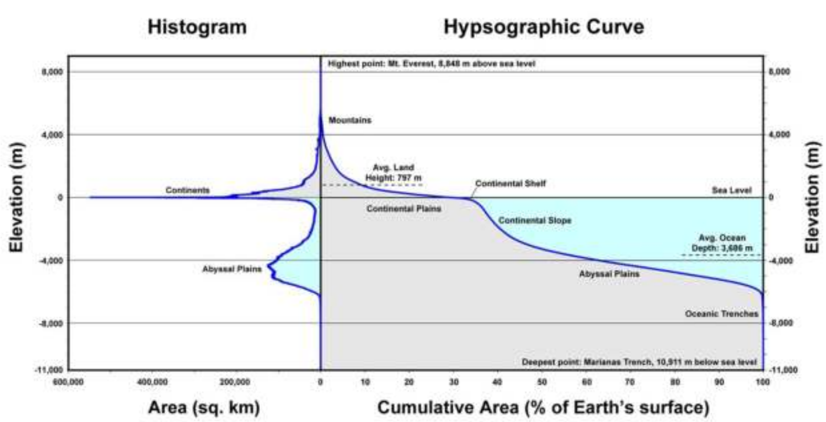


Figure 10.2

When a 2D hypsometric drawn, it discloses the elevation on Y axis (vertical) and area above the corresponding elevations on the X axis (horizontal) (Fig 1.2). The curve can also be display in non-dimensional form by scaling elevation and area by the maximum values.

The bottom of oceans conceals a wide variety of terrain that is very similar to that found on the continents. In ocean bottom, there are also mountains, basins, plateaus, ridges, canyons, and trenches etc features. These relief features found on the ocean floor are called submarine relief. There are two types of submarine relief features on ocean bottom. They are (A) Major relief features, and (B) Minor relief features.

(A) Major Relief Features

In the ocean basins, the major submarine relief features are subdivided into four relief features. They are:

(1) Continental Shelf (2) Continental Slope

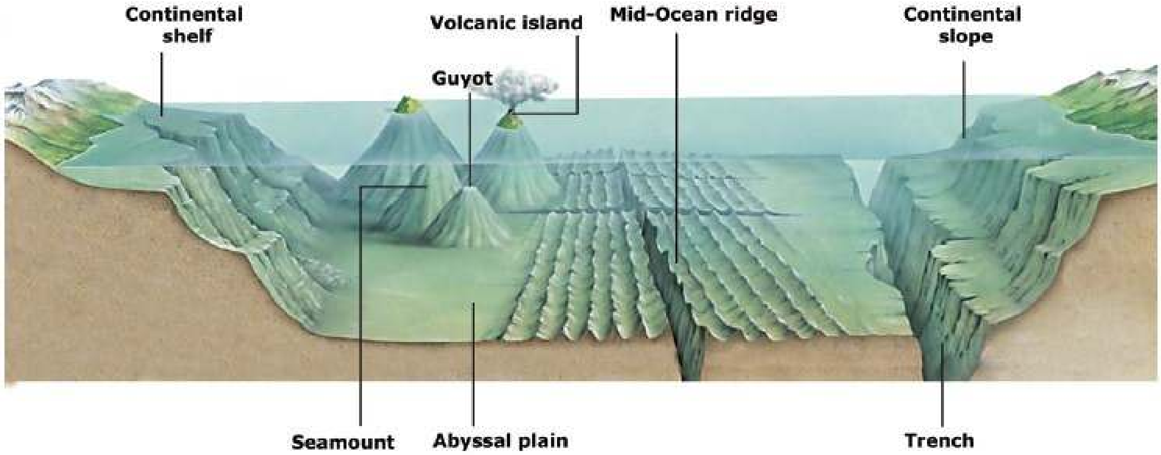
(3) Abyssal Plain (4) Oceanic Deeps

(1) Continental Shelf:

The gently sloping seaward extension of a continental plate is known as a continental shelf. They slope seaward from the coast to a point where the slope becomes very steep. The shallow submerged extension of continent is called the continental shelf. It has a gradient of 1° to 3°. Shallow seas and gulfs are connected to these extended margins of all continents. The depth of this shallow sea water over the continental shelf is upto 200 metres. The width of the continental shelf varies greatly ranging between a few kilometres to more than 100 kilometres. The continental shelves, which make up 7.5% of the total oceanic surface area. Most of the continental shelves represent land which has been inundated by a rise in sea level.

The continental shelves are crucial to humankind. The shallow water surrounding the shelf allows sunlight to reach the bottom and promotes the growth of microscopic organisms known as planktons. Fish eat these planktons as food. Fish, minerals, and other materials like sand and gravel are found on continental shelves. These shelves provide a significant portion of the world's natural gas and petroleum supplies. Examples of on shore drilling on the continental shelf include the Bombay High and the recent discovery of petroleum in the Godavari basin. On continental shelves, lipoclastic materials and coral reefs are also typical.

- Continental shelf is the submerged portion of the continent which gradually slope seawards from the shore line.
- Submarine canyon is a deep valley cut into a continental shelf and extends to continental slope.



Source: https://www.brainkart.com

(2) Continental Slope

The "continental slope" refers to the continuously sloping portion of the continental margin that lies seaward of the continental shelf and descends to the abyssal plain's deep ocean floor. The gradient of the slope region varies between 2-5°. The depth of the slope region varies between 200 and 2,000 m. The continental slope boundary indicates the end of the continents. The continental slope can reach great depths in some places, such as off the Philippine coast. Canyons and trenches are observed in this region. Continental slopes, mainly due to their steepness and increasing distance from the land have very little deposits of sediments on them. Sea life is also far less here than on the shelf.

- Continental slope is the steeply sloping part of the sea floor which marks the boundary between the sea floor and the continental shelf.
- The belt of sediments deposited along the base of the continental slope is called continental rise.

(3) Abyssal Plain

Abyssal plains are featureless, incredibly flat plains found on the deep ocean floor. The depths vary between 2,000 and 6,000 metres. The abyssal plains are probably the flattest places on the planet because of terrigenous and shallow water sediments that buries the irregular topography. These sediments are called oozes. Some of the open seas do not support enough life to produce ooze on the floor. They are covered with a type of sediment called red clay which is of volcanic origin or made up of tiny particles brought by wind and rivers. Previously thought to be featureless plains, modern technology has revealed that they are just as irregular as the continental plain or surface. They have numerous seamounts, hills, guyots, and subaerial plateaus.

(4) Oceanic Deeps

The deepest parts of the ocean are called as 'oceanic deeps'. They are generally referred to as trenches or troughs. These trenches relatively long, narrow, steep sided and flat-floored depressions on the ocean floor. These trenches are not always located in the middle of the ocean basins, as may be generally expected but are situated very close or parallel to the continents bordered by fold mountains or the island chains. They are usually associated with the areas of active volcanoes and strong earthquake activity. Great earthquakes and tsunamis are born in them. Mostly they occur in all the major oceans, but majority are found in Pacific Ocean followed by Atlantic and Indian Ocean. The Mariana Trench (11034 metres depth) in 'the Pacific Ocean is the deepest known part of the oceans.

- Abyssal plains are undulating plains of enormous extent which have many irregularities such as submarine plateaus, hills, guyots and seamounts.
- Long, narrow steep sided and flat floored depressions in the oceans are known as ocean deeps.

(A) Minor Relief Features

The minor relief features on ocean bottom includes oceanic ridges, seamounts, guyots, atolls, and reefs etc.

Mid Oceanic Ridges: The lofty mountains that found on ocean bottom are called as oceanic ridges or submarine ridges. The mountain ranges, sometimes, have peaks as high as 2,500 m and some even reach above the ocean's surface. They are linear belts occurring near the middle of the oceans along divergent plate margins and are also called mid-oceanic ridges. For example, Mid Atlantic Ridge in Atlantic Ocean. The Mid-Atlantic Ridge is the largest continuous submerged mountain ridge in the world which runs from north to south in the Atlantic-Ocean with a length of 14400 km and 960 km width. It is in the shape of letter 'S'. At some places, the peaks, rise above the surface of water in the form of islands. Many of the islands are volcanic in origin. The East Pacific Ridge and Carlsberg Ridge are some other important submarine ridges.

Seamounts: The mountain with rounded summits that rises from the ocean's floor but doesn't touch the ocean water surface is known as 'seamount'. They are volcanic in origin. These can reach heights of 3,001–4,500 m. The Emperor seamount, a continuation of the Hawaiian Islands in the Pacific Ocean, is a good example.

Guyots: The flat-topped mountains are called as 'guyots'. Volcano rising above the ocean floor whose top has been flattened by erosion and is covered by water is called guyot. More than 10,000 guyots exits in Pacific Ocean.

Check Your Progress

(i) What are the major submarine relief features? Explain.

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(ii) Describe the different minor submarine relief features?

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10.4 Summary

Water is necessary for all life on earth. Water covers about 71% of the earth's surface. The only planet in the solar system with a lot of water is the earth. The largest continuous body of water that completely encircles land is the ocean. 97.2% of the water in the world is in the oceans. The Pacific, Atlantic, Indian, and Arctic oceans are the four oceans that exist. A variety of features exist on the ocean floor, which was once thought to be flat, including the continental shelf, the continental slope, the abyssal plains, and the deeps.

The largest ocean is the Pacific Ocean. There are thousands of islands in it. The deep seas make up the majority of the ocean. With a depth of 11034 metres, the Mariana trench in the Pacific Ocean is the deepest known region of the ocean. The Pacific Ocean is almost twice as large as the Atlantic Ocean. The crucial aspect of the Atlantic Ocean is the largest continuous Mid Atlantic Ridge. More compact than the other two oceans is the Indian Ocean.

10.5 Check Your Progress – Model answers

i. Our earth is frequently referred to as a "watery planet" because it is the only planet in the solar system which comprises of abundance of water.

ii. In the world, there are five major oceans that are primarily distinguished by their geographic locations. The Pacific Ocean, Indian Ocean, Atlantic Ocean, Antarctic Ocean and Arctic Ocean are among them. All the other seas, inland seas or the arms of the oceans, are counted within these four main oceans.

iii. In the ocean basins, the major submarine relief features are subdivided into four relief features. They are: Continental Shelf, Continental Slope, Abyssal Plain and Oceanic Deeps.

iv. The minor relief features on ocean bottom includes oceanic ridges, seamounts, guyots, atolls, and reefs etc.

10.6 Terminal questions

Essay:

(1) Describe the various ocean basins in the world?

(2) Mention the different major submarine relief features? Describe any two.

(3) Give a detailed account on minor relief features on ocean bottom?

Short questions:

(4) Pacific Ocean

(5) Hypsographic curve

(6) Abyssal plain

(7) Oceanic Deeps

(8) Mid Atlantic Ridge

Very short questions:

(9) Watery planet

(10) Largest and deepest ocean

(11) average depth of oceans

(12) Deepest oceanic trench

(13) What is continental rise

(14) define guyot

(15) Define seamount

10.7 Further Readings

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https://www.geo.fu-berlin.de/en/v/geolearning

Chapter - 11

OCEANIC TEMPERATURE AND SALINITY

Contents

11.0 Introduction

11.1 Objectives

11.2 Oceanic Temperature

11.3 Oceanic Salinity

11.4 Summary

11.5 Check Your Progress – Model Answers

11.6 Terminal questions

11.7 Further Readings

11.0 Introduction:

The surface temperature of ocean water is primarily influenced by latitude and season. Water heats and cools relatively slowly, and the constant movement and mixing of ocean water by waves and currents result in minimal temperature variations at the surface. Generally, ocean water temperature decreases from the equator towards the poles. The surface temperature of ocean water in the equatorial region ranges from 27°C to 28°C, while at higher latitudes it can drop to below freezing. It also decreases with depth, with a notable decrease up to a certain depth and then a gradual decline. At great depths, the temperature changes are minimal.

There are many chemicals in ocean water that make it salty. The salts in the oceans are the result of millions of years of minerals leached and dissolved from the solid earth**.** The weather also plays a role on a smaller scale, as the rain deposits mineral particles into the oceans. The main one is sodium chloride, often just called salt. The salt content in seawater is indicated by salinity (S).

11.1 Objectives

After learning this lesson, you will be able to understand:

- Identify the properties of ocean water
- To study the distribution of ocean temperature
- Learn in details, the salinity of sea water and its distribution

11.2 Oceanic Temperature

Ocean water has highest absorbing capacity of heat than land surface from sun. Oceans are about 80 percent of the heat observed from sun. The temperature of ocean water changes from ocean to ocean, latitude to latitude and from surface to bottom of sea.

11.2.1 The Process of heating ocean water:

i. **Absorption of sun's radiation:** it is maximum over low latitudes due to vertical insolation and longer duration of daylight, whereas it decreases steadily towards poles. Even within the same latitude, the solar insolation received by the sea varies due to factors such as currents and cloudiness.

ii. **The conventional currents:** the convectional currents in the water bodies also heat up the oceanic water. Since, the temperature of the earth increases with increasing depth, the ocean water at great depths is heated rapidly than the subsurface and intermediate water layers. So, a convectional oceanic circulation at the bottom layers of oceans takes place causing circulation of heat in water.

iii. **Kinetic energy:** Heat is produced due to friction caused by the surface winds and the tidal currents which increase stress on the water body. Thus, the oceanic water gets heated up.

11.2.2 The Process of cooling ocean water:

1. **Back radiation:** Back radiation from the ocean surface takes place as the solar energy once received is re-radiated as long wave radiation form the seawater.

2. **Exchange of heat:** exchange of heat between the sea and the atmosphere takes place, but only if there is temperature difference.

3. **Evaporation:** it takes place when ocean water is warm, surface is cold and atmospheric stratification is unstable. Heat is lost in the form of latent heat of evaporation (atmosphere gains this heat in the form of latent heat of condensation).

11.2.3 Distribution of Oceanic Temperature:

The distribution pattern of temperature of ocean water is can be studied in two ways:

A. Horizontal distribution (Temperature of surface water)

B. Vertical Distribution (from surface water to the bottom)

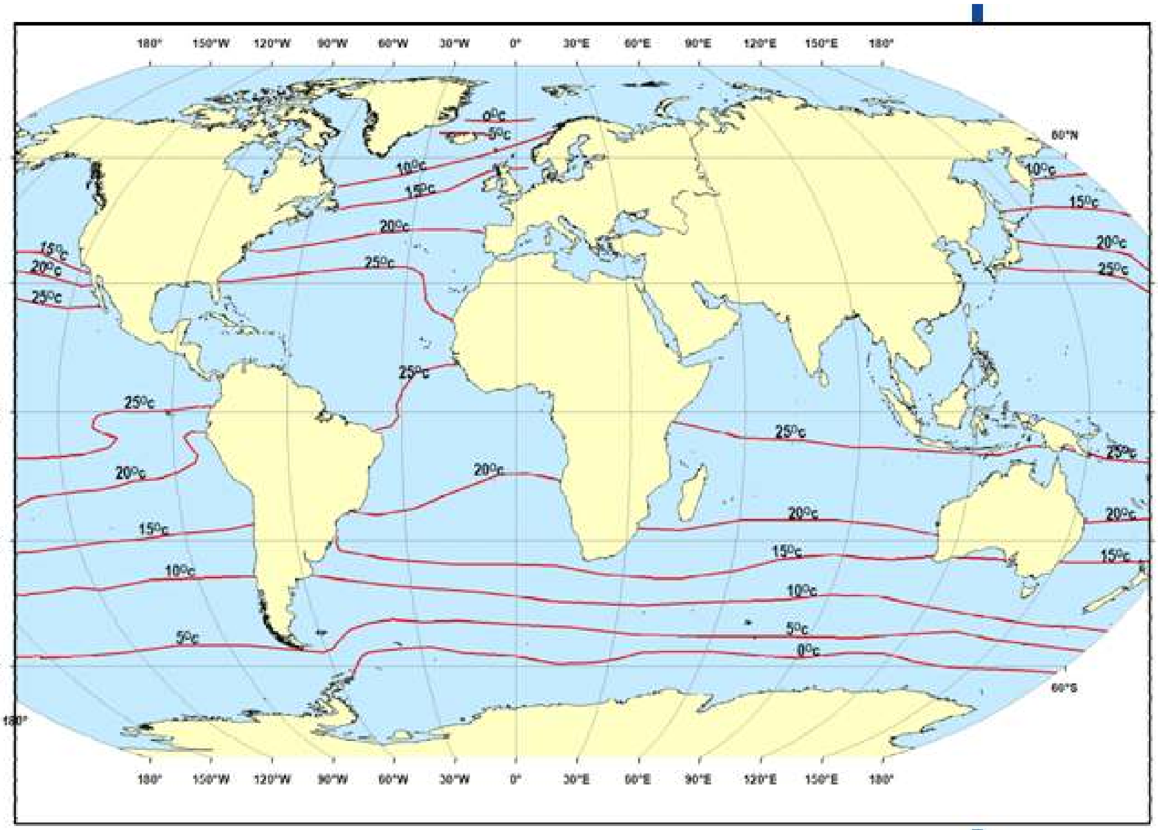
Since, the ocean has 3D shape, the depth of oceans, besides latitudes, is also taken into account in the study of temperature distribution.

***Factors influencing the ocean temperature*:**

- **Latitude:** Ocean surface temperature decreases from the equator towards the poles due to the vertical angle of the Sun's rays incidence at the equator and slanty incidence at the poles.

- **Prevailing Winds:** The direction of prevailing winds, such as the Trade Winds and Westerlies, plays a role in determining the surface temperature of ocean waters at a specific location.

- **Unequal Land-Water Distribution:** The Northern Hemisphere has a larger land area compared to the Southern Hemisphere, resulting in warmer oceans in the Northern Hemisphere due to the relatively smaller water-to-land ratio.



Source: https://nios.ac.in

Fig: Horizontal Temperature Distribution of the Oceans

(B) Vertical Temperature Distribution of Oceans:

As one descends into the depths of the ocean, both energy and sunlight diminish. The penetration of light energy into the ocean decreases significantly, with only around 45 percent reaching a depth of approximately one meter, and a mere 16 percent reaching a depth of 10 meters.

The sun's rays very effectively penetrate upto 20 m depth and they seldom go beyond 200 m depth in oceans. Consequently, the temperature decreases from the ocean surface with increasing depth, but the rate of decrease of temperature with increasing depth is not uniform everywhere. The ocean temperature falls very faster upto the depth of 200 m and thereafter the rate of decrease of temperature is slowed down. As the temperature decreases in water with increasing descent.

The sun's rays do not affect below 100 m of depth. Probably, 80 percent of ocean water has a temperature permanently below 40° F. the following table discloses the mean temperature for all the oceans at various depths which was collected y Murray during the challenger expedition.

Table 11.1: Mean Ocean Temperature at Various Depths

Depth (Fathoms)	Temperature (°C)
100	15.8
200	9.95
500	4.45
1000	2.47
1500	1.81
2200	1.76

Based on temperature, the vertical profile of the ocean can be divided into the following three zones:

- **Surface Zone or Mixed Zone:** This upper layer is also known as the Photic zone or Euphoric zone. It extends from the ocean's surface to a depth of approximately 100 meters. In this zone, both temperature and salinity remain relatively constant. It constitutes approximately 2 percent of the total volume of water in the ocean.
- **Thermocline:** The thermocline is located between depths of 100 meters and 1000 meters. It encompasses about 18 percent of the total volume of water in the ocean. Within this zone, there is a rapid decrease in temperature with increasing depth. The density of water also increases as one goes deeper into the ocean.
- **Deep Zone:** This zone extends beyond 1000 meters in mid-latitudes. It comprises approximately 80 percent of the total volume of water in the ocean. In this zone, the temperature remains relatively constant. The ocean floor in this zone typically maintains a temperature slightly above the freezing point, usually one or two degrees Celsius higher.

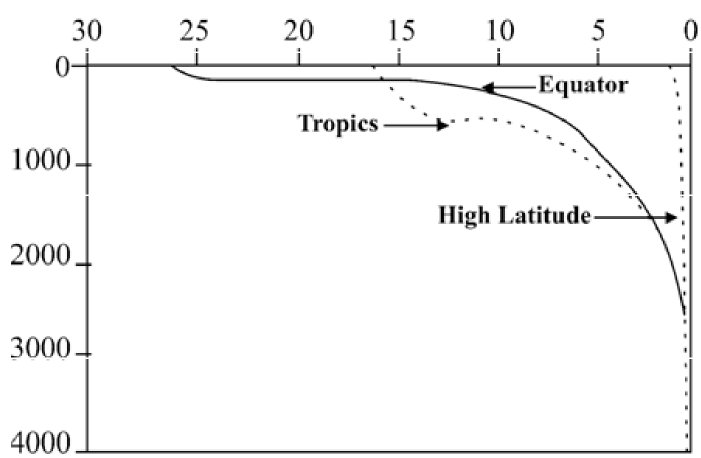


Fig: Vertical Distribution of Temperature

Check Your Progress

(i) What are the factors responsible for distribution of ocean temperature?

(ii) ____

(iIi) Write about vertical profile of ocean temperature?

____

11.3 Oceanic Salinity

There are many chemicals in ocean water that make it salty. The salts in the oceans are the result of millions of years of minerals leached and dissolved from the solid earth. Most of them get there from rivers carrying chemicals dissolved out of rock and soil. Salinity is defined as the ratio between the weight of the dissolved materials and the weight of the sample sea water. It means the amount of dissolved salts per unit mass of ocean water. Salinity is calculated as the number grams of dissolved salts in 1,000 grams (one kg) of seawater. It is usually expressed as parts per thousand or ppt. the average salinity of the ocean water is 35 per thousand. It means that in one kilogram of ocean water, there are 35 grams (7 teaspoons) of dissolved salts.

Composition of Ocean Water

Ocean water is weak, but comprises a complex solution of various mineral substances in diluted form, since it is active solvent. The volume of salt in ocean water is gradually increasing because it is brought in the form of particulates from the land every year. In every cubic kilometre of sea water, there exist 41 million tonnes of dissolved salts. The principle components of the ocean water are listed in the following table:

Table 11.2: Composition of Ocean Water

S. No.	Salinity constituents	Volume	Percentage
1	Sodium Chloride (Nacl)	27.213	77.8
2	Magnesium Chloride ($Mgcl_2$)	3.807	10.9
3	Magnesium Sulphate ($MgSo_4$)	1.658	4.7
4	Calcium Sulphate ($CaSo_4$)	1.260	3.6
5	Potassium Sulphate (K_2So_4)	0.863	2.5
6	Calcium Carbonate ($CaCo_3$)	0.123	0.3
7	Magnesium Bromide ($MgBr_2$)	0.076	0.2
8	**Total**	**35.00**	**100.00**

The above table represents the weights of salt in grams per 1000 grams (%o) and percentages of seven important salts with a total salinity of 35 %o Dittmar. Dittmar during his challenger expedition in 1884 reported the existence of 47 types of salts in sea water out of which 7 are most important mentioned above.

Sources of Salinity:

The salts dissolved in ocean water primarily originate from continental landmasses. They are transported into the oceans through various means such as rainfall, rivers, groundwater, sea-waves, winds, and glaciers. Additionally, some dissolved salts also come from the ocean floor. The molten minerals in the layers beneath the Earth's crust can reach the crust through volcanic activity or continuous gas emissions.

Factors Controlling the Salinity of Oceans:

Ocean salinity is influenced by various factors and exhibits spatial and temporal variations. The major factors controlling the ocean salinity include:

Evaporation: Salinity tends to be higher in regions with high rates of evaporation, such as tropical seas like the Red Sea and Persian Gulf. As water evaporates, it leaves behind the dissolved salts, increasing the salinity of the remaining water.

Temperature: Temperature and ocean salinity have a direct relationship. Generally, regions with higher temperatures also tend to have higher salinity levels. Warmer temperatures enhance evaporation rates, leading to higher salt concentrations in the water.

Precipitation: Precipitation and salinity have an inverse relationship. Regions with higher levels of precipitation typically experience lower salinity levels. Rainfall dilutes the salt content in the water, reducing its salinity.

Overall, the interplay of evaporation, temperature, and precipitation plays a significant role in determining the salinity of the oceans, leading to spatial and temporal variations in salinity levels.

- **Ocean Currents:** Ocean currents play a crucial role in the spatial distribution of salinity in ocean waters. Warm currents near the equatorial region transport salts away from the eastern margins of the oceans and accumulate them near the western margins. Similarly, ocean currents in temperate regions contribute to increased salinity near the eastern margins.
- **Influx of Fresh Water:** Salinity is generally lower in areas where major rivers meet the oceans, as the freshwater from rivers dilutes the salt content.

Distribution of Oceanic Salinity

The disparities in ocean salinity are both horizontal and vertical. The amount of salinity varies from enclosed seas through partially closed seas to open sea. It also varies from one part of the ocean to another. The spatial distribution pattern of ocean salinity can be studied in two ways: (I) **Horizontal distribution of salinity and (II) Vertical distribution of salinity**

(I) Horizontal Distribution of Salinity:

The surface salinity of oceans tends to decrease on either side of the tropics. For example, the surface salinity along the Tropic of Cancer is around 36 parts per thousand (ppt), while at the equator it is around 35 ppt. On the other hand, near the equator, there is heavy rainfall, high relative humidity, cloudiness and calm air of the doldrums. Thus, the equator accounts for only 35 %o salinity and the heist salinity of 36%o is observed between 20° – 40° N latitudes. The average salinity of 35 %o is recorded between 10° – 30° S latitudes. The zone between 40° – 60° N & S latitudes record low salinity where it ranges between 31 %o and 33%o (both north and south hemisphere). Salinity further decrease experiences in the polar zones because of very little evaporation and receive large amounts of freshwater from the melting ice. This leads to low levels of salinity, ranging between 20%o and 32%o.

Table 11.3: Latitudinal Distribution of Salinity

Latitudinal zones	Salinity (%o)
70° – 50° N	30-31
50° – 40° N	33-34
40° – 15° N	35-36
15° – 10° N	34.5-35
10° – 30° S	35-36
30° – 50° S	34-35
50° – 70° S	**33-34**

It is observed from the following table that on an average, the northern and southern hemispheres record average salinity of 34%o and 35%o respectively. The table also reveals that the maximum salinity occurs between 20° N and 40° N latitudes (36%o) and 10° S and 30° S latitudes (35%o).

Seas can be categorized based on their salinity levels:

(i) ***Seas with below-normal salinity***: They have a low salinity due to the influx of fresh water. They include the Arctic Ocean (20-35%o), North Australian Sea (33-34%o), Bering Sea (28 – 33%o), Sea of Japan (30-34%o), Baltic Sea (3-15%o), North Sea (31-35%o), Andaman Sea (30-32%o), Hudson Bay (3-15%o) etc. Their surface salinity can be as low as 21 ppt.

(ii) ***Seas with normal salinity levels***: These seas have salinity in the range of 35 to 36 ppt. They include the Caribbean Sea, Gulf of Mexico (35-36%o), Gulf of California (25-35.5%o), Bass Strait (35%o), Yellow Sea etc.

(iii) ***Seas with above-normal salinity levels***: These seas have higher salinity levels due to their location in regions with higher temperatures, leading to greater evaporation. They include the Red Sea (39 - 41 ppt), Persian Gulf (38 ppt), Mediterranean Sea (37 - 39 ppt) etc.

(II) Vertical Distribution of Salinity:

The vertical distribution of salinity does not follow a definite trend. Salinity levels can both increase and decrease with increasing depth. Ocean salinity at depth is remains fixed, due to there is no way to loss that water or addition of the salts.

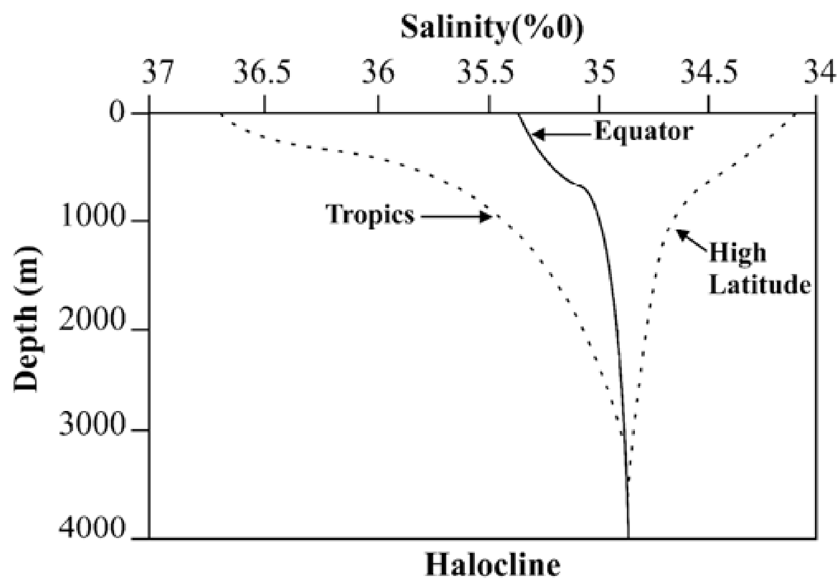


Fig: Vertical Distribution of Salinity

Source: https://nios.ac.in

However, some general patterns can be observed:

- Salinity, generally, increases with depth and there is a distinct zone called the halocline (compare this with thermocline), where salinity increases sharply.
- Salinity tends to decrease with increasing depth at the equator and near the tropics.
- At higher latitudes, salinity is found to increase with increasing depth.
- High salinity seawater, in general, sinks below the lower salinity water. This leads to stratification by salinity.

Check Your Progress

(iii) define ocean salinity

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(iv) What are important factors controlling ocean salinity? Explain.

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11.4 Summary

The distribution of ocean temperature is influenced by several factors, including latitude, prevailing winds, the unequal distribution of land and water, evaporation rate, water density, and ocean currents. Ocean salinity, on the other hand, is determined by factors such as evaporation, temperature, precipitation, and ocean currents.

11.5 Check Your Progress – Model Answers

(i) Factors influencing the ocean temperature: they include Latitude, Prevailing Winds, Unequal Land-Water Distribution, Evaporation Rate, Water Density, Ocean Currents and Local Factors.

(ii) The vertical distribution of salinity does not follow a definite trend. Salinity levels can both increase and decrease with increasing depth.

(iii) Salinity means the amount of dissolved salts per unit mass of ocean water. Salinity is calculated as the number grams of dissolved salts in 1,000 grams (one kg) of seawater.

(iv) The major factors controlling the ocean salinity include: Evaporation, Temperature, Precipitation, Ocean Currents, Influx of Fresh Water etc.

11.6 Terminal questions

Essay question:

1. Explain the horizontal distribution of ocean water?
2. Describe the horizontal distribution of oceanic salinity?
3. Give a detailed account on vertical distribution of ocean salinity?

Short questions:

4. Write about the process of heating of ocean water?
5. Explain the composition of ocean water?
6. Write a note on sources of salinity?
7. What are the types of seas on the basis of salinity?

Very short questions:

8. What is normal temperate of ocean water?
9. What is thermocline?
10. Define normal salinity?
11. What is normal salt?

11.7 Further Readings

- Geography, Senior Secondary Course, NIOS, Noida, India.
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Chapter - 12

CIRCULATION OF OCEANIC WATER - WAVES, TIDES AND OCEAN CURRENTS

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12.0 Introduction

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12.2 Circulation of Ocean water

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The ocean is a dynamic system with various movements of water driven by physical characteristics such as salinity, temperature, as well as external factors like the sun and moon. These movements can be categorized into three types: ocean waves, tides, and ocean currents.

12.1 Objectives

After reading this lesson, you will be able to understand:

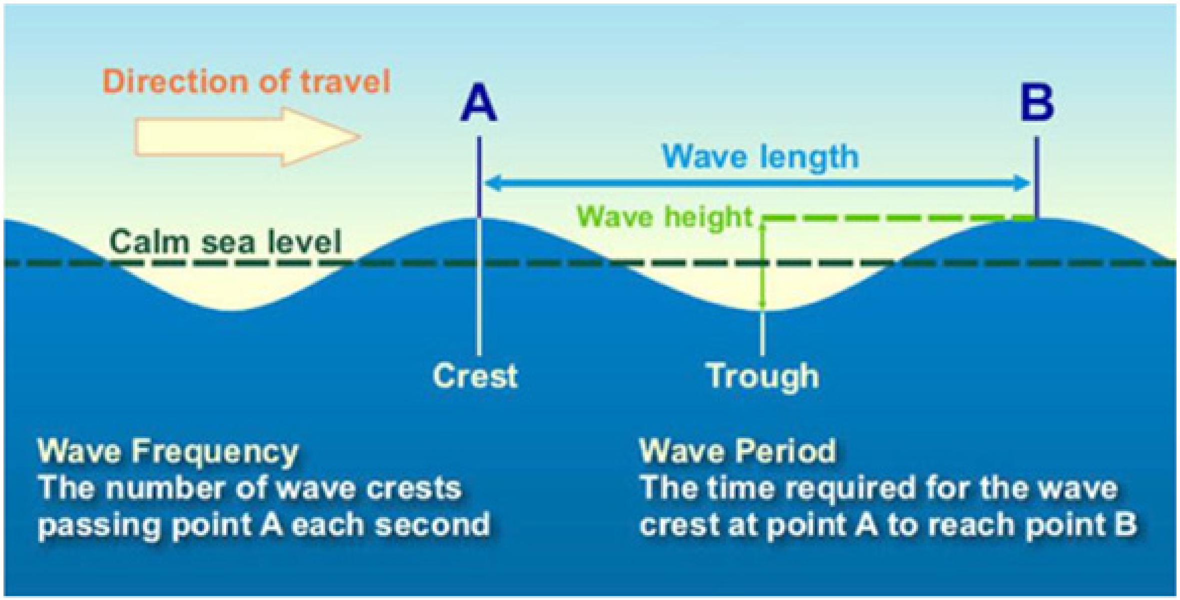
- o Understand the movement of ocean water
- o Study the formation of sea waves
- o Comprehend the formation tides and types of tides
- o Factors responsible for the origin of ocean currents
- o Study the ocean current system in pacific, Atlantic and Indian oceans

12.2 Circulation of Ocean water

The ocean is a dynamic system with various movements driven by physical characteristics such as salinity, temperature, as well as external factors like the sun and moon. These movements can be categorized into three types: ocean waves, tides, and ocean currents.

12.2.1 Waves

Waves are movement of water within the ocean is called as a waves, it is ridge of water spreading across the sea surface. Ocean waves are formed when wind blows across the surface of the ocean, creating ripples that eventually develop into waves over time and distance. Waves transmit energy across the ocean and can travel long distances if unobstructed. The primary cause of waves is wind, which creates surface waves through friction with the water. Severe weather conditions like hurricanes can also generate waves, known as storm surges. Underwater disturbances such as earthquakes or volcanic eruptions can produce tsunamis, which are very long waves. Tides, on the other hand, are not considered waves but are caused by the gravitational pull of the sun and moon.



The anatomy of a wave

The structure of sea waves refers to the physical components and characteristics that make up a typical ocean or sea wave. Sea waves have a distinct structure that includes various parts, each with its own unique features. Here's an explanation of the structure of sea waves:

Crest and Trough: A sea wave consists of alternating crests and troughs. The crest is the highest point of the wave, while the trough is the lowest point. The vertical distance between a crest and a trough is known as the wave height.

Wavelength: The wavelength of a wave is the horizontal distance between two consecutive crests (or troughs) of the wave. It represents the length of one complete wave cycle. Longer waves have larger wavelengths, and shorter waves have smaller wavelengths.

Wave Height: The wave height is the vertical distance between the crest and trough of a wave. It gives an indication of how tall the wave is. Wind-generated waves can have varying heights, from mere ripples to towering swells.

Wave Period: The wave period is the time it takes for one complete wave cycle (from crest to crest or trough to trough) to pass a specific point. It is usually measured in seconds. Longer-period waves have more time between crests, while shorter-period waves are more frequent.

Wave Frequency: The wave frequency is the number of waves passing a fixed point in a given amount of time. It is the reciprocal of the wave period and is often measured in hertz (waves per second).

Wave Steepness: Wave steepness is the ratio of wave height to wavelength. Steepness is an important factor that affects how waves break as they approach the shore. If the wave steepness becomes too high, waves can become unstable and break forcefully.

Wave Front: The wave front is the leading edge of a wave. It moves in the direction of wave propagation. As the wave front advances, it carries the wave energy along with it.

Wave Direction: The direction in which a wave is moving is called the wave direction. It is often measured in degrees clockwise from true north.

Wave Phase: The phase of a wave refers to its position within its cycle at a particular moment in time. Two waves are said to be “in phase” when their crests and troughs coincide, and “out of phase” when they are at different points in their cycles.

Grouping of Waves: In open water, waves often travel in groups or sets. This is due to the varying energy levels of individual waves within a wave train. The lead wave of a group is called the “primary wave,” followed by secondary and subsequent waves.

Check Your Progress

(i) Define sea waves?

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(ii) Explain the structure of sea waves?

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12.2.2 Tides

Tides are the periodic rise and fall of sea levels along coastlines and other bodies of water, primarily caused by the gravitational interaction between the Earth, the moon, and the sun. The gravitational forces exerted by these celestial bodies create a cyclical pattern of water movement, resulting in the phenomenon of tides.

Causes of tides:

There are two main factors that contribute to tidal behavior:

Gravitational Pull: The moon’s gravitational pull is stronger on the side of the Earth facing the moon than on the opposite side. This creates a “bulge” of water on both sides of the Earth, causing high tides. The area between these bulges experiences low tides.

Centrifugal Force: As the Earth and moon revolve around their common center of mass, a centrifugal force is generated on the side of the Earth that is farther from the moon. This also leads to a bulge of water and high tides.

The interaction of these gravitational and centrifugal forces creates a rhythmic pattern of two high tides and two low tides over a 24-hour period. This is known as a semi-diurnal tidal cycle. The height of the tides can vary due to factors like the shape of coastlines, ocean currents, and local geography.

Additionally, the sun's gravitational pull also influences tides, although its effect is less significant compared to the moon. When the sun, moon, and Earth are aligned (during full moons and new moons), their combined gravitational pull results in higher high tides, known as **"spring tides."** When the sun and moon are at right angles to each other (during first and third quarters of the moon), their gravitational pull partially cancels out, leading to lower high tides, known as **"neap tides."**

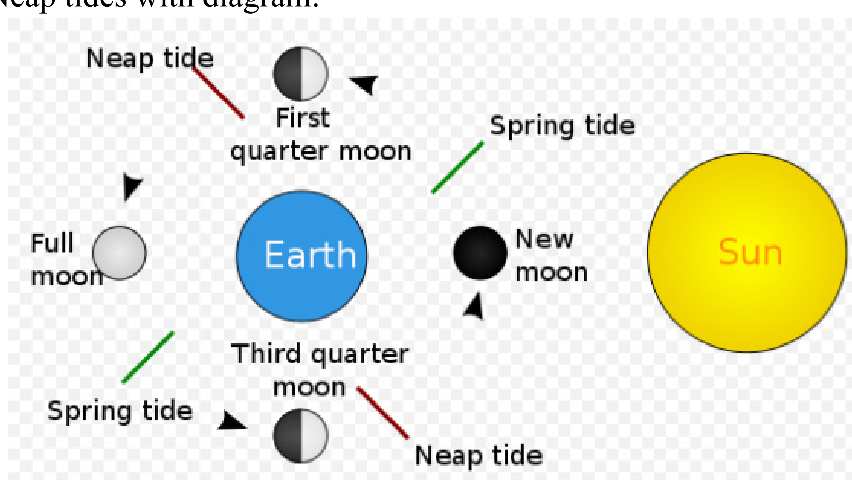
Tides play a crucial role in shaping coastal ecosystems, affecting navigation, and influencing the behavior of marine organisms. They also have practical implications for activities like fishing, shipping, and recreational boating.

High Tide: High tide is the point in the tidal cycle when the water level reaches its highest point along the shoreline. It occurs approximately twice a day as a result of the gravitational forces exerted by the moon and the sun on Earth's oceans. During high tide, the water covers a larger portion of the shore, submerging areas that are typically exposed during low tide.

Low Tide: Low tide is the opposite of high tide. It is the point in the tidal cycle when the water level reaches its lowest point along the shoreline. During low tide, more of the seabed becomes exposed as the water retreats from the shore. This exposes rocks, sandbars, and other features that are normally underwater during high tide.

Time Interval Between Tides: The time interval between consecutive high tides or low tides is not exactly 12 hours due to various factors, including the shape of coastlines, the depth of the ocean, and the influence of other celestial bodies like the sun. However, on average, there is roughly a 12-hour and 25-minute gap between successive high tides or low tides. This means that there are usually two high tides and two low tides in a 24-hour period. This pattern of tides is known as a semi-diurnal tidal cycle.

Spring tides and Neap tides with diagram:



It's important to note that the exact timing and magnitude of tides can vary based on factors such as geographical location, local topography, and weather conditions. This variability can result in differences in the actual interval between tides and the height of the tides from one location to another.

Tides are primarily influenced by the gravitational pull of the sun and moon. The study of tides is complex due to variations in frequency, magnitude, and height. The occurrence of tides is caused by an imbalance between the gravitational forces acting on the ocean water. The moon's gravitational pull has a greater effect on tides compared to the sun due to their relative distances. Other factors influencing tides include uneven water distribution globally and irregularities in ocean configurations. Tides can create tidal currents when channeled into bays and estuaries. There are different types of tides based on their frequency, positions of the Earth, moon, and sun, and magnitude.

There are three major forces that causes for origin of tides are as follows:

1. Moon's gravitational pull
2. Sun's gravitational pull
3. Centrifugal force which acts opposite to gravitational pull of the earth.

Check Your Progress

(i) What are the causes of tides?

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(ii) What are neap tides and springs tides?

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12.3.3 Ocean Currents

Ocean currents are continuous, flowing movements of seawater within the oceans, driven by a combination of factors such as wind patterns, temperature variations, Earth's rotation (Coriolis effect), and differences in salinity. These currents circulate throughout the world's oceans, playing a vital role in redistributing heat, nutrients, and marine life, and influencing global climate patterns.

Ocean currents are large masses of surface water that circulate in regular patterns around the oceans. They can be classified into two types, namely (i) warm currents and (ii) cold currents.

The warm currents flow from equatorial regions toward the polar regions, while cold currents flow from polar regions toward the equator. Warm currents are surface water currents while cold currents are sub surface water currents. (On the basis of speed, ocean currents are of two types. They are (i) Streams, (ii) Drifts.

"Streams" can refer to specific and well-defined currents that flow within the larger oceanic circulation patterns. These currents are often characterized by their strength, direction, and persistence. Here are a few notable examples of ocean currents often referred to as "streams"

Drifts" typically refer to areas of relatively slow-moving or stagnant water within the larger flow of ocean currents. These drifts can be caused by various factors and have significant implications for marine ecosystems, shipping routes, and other ocean-related activities.

Factors Responsible For Origin Of Ocean Currents:

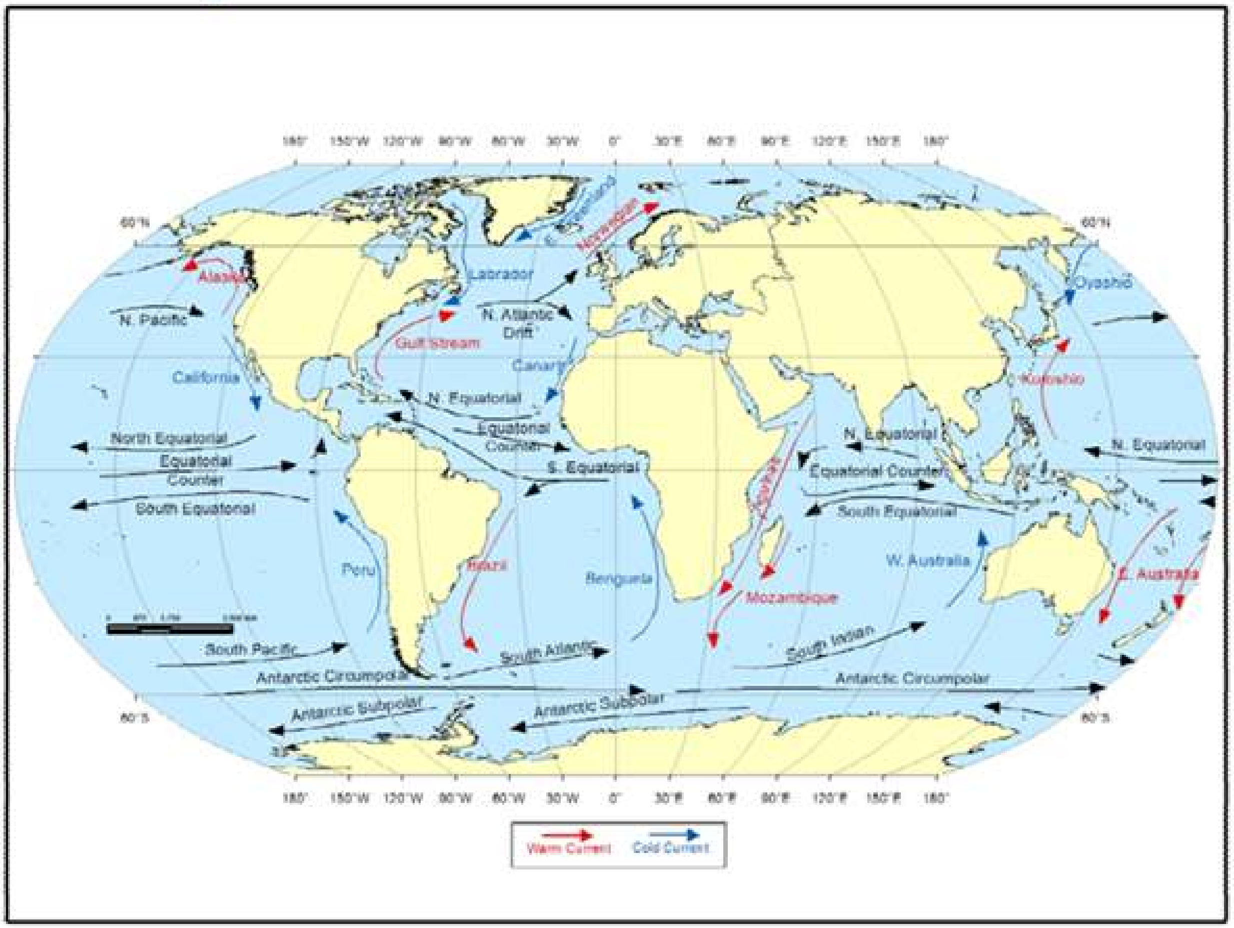
Wind Patterns: The most significant factor driving surface ocean currents is wind. As wind blows across the surface of the ocean, it creates friction with the water and imparts its energy to the water, setting it in motion. The direction and strength of the winds influence the direction and speed of the resulting currents.

Coriolis Effect: Earth's rotation causes a deflection of moving objects, including ocean currents. The Coriolis effect results from the rotation of the Earth and causes moving water to be deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. This effect influences the direction of ocean currents, particularly over long distances.

Temperature Differences: Variations in water temperature contribute to the density differences in ocean water. Cold water is denser than warm water. In regions where cold water sinks and warm water rises, circulation patterns are established, giving rise to deep ocean currents. These temperature-driven currents are crucial for the movement of nutrients and heat around the world's oceans.

Salinity Differences: Differences in salt concentration (salinity) affect water density. High-salinity water is denser than low-salinity water. This density contrast can lead to the sinking of denser water and the rising of lighter water, creating vertical currents that drive the movement of ocean water.

Continental Coriolis Effect: The presence of landmasses and the uneven distribution of continents affect the direction and intensity of ocean currents. In some cases, currents are deflected by the shape of coastlines, creating unique patterns of circulation.



(A) Atlantic Ocean Currents system:

1. North Equatorial Current (Warm)
2. South Equatorial Current (Warm)
3. Counter-Equatorial Current (Warm)
4. Gulf Stream (Warm)
5. Canary Current (Cold)
6. Labrador Current (Cold)
7. Brazil Current (Warm)
8. Falkland Current (Cold)

North Atlantic Currents:

Gulf Stream: One of the most well-known currents, the Gulf Stream flows northward along the eastern coast of North America before veering northeast across the Atlantic towards Europe. It is a warm and fast-flowing current that transports heat from the tropics to higher latitudes, significantly impacting the climate of western Europe.

North Atlantic Drift: An extension of the Gulf Stream, the North Atlantic Drift continues into the northeastern Atlantic, influencing the circulation of the North Atlantic Subpolar Gyre.

Subpolar Gyres:

North Atlantic Subpolar Gyre: This circulation pattern involves the movement of water in a large, counterclockwise direction in the northern part of the Atlantic Ocean. The North Atlantic Drift and other currents contribute to the formation of this gyre, which has implications for climate and marine ecosystems in the region.

South Atlantic Subpolar Gyre: Similar to its northern counterpart, this gyre forms in the southern Atlantic Ocean and influences ocean currents and climate in the South Atlantic region.

Equatorial Atlantic Currents:

North Equatorial Current: This westward-flowing current runs along the equator in the northern hemisphere, driven by the trade winds. It is part of the North Equatorial Current System and contributes to the circulation of warm water in the Atlantic.

South Equatorial Current: Analogous to its northern counterpart, this current flows westward along the equator in the southern hemisphere, affected by the southeast trade winds.

South Atlantic Currents:

Brazil Current: This warm current flows southward along the eastern coast of South America, playing a role in the transport of heat and marine life.

Benguela Current: Located along the southwestern coast of Africa, the Benguela Current brings cool, nutrient-rich waters to the surface, supporting productive marine ecosystems.

Other Currents:

Canary Current: This cold current flows southward along the western coast of North Africa, affecting climate and marine life in the region.

North Atlantic Subtropical Gyre: Formed by the interaction of various currents, including the Gulf Stream, this circular pattern of water circulation is significant for climate and oceanography.

(B) Pacific Ocean Currents System:

1. North Pacific Current
2. California Current
3. Kuroshio Current
4. North Equatorial Current
5. The South Pacific Current
6. Peru Current
7. East Australia Current
8. South Pacific Current

North Pacific Currents:

Kuroshio Current: Also known as the Japan Current, the Kuroshio flows along the eastern coast of Japan, moving northward from the subtropical region towards higher latitudes. It is a warm and fast-flowing current, analogous to the Gulf Stream in the **Atlantic Ocean.**

North Pacific Drift: This is an extension of the Kuroshio that continues eastward across the northern Pacific, influencing the circulation of the North Pacific Subtropical Gyre.

Equatorial Pacific Currents: North Equatorial Current: This current flows westward across the equator, driven by the trade winds. It is part of the North Equatorial Current System and contributes to the broader circulation of the North Pacific Ocean.

Equatorial Counter Current: Located between the North and South Equatorial Currents, this eastward-flowing current plays a critical role in redistributing warm water across the equatorial region.

South Pacific Currents: South Equatorial Current: Similar to its northern counterpart, this current flows westward along the equator in the southern hemisphere, affected by the southeast trade winds.

East Australian Current: This current flows southward along the eastern coast of Australia, transporting warm tropical waters toward the higher latitudes.

Subtropical Gyres:North Pacific Subtropical Gyre: Formed by the interaction of various currents, including the Kuroshio and North Pacific Drift, this vast circular pattern of water circulation spans the northern Pacific Ocean, influencing weather and marine life.

South Pacific Subtropical Gyre: Analogous to the northern gyre, this circulation pattern is shaped by currents like the South Equatorial Current and the East Australian Current.

Other Currents: Peru Current: Also known as the Humboldt Current, this cold current flows northward along the western coast of South America, bringing nutrient-rich waters to the surface and supporting productive marine ecosystems.

North Pacific Currents: These currents include the California Current, which flows southward along the western coast of North America, influencing the climate and marine life of the region.

(C) India Ocean currents system:

1. Monsoon Currents
2. Agulhas Current
3. Leeuwin Current
4. South Equatorial Current
5. Equatorial Undercurrent
6. Somali Current
7. East India Coastal Current
8. Mozambique Current
9. Indian Ocean Gyres

Monsoon Currents: The Indian Ocean is strongly influenced by the Asian monsoon system. During the summer monsoon, which typically occurs from June to September, winds blow from the southwest, causing the Indian Ocean to experience the Southwest Monsoon Current. This current flows along the western coast of India and brings moist air and heavy rainfall to the region.

Agulhas Current: The Agulhas Current is a warm, fast-flowing current that flows along the eastern coast of Africa, parallel to the coast of Mozambique and South Africa. It is part of the subtropical gyre in the South Indian Ocean and is known for its strong currents and eddy formations.

Leeuwin Current: Flowing southward along the western coast of Australia, the Leeuwin Current is a warm current that influences the climate of the region, bringing warm water and contributing to the temperate climate along the coast.

South Equatorial Current: This westward-flowing current is located near the equator and carries warm water from the eastern Indian Ocean toward the western Indian Ocean. It's a part of the larger Equatorial Counter current that encircles the Earth.

Equatorial Undercurrent: Below the South Equatorial Current, there exists an Equatorial Undercurrent that flows in the opposite direction, carrying cooler water eastward along the equator.

Somali Current: Flowing along the northern coast of Somalia, the Somali Current carries relatively cool water southward along the eastern edge of the Indian Ocean.

East India Coastal Current: This current flows southward along the eastern coast of India, influenced by the monsoon winds and local bathymetry. It transports water from the Bay of Bengal to the southern Indian Ocean.

Mozambique Current: Located along the southeastern coast of Africa, the Mozambique Current flows southward along the Mozambique Channel, between Madagascar and the African mainland.

Indian Ocean Gyres: The Indian Ocean is divided into two main gyres: the North Indian Ocean Gyre and the South Indian Ocean Gyre. These gyres are large circular patterns of currents that circulate around central areas of low pressure. They help redistribute heat and nutrients across the ocean.

The distribution of ocean currents varies in different ocean basins. In the Pacific Ocean, examples of warm currents include the North Equatorial Current, Kuroshio System, and East Australia Current, while cold currents include the Oyashio Current and California Current. In the Atlantic Ocean, warm currents include the Gulf Stream and North Equatorial Current, while cold currents include the Labrador Current and Benguela Current. In the Indian Ocean, warm currents include the Agulhas Current and North Equatorial Current, while the Somali Current is a cold current.

Ocean movements have significant importance in various aspects. Tides aid navigation, allowing ships to enter and leave harbours safely. They also help remove silt from river mouths and prevent freezing in cold regions. Tidal energy is harnessed as a renewable source of electricity. Ocean currents impact climate and weather patterns globally and serve as fishing zones.

Check Your Progress

(i) What are different types of ocean currents?

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(ii) What are North equatorial currents?

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12.3 Summary

Sea waves, refer to the rhythmic oscillations of the water's surface in oceans, seas, and other large bodies of water. These waves are primarily caused by the wind's interaction with the water's surface. Ocean tides occur due to the positions of the Earth, Moon, and Sun. There are two main types of tides: spring tides and neap tides.

Ocean currents represent the endless, fluid motion of seawater within the vast ocean expanses. These dynamic movements are propelled by a synergy of factors including prevailing wind distributions, fluctuations in temperature, the Coriolis effect resulting from Earth's rotation, and variations in salinity. These currents perpetually traverse the entirety of the Earth's oceans, assuming a pivotal function in the reassignment of heat, essential nutrients, and aquatic ecosystems, thereby exerting a profound influence on worldwide climate trends.

In the Indian Ocean, there are two significant drifts of currents: the North East Monsoon Drift and the South West Monsoon Drift.The Atlantic Ocean is characterized by several warm currents, including the North Equatorial Current, South Equatorial Current, Equatorial Counter Current, Gulf Stream, Florida Current, and Brazilian Current.In the Pacific Ocean, there are notable cold currents, namely the Oyashio Current, California Current, and Peruvian or Humboldt Current.

12.4 Check Your Progress – Model answers

i) Sea waves, refer to the rhythmic oscillations of the water's surface in oceans, seas, and other large bodies of water. These waves are primarily caused by the wind's interaction with the water's surface, but they can also be influenced by various factors such as tides, currents, and underwater topography.

ii) The structure of sea waves refers to the physical components and characteristics that make up a typical ocean or sea wave. Sea waves have a distinct structure that includes various parts, each with its own unique features. Here's an explanation of the structure of sea waves. Crest and Trough, Wavelength, Wave Height, Wave Period, Wave Frequency, Wave Steepness, Wave Steepness, Wave Front, Wave Direction, Wave Phase, Grouping of Waves

iii) Tides refer to the periodic rise and fall of water levels in oceans and seas, occurring once or twice a day. Tides are primarily influenced by the gravitational pull of the sun and moon. The study of tides is complex due to variations in frequency, magnitude, and height.

Gravitational: The moon exerts a stronger gravitational pull on the side of the Earth facing it compared to the opposite side. Consequently, this gravitational asymmetry causes water to bulge on both sides of the Earth, resulting in high tides. The region between these bulges experiences low tides.

Centrifugal: As the Earth and moon orbit around their shared center of mass, a centrifugal force arises on the Earth's farther side from the moon. This force also leads to water bulging and subsequently high tides.

The interplay between these gravitational and centrifugal forces gives rise to a predictable pattern of two high tides and two low tides within a 24-hour period, referred to as a semi-diurnal tidal cycle. The specific height of these tides can be influenced by factors such as coastal shapes, ocean currents, and local geography.

iv) Neap Tides: Neap tides are tides with the smallest difference between high and low tides, occurring when the sun, moon, and Earth are at right angles to each other.

Spring Tides: Spring tides are tides with the greatest difference between high and low tides, happening when the sun, moon, and Earth are aligned in a straight line.

v) Ocean currents are large masses of surface water that circulate in regular patterns around the oceans. They can be classified as warm currents, flowing from equatorial regions toward the polar regions, or cold currents, flowing from polar regions toward the equator. Warm currents have higher surface temperatures, while cold currents have lower surface temperatures. Warm currents have higher surface temperatures, while cold currents have lower surface temperatures. Several factors contribute to the formation of ocean currents, including planetary winds, temperature differences, salinity variations, the Earth's rotation, Coriolis force, and obstructions caused by landmasses. These currents play a significant role in redistributing heat around the planet, affecting global climate patterns.

vi) The North Equatorial Currents are major ocean currents that flow across the northern hemisphere along the equator in the Atlantic, Pacific, and Indian Oceans. These currents are part of the broader ocean circulation system and play a significant role in redistributing heat and maintaining global climate patterns. Here's more about the North Equatorial Currents. Atlantic North Equatorial Current: In the Atlantic Ocean, the North Equatorial Current flows from east to west across the equator. Pacific North Equatorial Current: In the Pacific Ocean, the North Equatorial Current flows from east to west across the equator.

12.5 Terminal Questions

Long questions:

1. What is ocean circulations
2. What is ocean water
3. What is tides

Short questions :

1) What are prevailing winds?
2) What is ocean currents?

Very short questions

1. Gravitational pull
2. North Equatorial Current
3. Gulf Stream
4. Indian Ocean

12.6 Further Readings

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Chapter - 13

OCEANIC DEPOSITS

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13.0 Introduction

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13.3 sources of oceanic deposits

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13.0 Introduction

The ocean floor is covered with a wide range of sediments, including rocks, sand, and organic matter. These sediments play a crucial role in the functioning of marine ecosystems and provide important insights into the geological history of the Earth. Ocean deposits contain many important resources includes: petroleum, gas hydrates, sand and gravels, etc.,

13.1 Objectives

After learning this lesson, you will be able to:

- Understand concept and importance of ocean deposits
- Identify sources of ocean deposits
- Classification of ocean deposits
- Understand transportation and distribution of ocean deposits

13.2 concept and definition of oceanic deposits

Ocean deposits refer to all the materials that being deposited on the bottom of the sea or ocean. The bulk of sediments is brought down and poured into the ocean by rivers. The ocean is the final repository of debris from the land. Most of the ocean bottom is covered by sediment deposits brought in by rivers, glaciers and winds along with shells and skeletons of marine organism. Only a few areas are devoid of ocean sediments, such as those areas that are swept clean by strong ocean currents, areas that are newly formed , like crests of ocean ridges, have no sediment accumulation.Ocean deposits are the accumulation of materials that settle at the bottom of the oceans. Ocean deposits are also known as marine deposits or sediments. The sediments, derived from various sources, deposited at the sea floors are in-cluded in ocean deposits. The sediments derived from weathering and erosion of continental rocks are transported to the oceans by rivers, winds etc. Volcanic eruptions also provide sediments. Besides, the decay and decomposition of marine organisms (both plants and animals) also con-tribute sediments to ocean deposits.

Importance of Ocean Deposits

Ocean deposits are essential for supporting marine ecosystems and providing important insights into the geological history of the Earth. In order to reconstruct the geological history of the earth, it is essential to obtain information on the rate of sedimentation in the oceans and to determine, either directly or indirectly, the total thickness, and hence the amount, of sediments which have been deposited in the sea. The sediments on the seafloor provide a habitat for a wide range of marine organisms, including bacteria, fungi, and invertebrates. As the consolidated sediments generally contain fossils, it is of equal importance to determine the biological associations under different conditions and the character of the organic materials that may form a part of the sedimentary record. These organisms play crucial roles in the functioning of marine ecosystems, including nutrient cycling and energy transfer.

The sediments on the seafloor can provide a record of past climate change, including changes in sea level, ocean currents, and atmospheric composition. The sediments can also provide information about the movement of tectonic plates and the formation of ocean basins. The study of ocean deposits is important in understanding the rocks exposed on the earth's surface which were once laid under sea. Ocean Deposits help scientists understand past climate conditions. They are critical for reconstructing historical climate data and predicting future climate scenarios. Many Ocean Deposits are rich in economically valuable minerals and metals, including manganese, nickel, and cobalt. Fossil-rich Ocean Deposits offer a wealth of information about extinct marine life forms and their evolutionary history. The distribution and type of Ocean Deposits provide important clues about the movement and formation of the earth's crust.

Check your progress

(i) What are Ocean deposits? Explain

(ii) Explain the Importance of ocean deposits ?

13.3 Sources of oceanic deposits

Since any solid material denser than sea water and relatively insoluble may fall to the sea floor, a wide variety of substances from many sources contributes to the sediments and may be considered following headings:

i. **Terrigenous origin:** Both biotic and abiotic sediments from continents get accumulated on the continental shelf and slope via river, winds, and wave erosion. Two processes are involved in the breakdown of terrigenous rocks of either igneous or sedimentary types. These are disintegration and decomposition Disintegration is the mechanical breakdown of the rock into smaller fragments and does not necessarily involve any change in the composition of the material. Decomposition involves chemical changes in the rock substances which are brought about by the action of water and air

ii. **Volcanic sediments:** Some oceanic sediment is of volcanic origin that deposit in the ocean directly or indirectly from the air. Two types of volcanism,must be considered, namely-subaerial and submarine. In both, essentially the same kinds of material may be ejected; but in the first Wise the volcanic ejecta will be subjected to mechanical and chemical weathering before reaching the sea. Volcanic material may be first deposited on the land and later transported to the sea by the action of running water, but the lighter and more finely divided fragments may be carried over the sea by the air. As a result of transport by winds, volcanic material may be deposited in relatively large amounts over a considerable area and, in fact, ash from single eruptions is thought to have encircled the whole world. Submarine volcanism is probably rather common and in some localities sufficient material has accumulated to reach the sea surface and give rise to volcanic oceanic islands.

iii. **Marine Organism:** The main sources of deposits in the deep ocean are dead marine organism that derives from Zooplankton and Phytoplankton. The hard skeletal structures of marine organisms are important constituents of marine sediments and certain types of deposits are almost entirely composed of the calcareous (calcium and magnesium carbonate) or siliceous (hydrated silica) remains of organisms. The skeletal structures are subject to mechanical disintegration and chemical transformation, the latter generally related to solution.

iv. **Inorganic precipitation**: Inorganic precipitates are formed when the volubility product of some substance is exceeded. The immediate products of organic activity are excluded although the conditions necessary for precipitation of some substances may result from metabolic processes. Supersaturation may be induced by physical agencies such as temperature changes, it may be associated with the removal of carbon dioxide where photosynthesis occurs, or it may be related to changes in hydrogen-ion concentration or oxidation-reduction potential brought about by the organisms. In addition, precipitation may result from evaporation in isolated lagoons and seas.

v. **Products of Chemical transformation** : This category includes substances which are formed by the interact ion of sea water and solid particles. The interaction may be between the solid material and "normal" sea water or the reaction may be restricted to the interstitial water of the sediments where modified properties may exist.

vi. **Extraterrestrial:** They are sediments from meteorites. In those marine sediments which accumulate at extremely slow rates, such as red clay, small black magnetic spherules and brown crystalline spherules are found.

vii. **Waste generated from human activities:** Deposits from waste generated by humans such as industrial waste, domestic waste, etc.

Check your progress

(iii) What are major sources of ocean deposit? Explain.

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(iv) Explain the volcanic sources ocean deposits ?

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13.4 Classifications of Ocean Deposits

Serval scientists have attempted to classify ocean deposits on the basis of location, depth and origin of sediments etc. John Murray has classified ocean deposits into two broad categories based on the settlement locations. a) Terrigenous deposits b) Pelagic Deposits

1. Terrigenous Deposits

The main sources of terrigenous deposits are terrestrial sediments. They are mainly found on the Continental shelf. Boulders, sand, gravel, rocks, and mud are major components of these deposits. Every year 15000 million tones – 20,000 million tones terrigenous sediments added to ocean. Coarser and larger sediments boulders, cobbles and pebbles found near the coast and smaller and finer sediments away from the coast. On basis of size, composition and chemical characteristics they are categorized in to Gravel, Sand, Silt, Clay, Mud

a) **Gravel:** Gravel refers to the coarser terrigenous deposits whose diameter ranges between 2mm -256mm. As there is a wide variation in the size of gravels, so bigger one of the order of 256 mm are called boulders and smaller ones of the order of 2- 4 mm are called granules and pebbles respectively .

b) **Sand** : Sand particles are also formed due to weathering of continental rocks with the diameter ranging form 0.166m to 1mm. Quartz is the most dominant mineral found in the sands. There is variation in diameter of the sand deposits. Coarse one are 0.5 -1 mm in diameter while finer ones

c) **Silt**: Slit is much finer sediments in relatively deeper parts of the ocean. The diameter ranging from 0.02mm – 0.05 mm

d) **Clay** : Clay acts as a cementing material . The diameter less than 0.002 mm generally found 100- 1000 fathoms or 600 – 6000 feet.

f) **Mud :** mud is still finer than clay. Mud is divided into three type on the basis of colour.

(i) **Blue Mud:** It is formed due to disintegration of rocks containing iron sulphide. It contains 35% of calcium carbonate. They are mostly found in Atlantic ocean , Mediterranean sea, Banda Sea.

(ii) Red Mud : The red colour is imparted by iron oxide . It contains an average of 32% calcium carbonate. Mostly confined to Yellow sea , Brazilin coast of Atlantic ocean.

(iii) Green Mud: The green silicates of potassium and iron are deposited on the rocks thus imparting its green colour. calcium carbonate -56%, found – North America , Atlantic coast, pacific coast , Japan, Australia and Africa coast : Depth is 100- 900 fathoms

On the basis of location and depth Terrigenous deposits are classi-fied into three categories

(i) **Littoral deposits** are generally found on the continental shelves mainly near the coastal margins upto the depth of 100 fathoms (600 feet) but they have been also traced upto the depth of 1000m-2000m. Littoral deposits consist of gravels, sands, silt, clays and muds.

(ii) **Shallow water deposits** include terrigenous sediments deposited between low tide water and 100- fathom depth. These deposits consist of gravels, sands, silt and clays of varying proportions. Sea waves and tidal waves help in the gradation and sorting of sediments but landslides, slumping, strong storm waves, and storms sometimes disturb the vertical stratification of sediments.

(iii) **Deep water deposits** include the sediments deposited below the depth of 100 fathoms. There is marked gradation of sediments in vertical succession where the sequence of sediments with increasing depths is blue mud, red mud, green mud, coral mud and volcanic mud.

2. Pelagic Deposit

The pelagic deposits are those found in deep water far from shore and may be predominantly either organic or inorganic in origin. Pelagic deposits are light-colored, reddish or brown, fine-grained and, generally, they contain some skeletal remains of plankton organisms.. Pelagic deposits are classified in the following way:

a. Inorganic deposits. Those which contain less than 30 per cent of organic remains are known as red clay. The inorganic material making up pelagic deposits consist mainly of red clay that usually originates from volcanic activity. Red clay is mainly made up of silicon and aluminum dioxide, while the other constituents can include radium, phosphorous manganese and iron. Red clay comprises the most widely distributed specific pelagic deposit and covers more than half of the total ocean floor in the Pacific Ocean

b. Organic deposits. Those which contain more than 30 per cent of material of organic origin are known as oozes. This class is further subdivided into: i)calcareous ii) Siliceous

i. *Calcareous oozes.*

These contain more than 30 per cent calcium carbonate, which represents the skeletal material of various plankton animals and plants. The calcareous oozes may be further divided into three types, depending upon a characteristic type of organism present in the sediment, namely:

(a) ***GloMgerinaooze***, in which the calcium carbonate is in the tests of pelagic foraminifera.

(b) ***Pteropod ooze,*** containing conspicuous shells of pelagic mollusos.

(c) ***coccolith ooze,*** containing large numbers of cocooliths and rhabdoliths that form the protective structures of the minute Coccolithophoridae

ii. Siliceous oozes.

These are pelagic deposits which contain a large percentage of siliceous skeletal material produced by planktonic plants and animals. The siliceous oozes are subdivided into two types on the basis of the predominance of the forms represented, namely,

(a) ***Diatom ooze,*** containing large amounts of diatom frustules, hence, produced by plankton plants.

(b) ***Radiolarian ooze,*** containing large proportions of radiolarian skeletons formed by these plankton animals.

Check your progress

(v) Explain the Muds and its types?

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(vi) Define Ooze and types of Calcareous ooze

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13.5 Transportation of ocean deposits

Materials transported by the first three agents (i.e. rivers, rain wash, ocean waves) are brought into the sea near the coast lines and the bulk is deposited near the coast, whereas material transported by the last four agents (i.e. Glaciers, winds, volcanic activity and biological activity) may be carried to great distances from land before dropping to the sea bottom, and *may* therefore contribute significantly to the deep-sea deposits

1. Rivers and streams carrying both particulate and dissolved material.
2. Rain-wash, slumping along river banks and sea coasts, and largescale landslides.
3. Shoreline erosion by waves.
4. Glaciers and sea ice carrying rock fragments. The transportation of sedimentary debris by ice has been and still is extremely important in high latitudes.
5. Biological activity which may also increase the transport by other agencies.
6. Winds, which pick up large amounts of fine-grained debris from barren arid areas.
7. Volcanic activity, which may discharge large amounts of fine grained dust into the atmosphere.

The following agents which transport material to the sea

Transportation by Ice: The transportation of sedimentary debris by ice has been and still is extremely important in high latitudes. Glaciers carry large amounts of material which they erode from the land surface, and in so doing, modify the general topography. Contemporary glacier ice carries large amounts of sediment to the sea. Such material is characterized by a great range in size, varying from enormous boulders to the finest material formed by mechanical abrasion

Organic rafting: A less significant amount of debris may be transported in the sea by the agency of buoyant organic material of both terrigenous and marine origin. Trees and clumps of vegetation eroded during floods or by wave action may float great distances in the sea before

decomposition releases the load of imbedded rock material or until the vegetation becomes waterlogged and sinks. Leaves, branches, and even entire terrigenous plant forms are sometimes found in marine deposits far from land.

Atmospheric transportation: In the dispersal of terrigenous material the atmosphere undoubtedly plays an extremely important part. The materials that are carried by the winds over the sea consist mainly of volcanic dust ejected directly into the air and of the particles that are swept up by the wind from the land surface. Wind erosion of the land is most effective in localities where high wind velocities occur and where the ground is not covered by a protective blanket of vegetation. Such areas are found in the high mountains and in desert regions and in in semiarid regions where there is large-scale agricultural activity.

Settling velocity: Sedimentary debris which has been transported to the sea settles through the water and is at the same time carried laterally by currents of different types. The settling velocity of a sedimentary particle depends upon its specific gravity, size, and shape, and upon the specific gravity and viscosity of the water.

Ocean Currents: The effective settling velocities of sedimentary particles probably range from less than one meter per day to many thousand meters per day. Coarse material which is brought to the sea near shore or which is released from icebergs or remains of plants at great distances from the coast will sink so fast that it is immediately deposited, but fine material with small settling velocities may be carried for considerable distances by currents. In deep water, tidal currents are weak, but currents associated with internal waves may have appreciable velocities near the bottom. The permanent currents are very weak but no matter how weak they are they will transport material, which can accumulate, therefore, only where the permanent currents practically vanish, that is, in the deeper parts 'of ocean basins.

Check your progress

(vii) What are first three transporting agents of ocean deposits?

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(viii) Mention the agents which transport material to the sea?

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13.6 Distribution of ocean deposits

About three fourths of the ocean bottom is covered by pelagic sediments. 48% of the pelagic sediments consist of calcareous oozes, while the red clay accounts for 38% and siliceous oozes occupy 14% of the total area. In the Indian and Atlantic oceans calcareous oozes cover larger area than any other ooze. In the Pacific Ocean it is red clay that claims to be the dominant pelagic sediment. It is due to the fact that the Pacific Ocean is deeper and larger part of its floor lies beneath the calcium carbonate compensation depth. Here it is worthwhile to remember that calcium carbonate is dissolved below 4500 m , leaving only minor concentration of biologically derived silica among the terrestrial and other sediments. Since the regions of high productivity of diatoms and radiolarians are limited in extent , the siliceous oozes in all the ocean covers a relatively smaller percentage of the ocean floor. This is because of the fact that diatoms and radiolarians constitute the major components of these deposits. Figure 13.1 shows the distribution of ocean deposits.

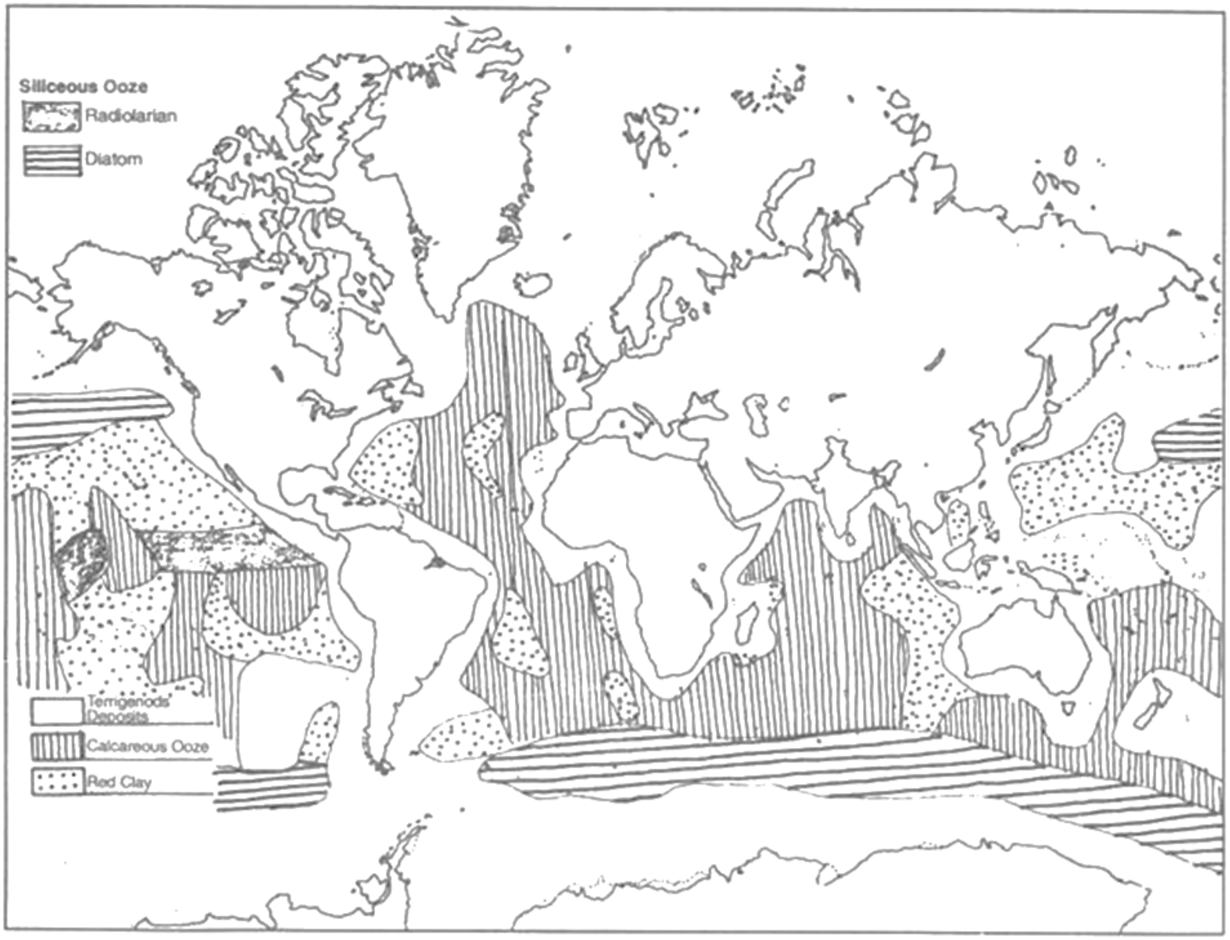

Figure 13.1: Distribution of ocean deposits

The width of the area of terrigenous sediments depends upon a number of factors such as the depth and the supply of material, but it should be noted that in general it is more extensive in high latitudes. The North Polar Basin and the seas adjacent to the northern Pacific and Atlantic Oceans are covered with terrigenous sediments.

Table 13.1 the percentages of the total area of pelagic sediments

Sediment	Indian Ocean	Pacific Ocean	Atlantic Ocean
Calcareous oozes	54.3	36.2	67.5
Siliceous oozes	20.4	14.7	6.7
Red clay	25.3	49.1	25.8
	100	100	100

It will be seen that calcareous deposits predominate in the Indian and the Atlantic Oceans, but that in the Pacific Ocean, which is somewhat deeper, red clay is the most extensive (table 13.1)

Check your progress

(ix) Pelagic sediments distribution in Pacific Ocean

____

(x) Explain the Percentage of distribution of oozes in Indian Ocean?

____

13.7 Summary

Ocean deposits are the unconsolidated materials settled on the bottom of the oceans. The ocean deposits gives information about past climate conditions. The ocean deposits also called as marine deposits. The major sources of ocean deposits are terrigenous, terrigenous origin, volcanos sediments, marine Organism, inorganic precipitation, products of Chemical transformation, extraterrestrial, waste generated from human activities. The ocean deposits are classified on the bases of terrigenous and pelagic. The terrigenous deposits are sub divided in to

gravel, sand, silt, clay, blue mud, red mud and green mud. On the basis of depth these terrigenous deposits are classified as littoral deposits, shallow water deposits and deep water deposits. The pelagic deposits are sub divided into inorganic (red clay) and organic deposit(oozes). The oozes are further subdivided into calcareous and siliceous based on carbon content. glomgerinaooz, pteropod ooze, coccolith ooze are calcareous. The siliceous oozes are diatom ooze, radiolarian ooze. Major transporters of materials to sea are by Ice, Organic rafting, Atmosphere, Ocean Currents and settling velocity. 75% of ocean deposit are covered by pelagic sediments. Distribution of Terrigenous sediments depends on depth and supply of material. The calcareous oozes predominate in Indian ocean.

13.8 Check Your Progress – Model answers

(i) Ocean deposits are also known as marine deposits or sediments. Ocean deposits are the accumulation of materials that settle at the bottom of the oceans. Ocean deposits includes: petroleum, gas hydrates, sand and gravels, etc.

(ii) Ocean Deposits help scientists understand past climate conditions. They are critical for reconstructing historical climate data and predicting future climate scenarios. Many

Ocean Deposits are rich in economically valuable minerals and metals, including manganese, nickel, and cobalt. Fossil-rich Ocean Deposits offer a wealth of information about extinct marine life forms and their evolutionary history.

(iii) The major sources of ocean deposits are terrigenous origin, volcanos sediments, marine Organism, in organic precipitation, products of chemical transformation, extraterrestrial, waste generated from human activities

(iv) Two types of volcanic sources are there subaerial and submarine. Subaerial volcanic material may be first deposited on the land and later transported to the sea by the action of running water. Submarine volcanism is probably rather common and in some localities sufficient material has accumulated to reach the sea surface and give rise to volcanic oceanic islands.

(v) Mud is still finer than clay; it is divided into three types Blue Mud, Red Mud and Green Mud

(vi) Those which contain more than 30 per cent of material of organic origin are known as oozes. Calcareous oozes are three types 1.GloMgerinaooze, 2. Pteropod ooze, 3,coccolith ooze.

(vii) River, Rain wash and Ocean waves are first three agencies transport material into the sea and near the coast lines

(viii) The following agencies which transport material are by Ice, Organic rafting, Atmosphere, Ocean Currents and settling velocity

(ix) In the Pacific Ocean it is red clay that claims to be the dominant pelagic sediment. It is due to the fact that the Pacific Ocean is deeper and larger part of its floor lies beneath the calcium carbonate compensation depth.

(x) The around 75% deposits of oozes , the Calcareous oozes is 54.3%, Siliceous oozes is 20.4%

13.9. Terminal questions

I. Essay Questions

(1) Define ocean Deposits and sources of deposits

(2) Explain the Classification Ocean Deposits

(3) Explain Distribution of Ocean Deposits

II. Short questions

(4) Terrigenous origin ocean deposits

(5) Shallow water deposits

(6) Organic deposits

(7) Atmospheric transportation

(8) Atlantic ocean deposits

III. Very short questions

(9) Gravel

(10)Red Mud

(11) Red Clay

(12) Ice transportation

(13) GloMgerinaooze

(14) *coccolith ooze*

(15) *Diatom*

13.10 Further Reading

- Savinder Singh (2021), Oceanography, Pravalika Publications , Allahabad, Uttar Pradesh, India
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Chapter - 14

BIOSPHERE AND BIOMES

Contents

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14.0 Introduction

You have studied different surroundings and forms of planet earth like atmosphere (air), hydrosphere (water), lithosphere (land). In this lesson you will study the life on the earth (Biosphere). In the universe as on toady life exists only on the planet earth. The plants and animals as well as micro – organisms is part of life on earth. The location and distribution of different plant species, animals are studied in this lesson.

14.1Objectives:

After learning this lesson, you will be able to:

- Understand the Concept of Biosphere
- Recognize relationship between living and non-living things
- Identify the process of energy flow among different living beings in biosphere
- Study difference between ecosystem and biome
- Understand importance of Biodiversity

14.2 Biosphere

On the surface of earth we find the different forms of life like plants, animals, human beings and micro –organism. The specific type of plants found in some places of the earth surface, while some species of life found in water some wild life animals like kangaroo's found in particular location. The reason behind the location and distribution and linkage of climatic elements like rainfall, temperature, etc. for the existence of specific plants, animal is the part of study of Bio-geography. Bio-sphere is the regions of the surface and atmosphere of earth, where living organism found. The concept of Bio-sphere can be understand by the following figure 14.1

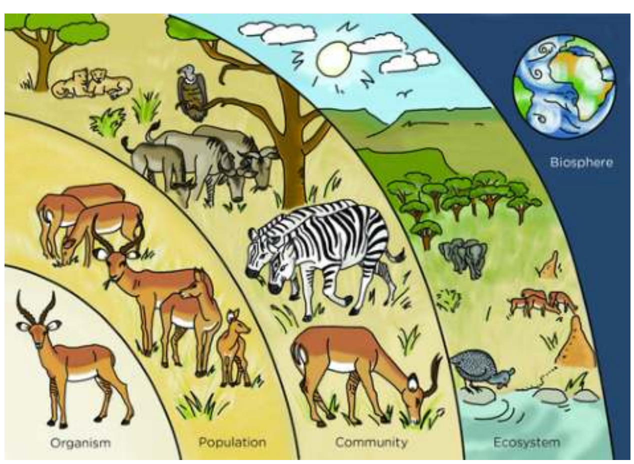

Figure 14.1: Organism to Biosphere

Individual, Species, Organism:

An individual is any living thing or organism. In the diagram above, you will notice individual organism deer.

Population:

A group of individuals of a given species that live in a specific geographic area at a given time. In the above figure, you will notice group of deer's and its family is called as population.

Community:

It includes all the populations in a specific area at a given time. A community includes populations of organisms of different species. In the figure above, note how populations of deer, zebra, cows, bats, plants and tigers coexist in a defined location.

Ecosystem:

Ecosystems include more than a community of living organisms and interacting with the environment. In the above figure, the living organism elephants, deer, peacock, plants interacting with water, sun, hills. The living organism we can call as Biotic and non – living organism we can call as Abiotic. The Biotic components include plants, animal and human beings and the Abiotic components such as rocks, water, air, and sun/ temperature. Smaller area

Biome:

Biome is large area as compared to ecosystem. A biome, an area of the planet which can be classified according to the plant and animal life in it, in simple terms, is a set of ecosystems sharing similar characteristics with their abiotic factors adapted to their environments. A very large ecosystem or collection of ecosystems with similar biotic and abiotic factors such as an entire Rainforest with millions of animals and trees, with many different water bodies running through them.

Biosphere:

The biosphere is the portion of Earth inhabited by life and which represents the sum of all communities and ecosystems**.** It describes the combination of every ecosystem on the planet. The biosphere includes all living beings and their relationships. When we consider all the different biomes, each blending into the other, with all humans living in many different geographic areas, we form a huge community of humans, animals and plants, and micro-organisms in their defined habitats

Check Your Progress

(i) What is Population?

____

____

(ii) What is Biosphere?

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14.3 Ecology and Ecosystems it's types

Ecology includes the study of relationship between living organisms and their environment. Ecology describes the relations of organisms to one another and to their corresponding environment. Three major components studied in ecology are living organisms, the relationship and interactions with other organisms, the relationships and interactions with the surrounding environment. An ecosystem consists of a community of living organisms, their interactions with each other and their physical environment within a particular location. The components of an ecosystem are either biotic (living) or abiotic (non-living, like rocks and bodies of water). Ecosystems also include habitats, which are the living conditions for a species within an ecosystem.

Ecology is the study of the Ecosystems throughout the world. The interaction of biotic and abiotic components of particular location is included in Ecosystem. Ecosystem is a place like a forest, still water, river or a stream, etc. Ecosystem can be classified into various types on various parameters. The most widely used and simple classification is on the basis of habitats. The idea behind this classification is that each habitat exhibits a particular physical environmental condition. These conditions determine the nature and characteristics of biotic communities. Therefore, there are spatial variations in the biotic communities. On this basis, the eco-system can broadly be divided as (i) terrestrial ecosystems and (ii) aquatic ecosystems. These ecosystems are further sub-divided in to various sub-types. A brief discourse about these two eco-systems and their subtypes is in the following:

I. Terrestrial Ecosystem

Terrestrial ecosystem covers about 29% of the land mass on the earth. The major source of food and raw materials is found in this ecosystem because a variety of flora and fauna are available here for humans. The terrestrial ecosystems are further subdivided into various sub-types. Major sub types are (i) upland or mountain ecosystem (ii) low land ecosystem and (iii) desert ecosystem. You will be surprised to know that the maximum life forms are found in lowlands on the earth and this diversity decreases with increasing altitude this is because of the levels of oxygen and atmospheric pressure decreases with increase in height.

II. Aquatic Ecosystem

Aquatic ecosystem includes various forms of water bodies / masses exist on the earth surface which covers about 71% of the entire planet earth. Aquatic ecosystems can further be divided as (i)fresh water, (ii) estuarine (iii) marine. In terms of size or extent it may range from open sea, lake, pond, etc. The biodiversity in aquatic ecosystems depends on the depth up to which sunlight can penetrate and the availability of nutrients and the concentration of dissolved oxygen. Keeping all these factors in view, estuarine ecosystems are found the most productive of aquatic eco-systems. On the ocean surface, shallow continental shelves are more productive than other configurations of ocean floor and open oceans. Open oceans are the least productive of all aquatic ecosystems. They are like the deserts in the terrestrial ecosystem. Some of the organisms exclusively live in water whereas some of the organisms can live in water and on land i.e. frogs, crocodiles, hippopotamus, etc. Moreover, some organisms live only in either fresh water or saline water and some others live in fresh and saline water both.

Check Your Progress

(iii) Define Ecology?

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(iv) Explain the Aquatic Ecosystem ?

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14.4 Food Chain and Food Web

The biotic and abiotic factors are linked by two factors: (a) the flow of energy through the ecosystem and (b) the cycling of nutrients within the ecosystem. To survive, one must eat. To get energy. Food chains and webs describe the transfer of energy within an ecosystem, from one organism to another. In other words, they show who eats whom. Food chains and food webs represent the feeding relationships in ecosystems. Therefore, they model the flow of energy and materials through ecosystems

A food chain represents a simple linear pathway through which energy and materials are transferred from one species to another in an ecosystem. In general, food chains show how energy and materials flow from producers to consumers. Energy and materials also flow from producers and consumers to decomposers, but this step usually is not included in food chains.

In the terrestrial food chain shown in figure 14. 2, grass is the producers. Grass, in turn, is consumed by grasshoppers. Because grasshoppers directly consume producers, they are called primary consumers. At the next level of the food chain, grasshoppers are consumed by frogs, which are called secondary consumers. Frogs are consumed by snakes (tertiary consumers), and snakes are consumed by Eagle (called quaternary consumers). Energy and materials also flow from producers and consumers to decomposers.

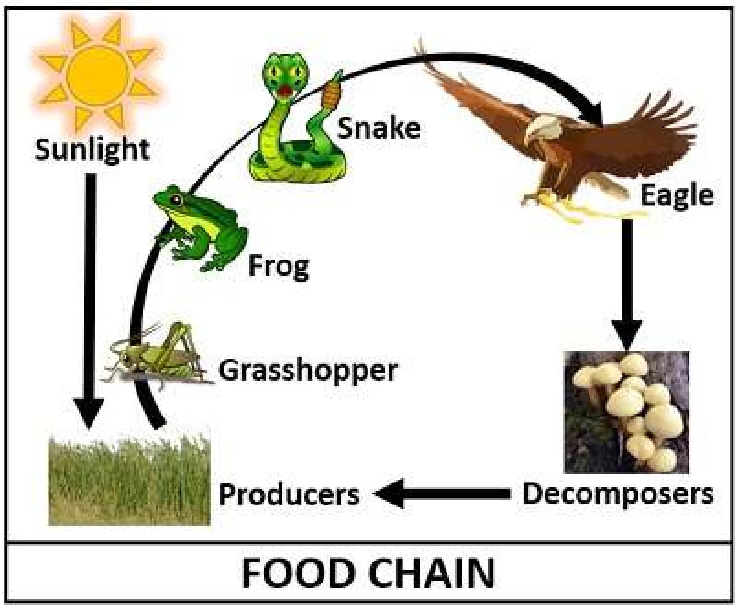

Figure 14.2: Food chain

A food chain is a sequence that shows how energy is transferred between different living things. Put simply, it shows what is eaten by what. For example, grass is eaten by a rabbit, which is eaten by a fox. The energy is transferred between the living things when they are eaten - so the rabbit gains energy by eating the grass and the fox gains energy by eating the rabbit. All living things need nutrition to stay alive, but we all get it in different ways.

Food Web

An ecosystem contains living things that are all part of multiple food chains. All of these food chains are then connected to create a food web. This helps us to visualize the path of energy and nutrients between different living organisms. Animals don’t eat the same food every day and like to interact with various prey, so a food chain alone might not be enough to represent the complexity of our ecosystems. By combining multiple food chains, food webs show you how energy flow all-around a habitat.

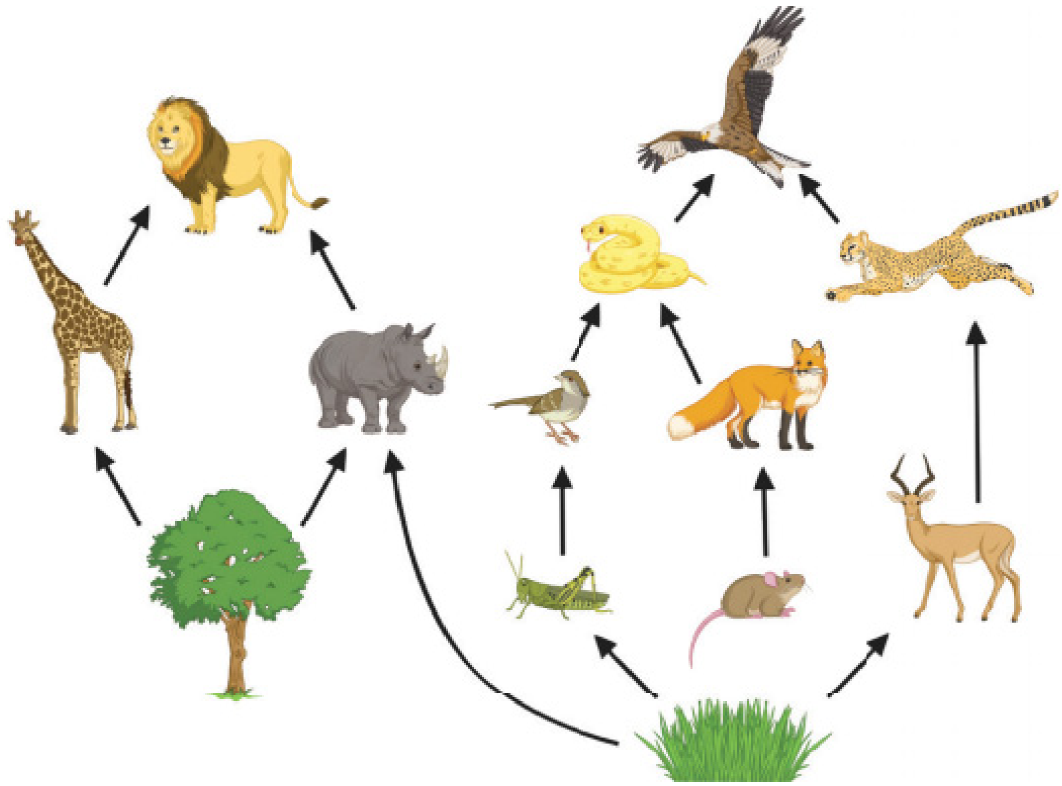

Figure 14.3 : food web

It is also observed that, some of the animals have more than one source of food. This gives them more options for food if one of the others decreases. The lion, for example, eats both giraffe and rhino (figure 14.3). If one were to become unavailable, it will still have a source of food to survive.

Check Your Progress

(i) Explain the food chain ?

____

____

(ii) Differentiate between food chain and food web?

____

____

14.5 Biome

Area of the planet earth which can be classified according to the plant and animal life in it. A place on the surface of earth which can be classified based on organisms live in it. A biome, is the community of plant and animals in a certain climate conditions. Biomes are seen to even spread across continents. A biome is a broad regional type of ecosystem characterized by distinctive climate and soil conditions. A distinctive kind of biological community adapted to such conditions. Biomes are of various types including terrestrial and aquatic biomes. The distribution biomes shown in the figure 14.4

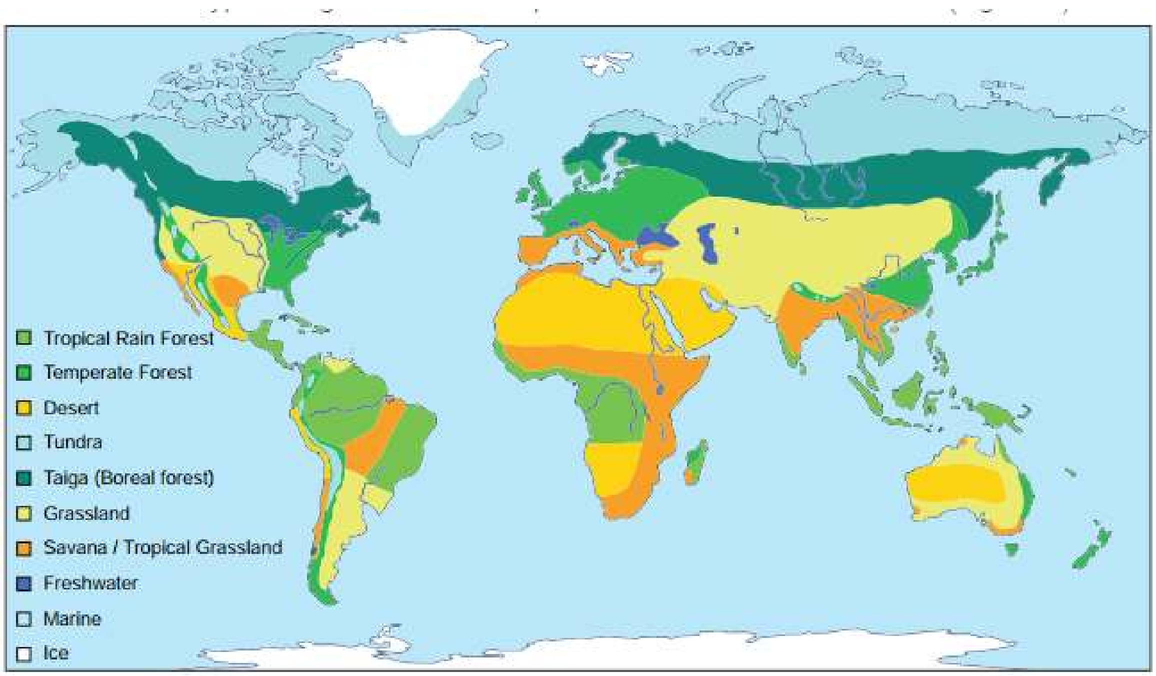

Figure 14. 4: Distribution of major biomes of the world

I. Terrestrial biomes: It consists of all the land areas on Earth where organisms live. The distinguishing features of terrestrial biomes are determined mainly by climate. The dominant terrestrial biomes include; Forest, Grass land, desert, tundra.

a) **Forest biome:** These forest types occur at different latitudes, and therefore experience different climatic conditions. Forests are dominated by trees, and cover about one-third of the Earth. The three major forest biomes are temperate forests, tropical forests, and boreal forests (also known as the taiga). Tropical forests are warm, humid, and found close to the equator. Temperate forests are found at higher latitudes and experience all four seasons. Boreal forests are found at even higher latitudes, and have the coldest, driest climate, where precipitation occurs primarily in the form of snow.

Tropical rainforests are located near the equator. Fifty seven percent of all tropical rainforests are found in Latin America. One third of the world's tropical rainforests are in Brazil. Other tropical rainforests are located in Southeast Asia and the Pacific

Islands (25% of the world's tropical rainforests) and West Africa (18%). Most tropical rainforest soils relatively poor in nutrients. Tropical rain forest soils contain less organic matter**.**

Temperate rainforests are found along some coasts in temperate zones. The largest temperate rainforests are found on the Pacific coast of North America. They stretch from Oregon to Alaska for 1,200 miles. Smaller temperate rainforests can be found on the southeast coast of Chile in South America. There are a few other coastal strips with temperate rainforests, including small areas in the United Kingdom, Norway, Japan, New Zealand, and southern Australia.

Boreal forest is also known as taiga occupies about 17 percent of earth's land surface area in the northern hemisphere.. The boreal covers most of inland Canada and Alaska, most of Sweden, Finland, and inland Norway, much of Russia, and the northern parts of Kazakhstan, Mongolia, and Japan. Taigas are thick forests. The soil of the taiga has few nutrients. The larch is one of the only deciduous trees able to survive in the freezing northern taiga.

b) **Grass land Biome:** Grasslands are open regions that are dominated by grass and have a warm, dry climate. The grassland seems like an endless ocean of grass. Grasslands receive about 10 to 30 inches of rain per year. If they received more rain, the grasslands would become a forest. If they received less, they would become a desert. Grasslands are often located between deserts and forests. Grassland soil tends to be deep and fertile. The roots of perennial grasses usually penetrate far into the soil. There are two types of grasslands: tropical grasslands (sometimes called savannas) and temperate grasslands (Steppe). Savannas are found closer to the equator and can have a few scattered trees. They cover almost half of the continent of Africa, as well as areas of Australia, India, and South America. Temperate grasslands are found further away from the equator, in South Africa, Hungary, Argentina, Uruguay, North America, and Russia. They do not have any trees or shrubs, and receive less precipitation than savannas. Prairies and steppes are two types of temperate grasslands; prairies are characterized as having taller grasses, while steppes have shorter grasses.

c) **Desert Biome:** Deserts are dry areas where rainfall is less than 50 centimeters per year. They cover around 20 percent of Earth's surface. Deserts can be either cold or hot, although most of them are found in subtropical areas. Any vegetation and wildlife living in a desert must have special adaptations for surviving in a dry environment. Desert wildlife consists primarily of reptiles and small mammals. Deserts can fall into four categories according to their geographic location or climatic conditions: hot and dry, semiarid, coastal, and cold.

Hot and dry: The seasons are generally warm throughout the year and very hot in the summer. The winters usually bring little rainfall. The four major North American deserts of this type are the Chihuahuan, Sonoran, Mojave and Great Basin. Others outside the U.S. include the Southern Asian realm, Neotropical (South and Central America), Ethiopian (Africa) and Australian. Many mean annual temperatures range from 20-25° C. The extreme maximum ranges from 43.5-49° C. Minimum temperatures sometimes drop to -18° C.

Semi-arid desert: The major deserts of this type include the sagebrush of Utah, Montana and Great Basin. They also include the Nearctic realm (North America, Newfoundland, Greenland, Russia, Europe and northern Asia). The summers are moderately long and dry, and like hot deserts, the winters normally bring low concentrations of rainfall. Summer temperatures usually average between 21-27° C. It normally does not go above 38° C and evening temperatures are cool, at around 10° C. Cool nights help both plants and animals by reducing moisture loss from transpiration, sweating and breathing. Furthermore, condensation of dew caused by night cooling may equal or exceed the rainfall received by some deserts.

*Coastal desert***:** The cool winters of coastal deserts are followed by moderately long, warm summers. The average summer temperature ranges from 13-24° C; winter temperatures are 5° C or below. The maximum annual temperature is about 35° C and the minimum is about -4° C. In Chile, the temperature ranges from -2 to 5° C in July and 21-25° C in January. The average rainfall measures 8-13 cm in many areas. The maximum annual precipitation over a long period of years has been 37 cm with a minimum of 5 cm. A good example is the Atacama of Chile.

Cold desert **:** These deserts are characterized by cold winters with snowfall and high overall rainfall throughout the winter and occasionally over the summer. They occur in the Antarctic and Greenland. They have short, moist, and moderately warm summers with fairly long, cold winters. The mean winter temperature is between -2 to 4° C and the mean summer temperature is between 21-26° C.

d) **Tundra Biome:** The tundra biome is located at the top of the world, near the North Pole. The most distinctive characteristic of tundra soil is its permafrost, a permanently frozen layer of ground. During the brief summers, the top section of the soil may thaw out allowing plants and microorganisms to grow and reproduce. However, these plants , micro-organisms become dormant during the cold winter months. There is another region called alpine tundra, which is found on the tops of tall, cold mountains. A tundra has extremely inhospitable conditions, with the lowest measured temperatures of any of the five major biomes with average yearly temperatures ranging from -34 to 12 degrees Celsius (-29 to 54 degrees Fahrenheit). They also have a low amount of precipitation, just 15–25 centimeters (six to ten inches) per year, as well as poor quality soil nutrients and short summers. There are two types of tundra: arctic and alpine. This is partly due to a frozen layer under the soil surface, called permafrost. The arctic tundra is found north of boreal forests and the alpine tundra is found on mountains where the altitude is too high for trees to survive. Any wildlife inhabiting the tundra must be adapted to its extreme conditions to survive.

II. Aquatic Biome: Aquatic biomes occupy the largest part of biosphere. These are divided into two, i.e. marine and freshwater. The marine biomes e.g. oceans which is the biggest of the two have a very high salt concentration and have fauna adapted to them. The fresh water biomes such as lakes and rivers have a low salt concentration of less than 1%. Marine biomes cover close to three-quarters of Earth's surface.

Fresh water biome: A lake is a large body of fresh water. Lakes can range in size from small ponds to huge bodies of water. Lakes and rivers are closely tied. Some lakes are the source for some rivers. Important rivers, most often, originate from lakes. Some rivers end in lakes.Since both rivers and lakes are freshwater and flow in and out of each other, they share similar characteristics and many species reside in both habitats.

Marine Biome :. Marine regions cover about three-fourths of the Earth's surface and include oceans, coral reefs, and estuaries. Marine algae supply much of the world's oxygen supply and take in a huge amount of atmospheric carbon dioxide. The evaporation of the seawater provides rainwater for the land.   Marine biomes include the oceans, coral reefs, and estuaries. The oceans are the largest of all the ecosystems. They can be divided into four separate zones based on the amount of sunlight. Ocean zones are also divided based on their depth and their distance from land. Each zone has a great diversity of species. Within a coral reef, the dominant organisms are corals. Corals consist partially of algae, which provide nutrients via photosynthesis. Corals also extend tentacles to obtain plankton from the water. Coral reefs include several species of microorganisms, invertebrates, fishes, sea urchins, octopuses, and sea stars. Estuaries are areas where freshwater streams or rivers merge with the ocean.

Check Your Progress

(i) Explain Forest biome types in detail ?

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(ii) Describe about Marine biome types in brief?

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14.6 Biodiversity

Biodiversity is the part of nature which includes the difference in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space, locally in a region, in the country and the world and various types of ecosystems, both terrestrial and aquatic within a defined area. The great variety of life on earth has provided for man's needs over thousands of years. This diversity of living creatures forms a support system which has been used by each civilization for its growth and development. Biodiversity deals with the degree of nature's variety in the biosphere.

Types of Biodiversity:

Genetic Diversity: Each member of any animal or plant species differs widely from other individuals in its genetic makeup. This is because of the large number of combinations possible in the genes that give every individual specific characteristic. Thus, for example, each human being is very different from all others.

Species Diversity: Species is a basic unit of classification and is defined as a group of similar organisms that mate and produce offspring's with one another and thus, share a common lineage. The numbers of species of plants and animals that are present in a region constitutes its species diversity.

Ecosystem or Community Diversity: There are a large variety of different ecosystems on earth, which have their own complement of distinctive inter linked species based on the differences in the habitat. Ecosystem diversity can be described for a specific geographical region, or a political entity such as a country, a state or a taluka.

Biodiversity hotspots

A biodiversity hotspot is a biogeographic region that is both a significant reservoir of biodiversity and is threatened with destruction. The term biodiversity hotspot specifically refers to 25 biologically rich areas around the world that have lost at least 70 percent of their original habitat. The remaining natural habitat in these biodiversity hotspots amounts to just 1.4 percent of the land surface of the planet, yet supports nearly 60 percent of the world's plant, bird, mammal, reptile, and amphibian species.

Biodiversity Hotspots in India :

(1) Himalaya: Includes the entire Indian Himalayan region (and that falling in Pakistan, Tibet, Nepal, Bhutan, China and Myanmar)

(2) Indo-Burma: Includes entire North-eastern India, except Assam and Andaman

group of Islands (and Myanmar, Thailand, Vietnam, Laos, Cambodia and southern China)

(3) Sundalands: Includes Nicobar group of Islands (and Indonesia, Malaysia, Singapore, Brunei, Philippines)

(4) Western Ghats and Sri Lanka: Includes entire Western Ghats (and Sri Lanka)

Biodiversity Degradation :

The main cause of the loss of biodiversity can be attributed to the influence of human beings on the world's ecosystem, In fact human beings have deeply altered the environment, and have modified the territory, exploiting the species directly, for example by fishing and hunting, changing the biogeochemical cycles and transferring species from one area to another of the Planet. The threats to biodiversity can be summarized in the following main points:

- **Alteration and loss of the habitats**: the transformation of the natural areas determines not only the loss of the vegetable species, but also a decrease in the animal species associated to them.
- **Introduction of exotic species and genetically modified organisms**: species originating from a particular area, introduced into new natural environments can lead to different forms of imbalance in the ecological equilibrium. Refer to, "Introduction of exotic species and genetically modified organisms".
- **Pollution**: human activity influences the natural environment producing negative, direct or indirect, effects that alter the flow of energy, the chemical and physical constitution of the environment and abundance of the species;
- **Climate change**: for example, heating of the Earth's surface affects biodiversity because it endangers all the species that adapted to the cold due to the latitude (the Polar species) or the altitude (mountain species).
- **Overexploitation of resources**: when the activities connected with capturing and harvesting (hunting, fishing, farming) a renewable natural resource in a particular area is excessively intense, the resource itself may become exhausted, as for example, is the case of sardines, herrings, cod, tuna and many other species that man captures without leaving enough time for the organisms to reproduce.

Check Your Progress

(iii) Explain the Types of Biodiversity ?

(iv) What Factors responsible for the loss of biodiversity?

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14.7 Summary

Bio-sphere is the regions of the surface and atmosphere of earth, where living organism found. The relationship between living organism and non-living organism is called as ecosystem. The ecosystem further classified as territorial ecosystem and aquatic ecosystem. Food chain and food web shows energy transformation within an ecosystem form one organism to another. Biome is community of plant and animals in a certain climate in certain area. There are broadly two types of biomes terrestrial biome and aquatic biome. Terrestrial biomes include; Forest, Grass land, desert, tundra. Forest biome further divided as tropical temperate and taiga. The grass land biome classified as savanna (tropical) and prairies, steppe (temperate). Desert biome can fall into four categories hot and dry, semiarid, coastal, and cold. The tundra biome have two types arctic and alpine. The aquatic biome divided into two type marine and fresh water biome. Both rivers and lakes are include in fresh water biome. Marine biomes include the oceans, coral reefs, and estuaries. Biodiversity is the great variety of life on earth, all the plant and animal species at different scales in space, locally in a region, in the country and the world and various types of ecosystems. Biodiversity deals with the degree of nature's variety in the biosphere. Pollution, climate change and overexploitation of resources are causes of loss of biodiversity.

14.8 Check Your Progress - Model Answers

(i) A group of individuals of a given species that live in a specific geographic area at a given time.

(ii) The biosphere includes all living beings on the earth surface

(iii) Ecology is the study of the Ecosystems throughout the world

(iv) Aquatic ecosystem includes (i)fresh water, (ii) estuarine (iii) marine

(v) A food chain is a sequence that shows how energy is transferred between different living things.

(vi) Food chain shows the liner energy transformation between different living things where as food web shows combining multiple food chains.

(vii) Forest biomes are three types , they are temperate forests, tropical forests, and boreal forests (also known as the taiga).

(viii) Marine biomes include the oceans, coral reefs, and estuaries

(ix) Genesis, Species, Community or Ecosystem

(x) Pollution, climate change and over exploitation of resources

14.9 Terminal questions

I. Essay Questions

1. Explain the concept of Bio-geography
2. Define biome. Explain the Tropical forest biome

II. Short answer questions

3. Community
4. Terrestrial ecosystem
5. Grassland biome
6. Ecosystem biodiversity

III. Very Short answer questions

7. Food web
8. Taiga
9. Estuaries
10. Species Diversity
11. Pollution

14.10 Further Readings

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Chapter - 15

LAND SLIDES, VOLCANOES, EARTHQUAKE AND TSUNAMIS

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15.3 Earthquake

15.4 Tsunamis

15.5 Volcanoes

15.6 Landslides

15.7 Summary

15.8 Check Your Progress

15.9 Terminal Questions

15.10 Further Readings

15.0 Introduction:

You might have read about tsunami or seen the images of horror on television set immediately after it happened. You may also be aware of the severe earthquake in Kashmir on both sides of the Line of Control (LOC). The damage caused to human life and properties during these episodes has moved us all. What are these as phenomena and how they are caused? How can we save ourselves? These are some questions which come to our minds. This chapter will attempt to analyse some of these questions.

15.1 Objectives

After learning this chapter, you will be able to:

- Understand the terms "Natural Hazard" and "Disaster"
- Differentiate between a hazard and a disaster.
- Identify and describe the regions prone to disasters in India
- Explain the negative impacts of natural disasters.
- Suggest ways to reduce problems and suffering that arise before, during, or after a disaster through mitigation measures.

15.2 Definition of Disaster & Natural Hazard

What is Disaster?

The term disaster is derived from a French word "Desastre" (Des-aster) which implies 'bad/evil star'. Disasters are debilitating events in which there is widespread loss of life and property in a given society. The social and environmental losses are beyond the capacity of community to cope using its own resources. Therefore, external support is required to overcome its effects.

The Disaster Management Act (2005) of India defines disaster as:

"A catastrophe, mishap, calamity or grave occurrence in any area arising from natural or man-made causes or by accident or negligence, which results in substantial loss of life or human suffering or damage and destruction of property or damage, or degradation of environment and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area."

A disaster is a result of the combination of hazard, vulnerability and insufficient capacity to reduce the potential chances of risk. In order to understand the causes of disaster, we must understand certain terms like hazard, vulnerability, insufficient capacity and disaster risk.

What is Hazard?

The word 'hazard' owes its origin to the word 'hasard' in old French and 'az-zahr' in Arabic meaning 'chance' or 'luck'. Hazard may be defined as "A dangerous condition or event, that threat or have the potential for causing injury to life or damage to property or the environment."

Hazards are such natural or human caused events which can possibly become a disaster with negative consequences when people are exposed to it. Typical examples of hazard can be the absence of rainfall leading to drought, excessive rainfall causing flooding or leakage of chemicals from manufacturing units. Such events near to human settlement are regarded as hazardous as they expose human beings to peril. When there are widespread negative impacts of such events on humans, then hazard turns to become disaster.

Hazard	Disaster
Hazard is a threat. A hazard is a dangerous Physical condition or event.	Disaster is an event. It is a calamity or tragedy or a consequence of a hazard. Natural hazards that cause great loss to human life and economy are called disasters and catastrophes. A disaster disrupts the normal functional of the society.
Earthquakes, floods, volcanic eruption, landslides, droughts etc. are called natural hazards before they cause great loss of life and damage to property.	It causes damage to proterty and loss of life but it also disrupts the opportunities of employment.
Small numbers of people are affected.	A large number of people are affected.
It may cause injury, loss of life or damage of property.	It causes wide spread loss to life and property.
Earthquakes, floods, volcanoes, tsunami, landslide, drought etc. are natural hazards.	It effects the society to such an extent that It effects the society to such an extent that external aid becomes state the losses.

15.2.1 Types of Hazards

Primarily hazards are of two kinds-natural hazards and human induced hazards. However, disaster may be caused by a combination of both.The UN Inter Governmental Panel on Climate Change (IPCC) has shown that man-made hazards have significantly increased the intensity of disasters. The effects of cyclone, heavy rainfall, earthquake, etc., have been worsened by human activity.

Natural Hazard:

Hazard which is the result of natural phenomena is called natural hazard.

National Disaster Management Authority has classified natural hazards into five categories:

A) Geological

B) Hydrological

C) Meteorological

D) Climatological

F) Biological

A) Geological: Geological hazards are those that are are formed due to physical & geological earth movement activity. These center around crustal rupture , deformation & Displacement

Examples : Earthquakes , Volcanic activity-Lahar, Avalanches Landslides(Dry),Sinkhole Land subsidence, etc.

B) Hydrological: Hydrological hazards are caused by abnormal/changes in water cycle like Flood , Landslide(Wet), Wave action, Coastal erosion, Tsunami, Limnic eruption

C) Meteorological: Meteorological hazards are caused due to short term atmospheric processes like Cyclone , Heat wave, Cold wave, Cloud burst, Tornado, Storm, Lighting, etc.

D) Climatological: Climatological hazards are caused by long term natural processes like Climate changes, Blizzards, Hailstorms, Maelstroms, Rise in sea level, Droughts, Glacial lake outburst etc.

E) Biological: Biological hazards are caused by bioactive substances (pathogenic microorganisms). These include Epidemics, Insect infestation, Animal stampede etc.

15.2.2 What is Vulnerability?

The term vulnerability implies the possibility of being harmed. In respect to disaster, it signifies the extent of exposure of the people to suffer damage due to hazard.

UNDRR explains the vulnerability as "A set of prevailing or consequential conditions arising from various physical, social, economic and environmental factors, which increase the susceptibility of a community to the impact of hazards".

There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Vulnerability varies significantly within a community and over time.

Types of vulnerability

Physical Vulnerability:

The physical vulnerability of an area depends on its geographic proximity to the source and origin of the disasters. Example: if an area lies near the coast lines, fault lines, unstable hills etc. it makes the area more vulnerable to disasters as compared to an area that is far away from the origin of the disaster.

Social Vulnerability:

It refers to the inability of people, organizations and societies to withstand adverse impacts to hazards due to characteristics inherent in social interactions, institutions and systems of cultural values.

Economic Vulnerability:

The level of vulnerability is highly dependent upon the economic status of individuals, communities and nations. The poor are usually more vulnerable to disasters because they lack the resources to build sturdy structures and put other engineering measures in place to protect themselves from being negatively impacted by disasters.

Environmental Vulnerability:

Natural resource depletion and resource degradation are key aspects of environmental vulnerability. Example: Wetlands are sensitive to increasing salinity from sea water, and pollution from storm water runoff containing agricultural chemicals, eroded soils, etc

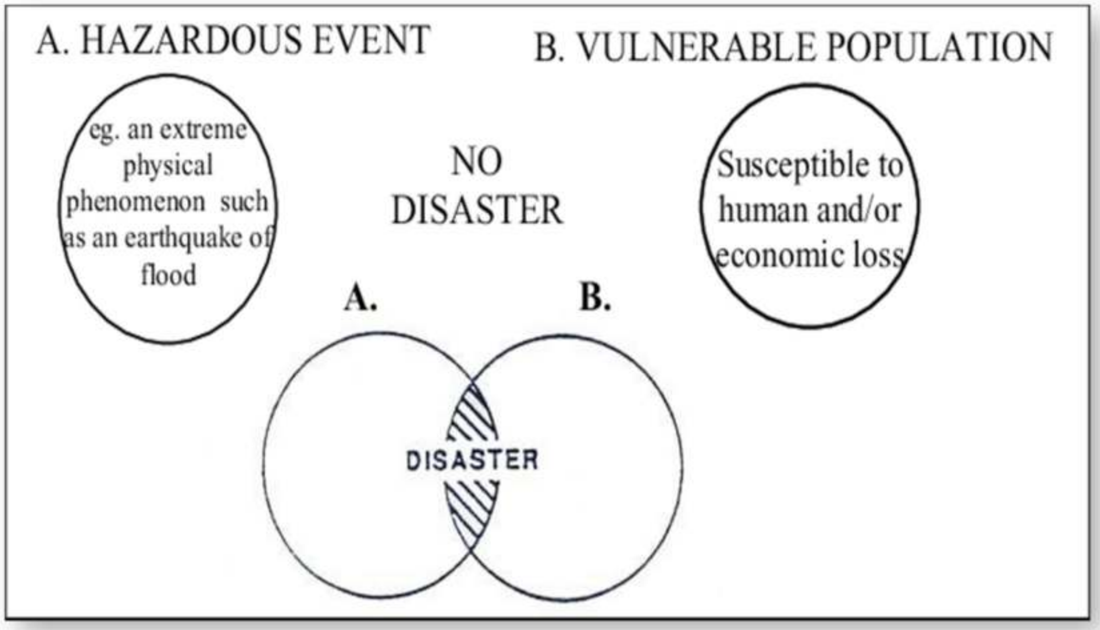
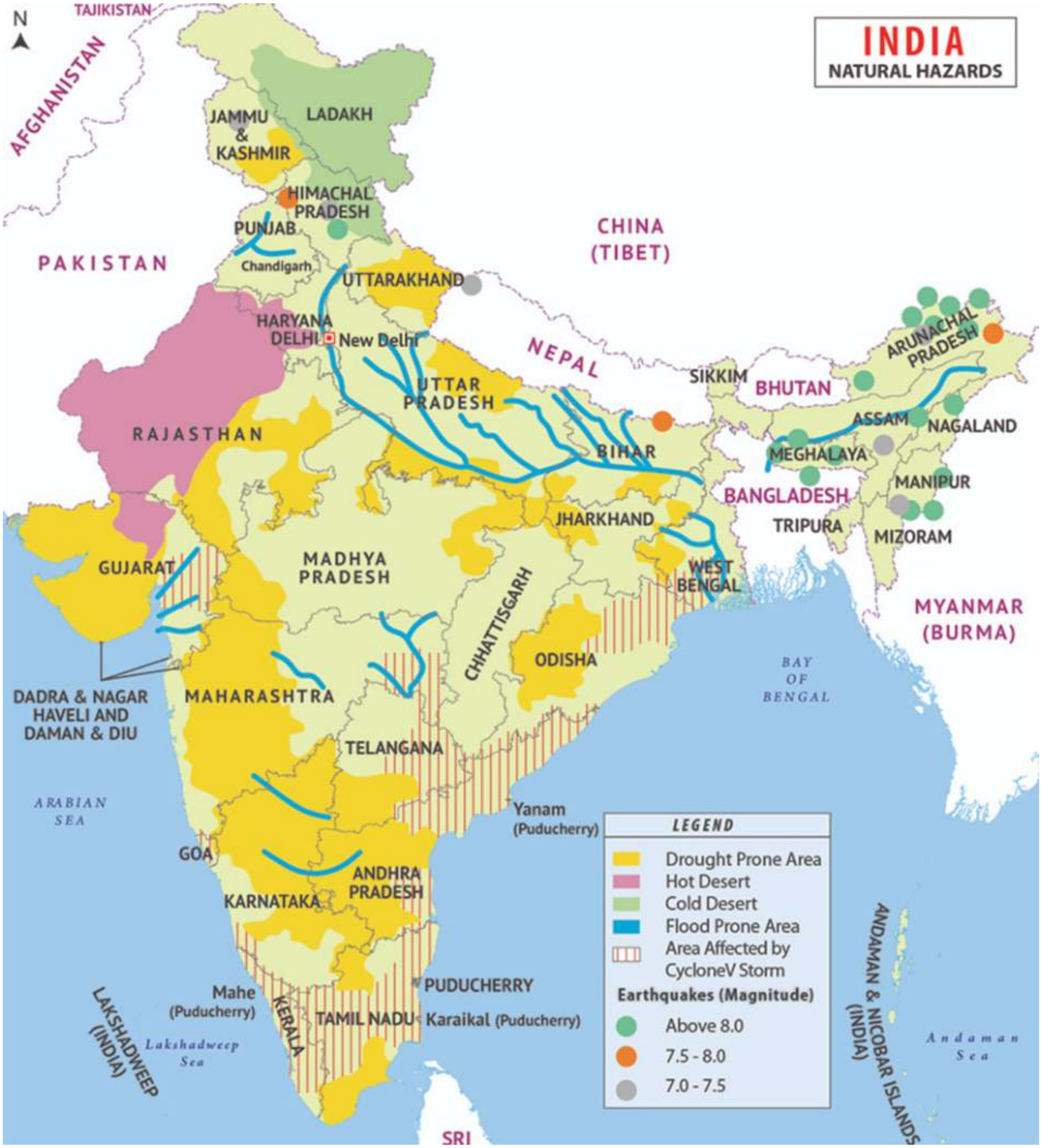


Fig 15.1 Difference between Hazard & Disaster

Vulnerability Profile of India

India is vulnerable in varying degrees to a large number natural as well as man-made disasters

1. 85% of Indian landmass is vulnerable to single or multiple disasters
2. Of the 7,516 km long coastline, close to 5,700 km is prone cyclones & Tsunamis.
3. 8%- 10% is vulnerable to cyclones and
4. 58.6% of the landmass is prone to earthquake of Moderate to very high intensity seismic zones
5. Over 40 million hectare (~12% of land) is prone to floods & River erosion
6. 68% area is susceptible to drought
7. 15% Lanslides Out of 35 states and UTs- 27 are prone to one or more of these events.



What is Disaster Management?

Disaster management is the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to Reduce the risk of the disaster. There are three stages of the disaster risk management which are collectively called Disaster Management Cycle.

Fig 15.3 Disaster Management Cycle

Check Your Progress

(i) When do natural events become natural hazards?

____

____

(ii) Give two examples of Geological Hazards?

____

____

15.3 Earthquake

An earthquake is a motion of the ground surface, ranging from a faint tremor to a wild motion capable of shaking buildings. An earthquake in simple words is shaking of the earth. It is a natural event. It is caused due to release of energy, which generates waves that travel in all directions.

Causes of Earthquakes

1. Tectonic Plate movement
2. Volcanic Eruptions
3. Fault Zones
4. Human-induced Earthquake

15.3.1 Effects of Earthquakes

Earthquake is a natural hazard. The following are the immediate hazardous effects of earthquake:

(i) Ground Shaking

(ii) Differential ground settlement

(iii) Land and mud slides

(iv) Soil liquefaction

(v) Ground lurching

(vi) Avalanches

(vii) Ground displacement

(viii) Floods from dam and levee failures(Rivers change there course)

(ix) Fires

(x) Structural collapse

(xi) Falling objects

(xii) Tsunami

15.3.2 Earthquake Prone Zones in India

Bureau of Indian Standards, based on the past seismic history, divided the country into four seismic zones, viz. Zone II, III, IV and V.The regions away from the Himalayas and other inter-plate boundaries were considered to be relatively safe from damaging earthquakes.

However, occurrence of the Killari earthquake in Maharashtra (1993) resulted in revision of the seismic zoning map in which the low hazard zone or Seismic Zone I was merged with Seismic Zone II. Thus Zone I does not appear in mapping. Zone V is the most seismically active region, while zone II is the least active region. The zones are divided on the basis of Modified Mercalli (MM) intensity, which measures the impact of earthquakes.

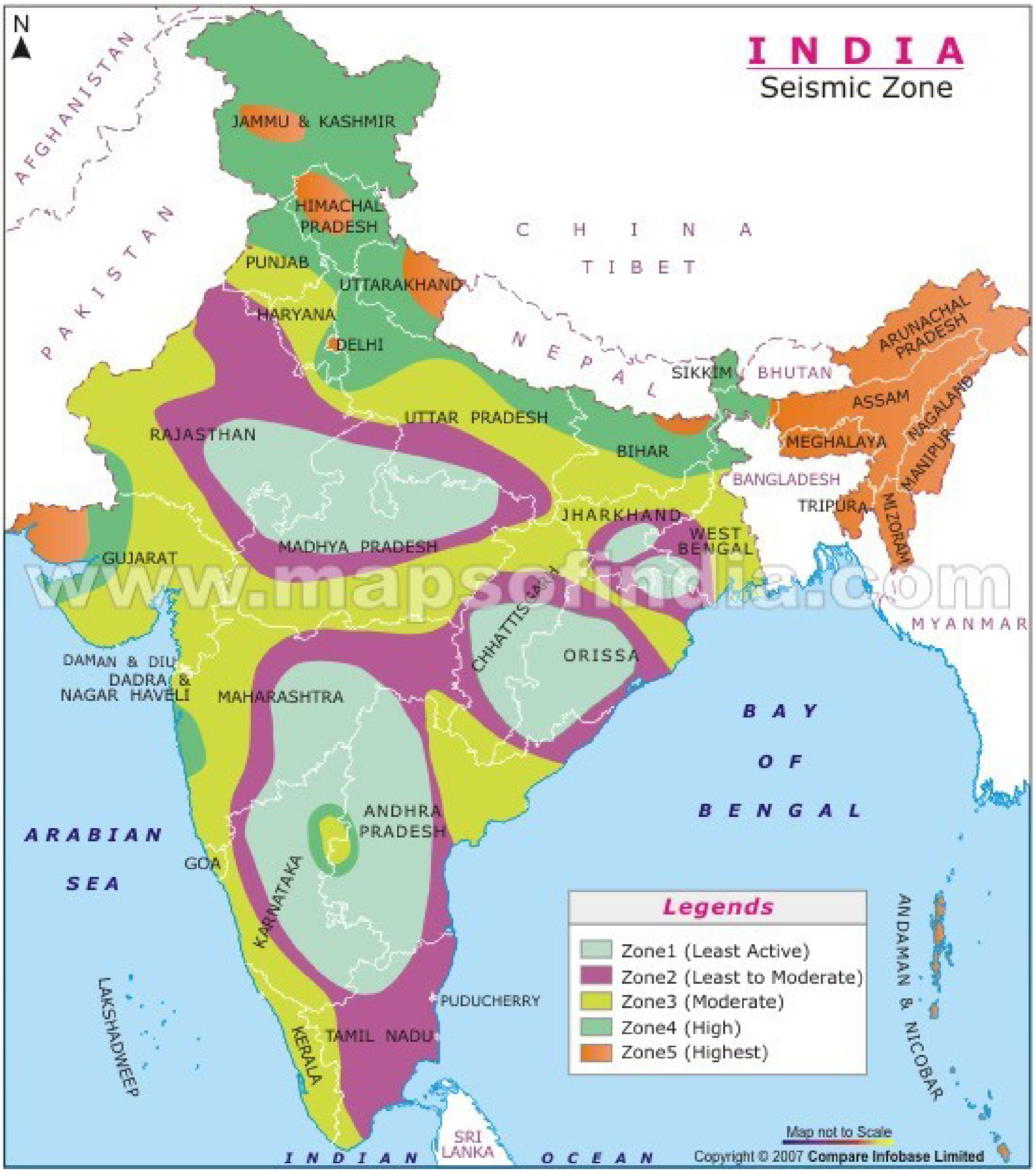


Fig. 15.4 Earthquake Prone Zones of India

Zone - V : covers 10.79% area of the country

It comprises entire North-eastern India, parts of Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Rann of Kutch(Alibandh fault) in Gujarat, part of North Bihar and Andaman & Nicobar Islands. This is very high damage risk zone

Zone – IV: covers 17.49% area of the country

It comprises remaining parts of Jammu and Kashmir and Himachal Pradesh, National Capital Territory (NCT) of Delhi, Sikkim, Northern Parts of Uttar Pradesh, Bihar and West Bengal, parts of Gujarat and small portions of Maharashtra near the west coast and Rajasthan

Zone III : covers 30.79% area of the country.

It comprises Kerala, Goa, Lakshadweep islands, remaining parts of Uttar Pradesh, Gujarat and West Bengal, Parts of Punjab, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, Chhattisgarh, Maharashtra, Orissa, Andhra Pradesh, Tamil Nadu and Karnataka.

Zone – II : covers 40.93% area of the country

It comprises major parts of peninsular region.

Dos and Don’ts during and after the earthquake:

Inside the house - Don’t run outside, set your family into-doorways, under table or if they are bedridden, move them under the beds; keep away from windows and chimneys.

Outside the house - Don’t go near the buildings, high walls, or electric wires.

While driving - If an earthquake occurs stop driving and keep sitting in the vehicle.

1. To be done immediately
2. Put off domestic fire, and all electrical switches.
3. Leave the house if possible and go to open space.
4. Leave the house if a gas leak is detected after the gas is turned off.
5. Save water
6. Untie and free pets and domestic animals (dogs, cats and cattles)

Check Your Progress

(iii) Name any two causes for Earthquake?

____

____

(iv) In which earthquake zone Delhi has been included on the basis of the tensity of the earthquakes?

____

____

15.4 TSUNAMIS

Tsunami meaning “harbour wave” in literal translation comes from the Japanese characters for harbour (tsu) and wave (name). A tsunami also called seismic sea waves, is one of the most powerful and destructive natural forces.

It is a series of extremely long waves caused by a large and sudden displacement of the ocean due to earthquake, volcanic eruptions etc. When they reach the coast, they can cause dangerous coastal flooding and powerful currents that can last for several hours or days.

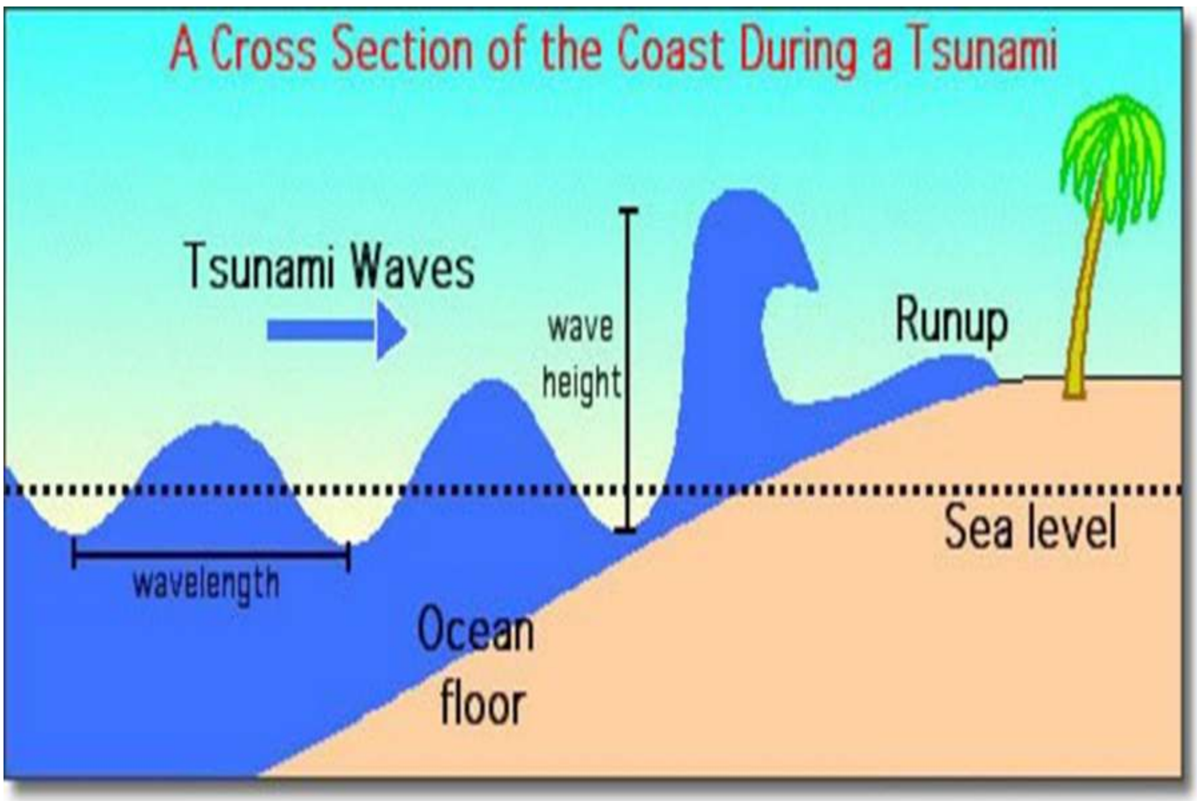


Fig. 15.5 Tsunami Waves

A Tsunami is not just a single wave but a series of ocean waves called a wave train caused by an underwater earthquake, by a volcanic eruption, landslide, rapid changes in atmospheric pressure, a meteorite or nuclear test.

Tsunami waves travel at 500 to 1000km per hour as a under current. Tsunami is small in open ocean yet may be over 30m high(Run up - Height) when it reaches a coastline. Tsunamis have long wavelength (100 km) and they travel across the open ocean at high speed. As they approach shore(shallow depth), the wavelength decreases and the wave height increases – Shoaling

15.4.1 Tsunami 2004

On 26 December 2004, a magnitude 9.1 earthquake struck the Indian Ocean off the west coast of Northern Sumatra. This resulted in the Indian Ocean tsunami, which impacted 13 countries and killed 230,000 people. The epicentre was very close to heavily populated coastal cities, such as Indonesia.

Effects on India:

Southwest Coast comprises Kerala, which suffered significant damage that impacted the largest number of people compared to any other state. But suffered a relatively lower loss of life. The Kanyakumari district of Tamil Nadu suffered heavy loss of life due to a large extent, to human-created local topographical features.

Southeast Coast: This comprises the rich alluvial delta region of the Tamil Nadu coast and Pondicherry, which experienced maximum wave heights and recorded the ultimate loss of life and damage in overall mainland India.

Check Your Progress

(v) The word 'TSUNAMI' derived from which language?

____

____

(vi) What names is given to the high sea-wave triggered by earthquake?

____

____

15.5 Volcanoes

A volcano is a vent(opening) or a fissure in the crust from which lava (molten rock), ash, gases, rock fragments(tephra) erupt from a magma chamber below the surface. Gases such as nitrogen compounds, Sulphur compounds and minor amounts of chlorine, hydrogen and argon

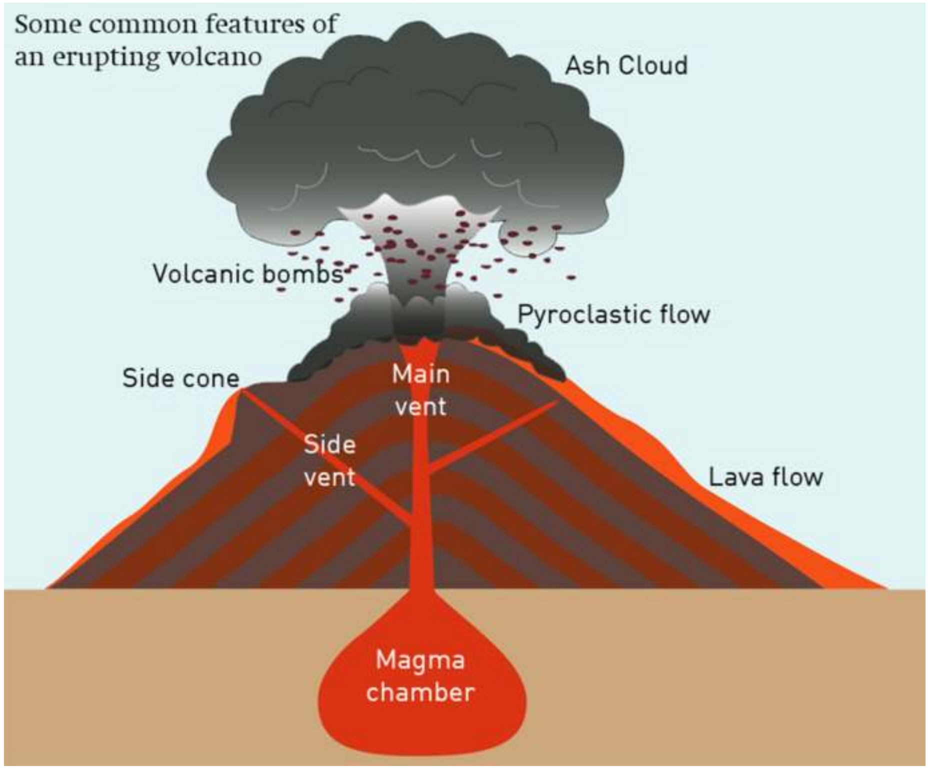


Fig 15.6 Volcano

15.5.1 Causes of Volcanism

There is a huge temperature difference between the inner layers and the outer layers of the earth due to the differential amount of radioactivity. This temperature difference gives rise to convectional currents in the mantle. The convection currents in the mantle create convergent and divergent boundaries (weak zones). These weak zones are areas from which lava comes out.

15.5.2 Distribution of Volcanoes in India

The Barren Island of Middle Andaman and Nicobar Islands which is in the northeast of Port Blair is a volcanic island. The Barren Island volcano was the last active recently in 1995 after 150 years. It has once again started spewing ash in January 2017. The volcanic island is uninhabited and the northern part of the island is barren and devoid of vegetation.

Narcondam (North Andaman) which is in the north-east of Barren Island is another volcanic Island in India. Narcondam volcano has not been active in the recent past. Other parts of India do not have an active volcano.

Check Your Progress

(vii) Name two volcanic Islands of India?

____

____

15.6 Landslides

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity Landslides are one of the natural hazards that affect at least 15 per cent of the land area of our country

15.6.1 Causes of Landslides

(i) Natural Causes

1.Heavy rain , cloud burst & floods

2.Earthquake & volcanic explosions

3.Steep topography

(ii) Man made Causes

1.Deforestation

2.Building of Roads on hilly areas

3.Shifting agriculture & overgrazing

4.Construction of houses & other buildings on hill slopes

5.Soil erosion

6.Mining

Landslides and avalanches are among the major hydro-geological hazards that affect large parts of India besides the Himalayas, the Northeastern hill ranges, the Western Ghats, the Nilgiris, the Eastern Ghats and the Vindhyans, in that order, covering about 15 % of the landmass.

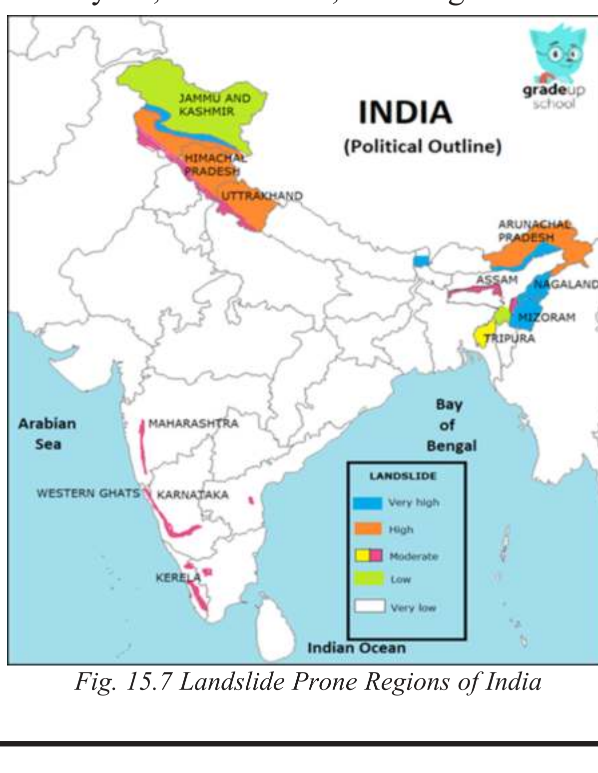


Fig. 15.7 Landslide Prone Regions of India

Impact of landslide

(i) Degrading of environment : Landslides are degrading the environment of mountains. Natural beauty is deminishing slowly and slowly.

(ii) Sources of water are drying up.

(iii) Flooding in rivers is increasing.

(iv) Roads are blocked.

(v) Life and property are lost

Measures to control landslides and to mitigate their impact

(i) Afforestation : Trees and brushes help in binding the soil particles.

(ii) New technology in road construction : Roads should be constructed in such a way, that lesser amount of debrisses are generated.

(iii) Ban on quarrying of stones and mining of minerals

(iv) Instead of exploitation of forests, they should be used scientifically.

(v) Permanent crops like orchards of fruits should replace the seasonal or annual Drops.

(vi) By controlling the surface flow of water, seepage of water should be minimised.

(vii) Retaining walls can be built of mountain slopes to stop land from slipping.

(viii) Hazard mapping should be done to locate areas commonly prone to landslides. Building and construction activities may be banned in such areas.

Check Your Progress

(viii) Name any two causes of landslide ?

(a) ________________________ (b) ________________________

(ix) Name two most landslide prone areas ?

(a) ________________________ (b) ________________________

15.7 Summary

Disasters are catastrophic events that cause extensive loss of life and property beyond a community's coping capacity, while hazards are dangerous conditions with potential harm. Various types of hazards, such as geological, hydrological, meteorological, climatological, and biological hazards, are identified, showcasing India's vulnerability to disasters in different regions.

The chapter provides insights into specific natural hazards like earthquakes, tsunamis, volcanoes, and landslides, explaining their causes, effects, and preventive measures. Emphasis is placed on disaster management, preparedness, and mitigation strategies as crucial tools to protect human lives and minimize damage from these powerful natural forces. The significance of proactive measures and resilience-building is underscored to ensure the safety and well-being of communities in the face of nature's challenges

15.8 Check Your Progress – Model answers

1. When physical events pose danger to humans and their property, they are called hazards.
2. Earthquake and Volcanoes
3. Tectonic plate movement & Volcanic eruptions
4. Zone IV
5. Tsunami meaning "harbour wave" in literal translation comes from the Japanese characters for harbour (tsu) and wave (name).
6. TSUNAMI
7. Barren Island & Narcondam Island
8. Heavy Rainfall & Steep Topography
9. Himalayas & Western Ghats

15.9 TERMINAL QUESTIONS

Essay Questions:

1. Differentiate between natural hazard and natural disaster.
2. What is a landslide? What activities of human being have increased the frequency of landslides.

Short Questions:

3. What is an earthquake? Describe its impact on humans.
4. How do underwater earthquakes trigger tsunamis?

Very Short Questions:

5. What is the primary cause of earthquakes?
6. Name two ways in which humans can contribute to landslides.

15.10 Further Readings

- "Natural Hazards and Disasters" by G.C. Leong
- "Geography of Natural Disasters" by S. Singaracharya
- "Our Earth: Natural Hazards and Disasters" by C. Vaidyanathan
- Website: https://nidm.gov.in/

Chapter - 16

CYCLONES, FLOODING, DROUGHT

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16.1 Objectives

16.2 Cyclones

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16.0 Introduction:

Natural disasters such as cyclones, floods, and droughts have significant impacts on the environment and human populations. India, being a geographically diverse country, is prone to these hazards, and they pose considerable challenges to disaster management and preparedness. This chapter explores the characteristics of cyclones, the causes and consequences of flooding, and the challenges posed by droughts. It also delves into the measures adopted for protection and mitigation against these natural disasters.

16.1 Objectives:

After learning this Chapter, you will be able to :

- Understand the concept of cyclones and their characteristics, including their formation and circulation patterns.
- Examine the vulnerability of different regions in India by cyclone disasters.
- Explore the consequences of cyclones, including the impact on coastal regions and the measures taken for protection.
- Analyse the causes of flooding in India and its effects on various aspects of life, including agriculture and infrastructure.
- Gain insights into the concept of droughts, their causes, and their implications for water resources and agriculture.

16.2 Cyclones

Cyclones are rapid inward air circulation around a low-pressure area. The word Cyclone is derived from the Greek word 'Cyclos' meaning the coils of a snake. It was coined by Henry Peddington because the tropical storms in the Bay of Bengal and the Arabian Sea appear like coiled serpents of the sea. The air circulates in an anticlockwise direction in the Northern hemisphere and clockwise in the Southern hemisphere. Cyclones are usually accompanied by violent storms and bad weather.

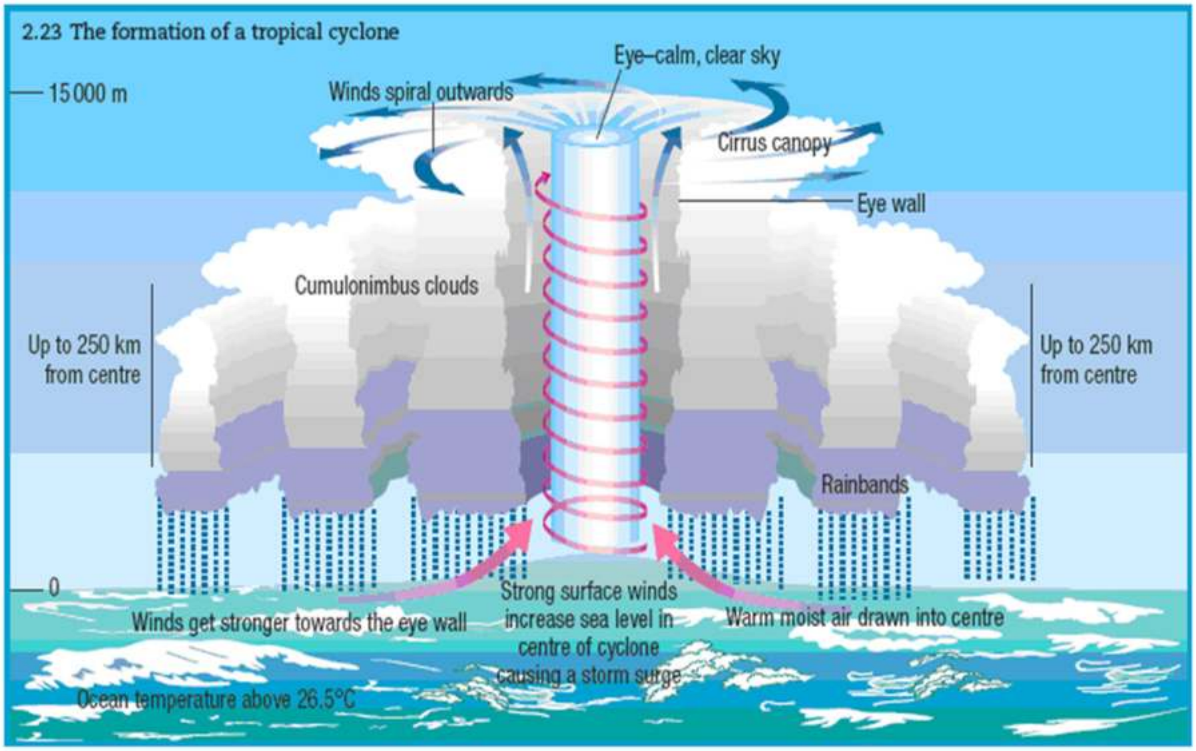

Fig. 16.1 Cyclone Formation Daigram

Tropical cyclones originate and intensify over warm tropical oceans. The conditions favourable for the formation and intensification of tropical storms are:

1. Large sea surface with temperature higher than 27° C. Up to 50mt Depth
2. High relative humidity in the atmosphere up to a height of about 5,000 metres,
3. Presence of the Coriolis force.
4. Small variations in the vertical wind speed(Lower & Upper atmosphere levels).
5. A pre-existing weak low- pressure area or low-level-cyclonic circulation.
6. Upper divergence above the sea level system.

16.2.1 Cyclone risks in India

In India, tropical cyclones occur in the months of October, November, December, April and May The cyclones of severe intensity and frequency in the northern part of the Indian Ocean are bimodal in character, with their primary peak in November and secondary peak in May.13 coastal states and union territories (UTs) in the country, encompassing 84 coastal districts which are affected by tropical cyclones. Four states (Tamil Nadu, Andhra Pradesh, Odisha and West Bengal) and one UT (Puducherry) on the east coast and one state (Gujarat) on the west coast are highly vulnerable to cyclone disasters.

16.2.2 Consequences of Cyclone Hazard

1. Inundation of sea water in low lying areas of coastal regions,
2. Heavy floods, landslides
3. Erodes beaches and embankments,
4. Destruction of vegetation, infrastructure and loss of life
5. Loss of crops and food supplies along with loss of soil fertility
6. Contamination of ground and pipe water supply
7. Severe disruption in the communication links

16.2.3 Some do's and don'ts before, during and after the cyclone

- Listen to the radio for advance information and advice
- Keep considerable margin of time for safety.
- A cyclone may change direction, speed, or intensity within a few hours, so stay tuned to the radio for updated information.

16.2.4 If high velocity winds or severe gales are forecasted for your area:

- Store or secure loose boards, corrugated iron sheets, old tin boxes, anything else that could become dangerous.
- Close the windows tightly to prevent them from breakage.
- Move to the safe shelter built for this purpose, or leave the area on the advice of some authoritative government agency.

16.2.5 When the storm strikes.

- Stay in the house and take shelter in the stronger portion of your house.
- Listen to the radio and follow instructions.
- Open windows of the safe portion of the house if the roof begins to lift.
- Find shelter if you are in open at the hitting time of the cyclone.
- Do not go out of your house or to a beach during or lay down along an elevated footpath in open field the storm. Cyclone often generates large surges in these oceans or lakes.

CHECK YOUR PROGRESS

(i) Which are the most cyclone prone months?

____

(ii) Which state is most vulnerable by cyclone on the western coast of India?

____

16.3 Floods

Flood is a state of high water level along a river channel or on the coast that leads to inundation of land which is not normally submerged. Out of the total geographical area of 329 million hectares, Rashtriya Barh Ayog (RBA)/National Flood Commission has assessed that more than 40 million hectare area is flood prone(12% of India's land) State wise study shows that about 27% of the flood damage in the country is in Bihar, 33% by Uttar Pradesh and Uttarakhand and 15% by Punjab and Haryana.

Our country receives an annual rainfall of 1200 mm, 85% of which is concentrated in 3-4 months i.e. June to September.

Due to the intense and periodic rain, most of the rivers of the country are fed with huge quantity of water, much beyond their carrying capacity leading to mild to severe flood situations in the region

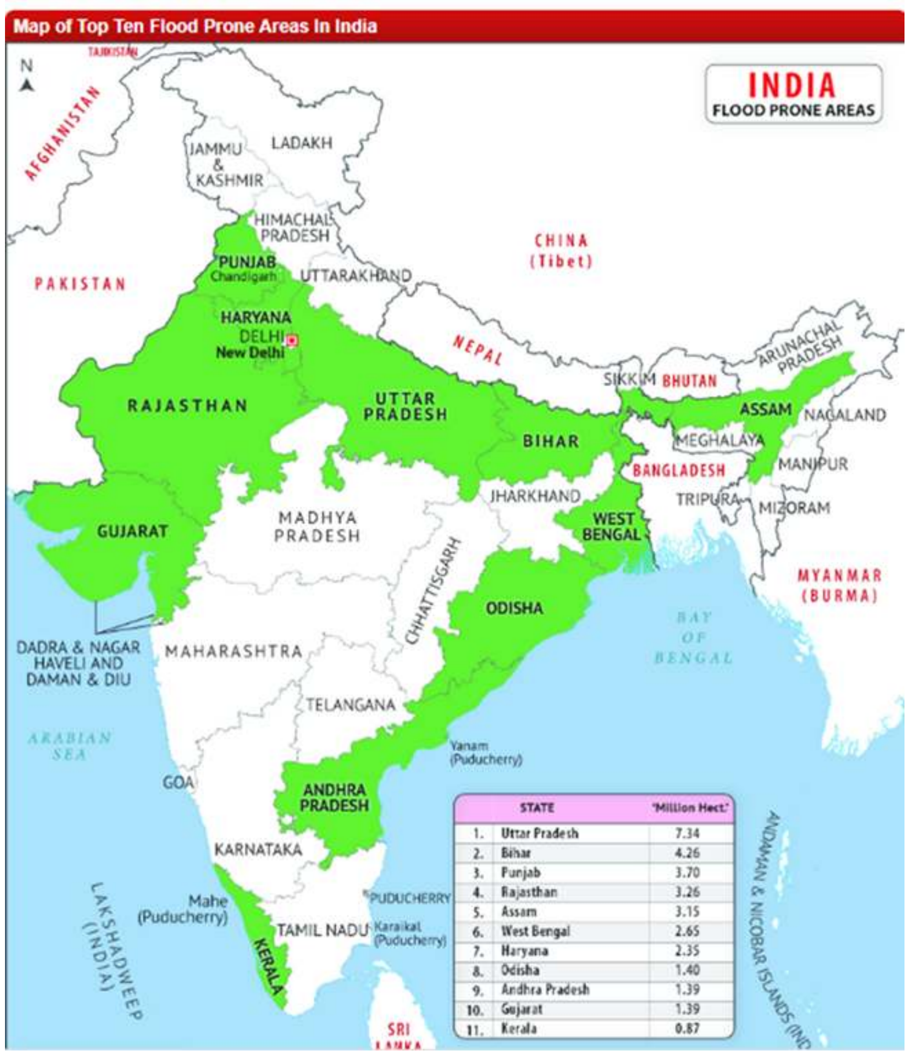

Fig 16.2 Flood Prone Areas in India

16.3.1 Cause of flood

The causes of flood in India are as follows:

(i) Heavy rainfall : Heavy rain in the catchment area of a river causes water to over flow its banks, which results in the flooding of nearby areas.

(ii) Sediment deposition : River beds become shallow due to sedimentation.The water carrying capacity of such river is reduced. As a result the heavyrain water over flows the river banks.

(iii) Deforestation : Vegetation hampers the flow of water and forces it topercolate in the ground. As a result of deforestation, the land becomesobstruction free and water flows with greater speed into the rivers and causes flood.

(iv) Cyclone : Cyclone generated sea waves of abnormal height spreads the water in the adjoining coastal areas. In October 1994 Orissa cyclone generated severe floods and caused unprecedented loss of life and property.

(v) Interference in drainage system: Drainage congestion caused by badly planned construction of bridges, roads, railway tracks, canals etc. hampersthe flow of water and the result is flood.

(vi) Change in the course of the river: Meanders and change in the course of the river cause floods.

(vii) Tsunami : Large coastal areas are flooded by rising sea water, when a tsunami strikes the coast.

16.3.2 Losses by flood :

Humans and animals both are affected by flood. People are rendered homeless. Houses are damaged or collapse. Industries are crippled. Crops are submerged in flood water. Domestic as well as wild animals die. Boats and fishing nets etc. are lost or damaged in coastal areas. Out break of epidemics like malaria and diarrhoea etc. are common after flood. Potable water is contaminated and sometimes becomes scarce. Food grains are lost or spoiled, their supplies from outside become difficult.

16.3.3 Flood control measures

(i) Reservoirs : By constructing reservoirs in the courses of rivers could stores extra water at the time of flood. Such measures adopted till now however, have not been successful. Dams built to control floods of Damodar could not control the flood.

(ii) Embankments : By building flood protection embankments, floods water can be controlled from overflowing the banks and spreading in near by areas. Building of embankments on Yamuna, near Delhi, has been successful in controlling the flood.

(iii) Afforestation : The furry of flood could be minimized by planting trees in catchment areas of rivers.

(iv) Restoration of original drainage system : Drainage system is generally choked by the construction of roads, canals railway tracks etc. Floods could be checked if the original form of drainage system is restored.

16.3.4 Some do's and donts before, during and after the flood

(i) Listen to the radio for advance information and advise.

(ii) Disconnect all electrical appliances, move all valuable household goods and clothing out of reach of flood water. Adopt such measures only when there is a forecast of flood or you suspect that flood water may reach the house.

(iii) Move vehicles, farm animals and moveable goods to the higher ground.

(iv) Prevent dangerous pollution.

(v) Keep all insecticides, pesticides etc. out of the reach of flood water.

(vi) Switch off electricity and gas, in case you have to leave the house.

(vii) Lock all door and windows if you have to leave the house.

(viii) Do not enter flood water on foot or in a vehicle as far as possible.

(ix) Never wander in the flooded area on your own.

CHECK YOUR PROGRESS

(iii) Mention any two causes of flood.

____

____

(iv) How much percentage of India's total area of is flood prone?

____

____

(v) Mention any two measures of flood control.

____

____

16.4 Drought

Droughts refer to a serious shortfall in availability of water, mainly, but not exclusively, due to deficiency of rains, affecting agriculture, drinking water supply and industry.

It is a slow onset disaster which evolves over months or even years and affects a large spatial extent. About 70% of India's total area is drought prone area

16.4.1 Causes of drought

Major cause of drought in India is scarcity of rain. But humans have interfered in the environment processes by their activities. People have filled up the natural resources like ponds and lakes. They have destroyed the vegetation cover. Vegetation cover impedes the flow of rainwater and force it to percolate in the ground. Humans have dug lakhs of tube wells and depleted the ground water reservoirs.

16.4.2 Impact of drought

Droughts cause scarcity of food and water. Hungry and thirsty people cry for help. People die of hunger, malnutrition and epidemics. People are forced to migrate from their area of residence. Crops fail due to scarcity of water. Cattle because fodder and water are not easily available.

Extreme Drought Affected Areas	Most parts of Rajasthan, particularly areas to the west of the Aravali hills, i.e. Marusthali and Kachchh regions of Gujarat fall in this category.
Severe Drought Affected Areas	Parts of eastern Rajasthan, most parts of Madya Pradesh, eastern parts of Maharashtra, interior parts of Andhra Pradesh and Karnataka Plateau, northern parts of interior Tamil and Southern parts of Jharkhand and interior Odisha.
Moderate Drought Affected Areas	Northern parts of Rajasthan, Haryana, Southern districts of Uttar Pradesh, the remaining parts of Gujarat, Maharashtra except Konkan, Jharkhand and Coimbatore Plateau of Tamil Nadu

16.4.3 Drought Hazard Mitigation

1. Water Harvesting & Conservation – check dams , water recycle
2. Sowing drought resistant crops – Bajra,
3. Livelihood planning – least drought effected
4. Suitable farming methods for arid areas – Drip irrigation , Sprinkler Irrigation & ponds
5. Drought planning
6. Drought Monitoring
7. Identification of Ground water potential & Inter-linking rivers
8. Cloud seeding /Create artificial rain by electric shock to clouds And using Silver iodide.

16.4.4 Drought prone area programme

This programme was initiated in 1973. The objectives of the programme are as follows:

(i) To minimise the adverse impact of drought on crops, domestic animals, productivity of land, water and human resources. This could be done by integrated development by using appropriate technologies as it was done for the natural resources of Gujrat.

(ii) By developing, conserving and suitably using the rainwater, the ecological balance could be maintained for a longer period.

(iii) To improve the economic and social conditions of the section of society who do not have access to resources and facilities.

Drought Crisis Management Plan, 2015

The NDMA manual sets out four important measures that a State government should take at the time of a drought, with the Union government's help. MGNREGA to provide immediate employment to drought-affected people. The public distribution mechanism should be strengthened to provide food and fodder Initiate actions to recharge the groundwater table by building check dams and providing pipeline water and other irrigation facilities. The government should either waive off or defer farmer loans and arrange for crop loss compensation.

CHECK YOUR PROGRESS

(vi) How much percentage of India's total area is drought prone area?

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(vii) Mention any two drought Mitigation measures ?

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16.5 Summary

Cyclones are characterized by rapid inward air circulation around a low-pressure area, primarily occurring over warm tropical oceans. India experiences severe cyclones in October, November, December, April, and May, with the east and west coasts being most vulnerable. Cyclones lead to coastal inundation, heavy floods, erosion, destruction of infrastructure, and loss of crops and life. The chapter also highlights the measures to protect against cyclones, including timely warnings, securing loose objects, and seeking safe shelter.

Floods, on the other hand, result from heavy rainfall, sediment deposition, deforestation, cyclones, drainage system interference, river course changes, and tsunamis. Floods affect about 12% of India's geographical area, causing damage to homes, infrastructure, crops, and wildlife, and leading to outbreaks of epidemics. To mitigate floods, strategies like building reservoirs, embankments, and afforestation are adopted. Droughts, characterized by water scarcity due to deficiency of rains, impact around 70% of India's total area. Droughts result in food and water shortages, migration, crop failure, and adverse effects on animals. Drought mitigation measures include water harvesting, drought-resistant crops, and drought planning.

Overall, understanding these natural disasters and implementing effective mitigation strategies are essential for disaster management and preparedness in India.

16.6 Check Your Progress – Model Answers

(i) October, November, December, April and May

(ii) Gujarat

(iii) Heavy rainfall & River sedimentation

(iv) 12% of India's Geographical Area

(v) Construction of reservoirs and embankments, tree plantation, restoration of natural drainage system

(iv) 70% of India's total geographical area

(vi) Rajasthan & Drip irrigation

16.7 TERMINAL QUESTIONS

Essay Questions:

1. What are cyclones, and how do they form? Mention the most cyclone-prone months in India and the highly vulnerable states on the east and west coasts.

2. Explain the concept of droughts, their causes, and implications for water resources and agriculture in India. Discuss the drought hazard mitigation strategies.

Short Questions:

3. Give an account on drought prone areas of India
4. Explain the causes of floods in India and the consequences of flooding on various aspects of life. Describe two flood control measures that have been successful.

Very Short Questions:

5. Name two successful flood control measures and the percentage of India's flood-prone area.
6. How much percentage of India's total area is considered drought-prone, and what are two drought hazard mitigation strategies mentioned in the chapter?

16.8 Further Readings

- Geography Text book, NCERT, India

  Website: https://ndma.gov.in/

VII: PHYSICAL SETTING OF INDIA

Chapter - 17

PHYSICAL DIVISIONS, CLIMATE AND DRAINAGE

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17.0 Introduction

In size, India is the seventh largest country in the world. It is a vast country characterized by great diversity in its physical feature. Therefore, it is necessary to acquire some knowledge about principal physical features. The students should make themselves familiar with the main aspects of its geography, the broad facts regarding the external relief, mountain systems, plateaus, plains, drainage systems, etc

17.1 Objectives

After studying this lesson, you will be able to :

- Describe the location of India and neighbouring countries
- Describe the major physiographic divisions of India
- Describe climate and monsoon mechanism of India
- Describe rivers system of India

17.2 Location and Boundaries of India

According to the Constitution of India, the country is known as India i.e. Bharat. India accounts for 2.42 per cent of the world's total land area. 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. The northern most point of the Indian mainland lies in the state of Jammu and Kashmir and the southern most point is Kanyakumari in Tamilnadu. However, the southern most 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. 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

India is the most populated country in the world and it is located near the Bay of Bengal and the Arabian sea. The neighboring countries of India are China, Nepal, Bhutan, Pakistan, Myanmar, Sri Lanka, and Bangladesh. India shares its coastline border with Sri Lanka and Myanmar. The land border of India is 15,106.7 km and the coastline of India is 7,516.6 km. Ladakh is the only union territory that has three international borders with Afghanistan, China, and Pakistan. Afghanistan has a borderline of 106 km with India and the border touches states like Jammu and Kashmir. Border-line between Bhutan and India is 699 kilometers which touches states like Sikkim, Assam, Arunachal Pradesh, and West Bengal. The borderline of Bangladesh and India is 4156 km which touches the states Assam, Meghalaya, Tripura, Mizoram, and West Bengal. The border between India and China is 3488 km and the border touches Himachal Pradesh, Arunachal Pradesh, Jammu, and Kashmir Sikkim Uttarakhand. The border of India and Myanmar is 1643 km and it touches Arunachal Pradesh, Nagaland, Mizoram, and Manipur in India. The length of the Nepal and India border is 1751 km which touch is the States Bihar, Uttarakhand, West Bengal, Sikkim, and Uttar Pradesh in India. The borderline of Pakistan and India is 3323 km and it touches the states Jammu and Kashmir, Punjab, Gujarat, and Rajasthan in India. Indian Sri Lanka and India border is a coastline which is separated by the Gulf of Mannar.

Check your progress

(i) Explain the latitudinal extent of India?

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(ii) Which of the countries share the boundaries with India?

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17.3 Physiographic divisions of India

The physical features of India can be grouped under the following physiographic divisions (Figure):

(1) The Himalayan Mountains (2) The Northern Plains (3) The Peninsular Plateau (4) The Indian Desert (5) The Coastal Plains (6) The Islands

1.The Himalayan Mountains

The Himalayas are not only a physical barrier for the entire Indian subcontinent but they also act as a climatic, drainage and cultural divide. These mountain ranges run in a west-east direction from the Indus to the Brahmaputra. The Himalayas represent the loftiest and one of the most rugged mountain barriers of the world. They form an arc, which covers a distance of about 2,400 Km. Their width varies from 400 Km in Kashmir to 150 Km in Arunachal Pradesh. The altitudinal variations are greater in the eastern half than those in the western half. They consist of a series of mountain ranges. Some of the important ones from north to south are

- Greater Himalayas or Himadri also includes Great Himalayas and Trans Himalayan ranges.
- The Middle Himalayas or Himachal
- The Shiwaliks

Himadri

The Himalaya consists of three parallel ranges in its longitudinal extent. A number of valleys lie between these ranges. 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. It contains all prominent Himalayan peaks. The folds of the Great Himalayas are asymmetrical in nature. The core of this part of Himalayas is composed of granite. It is perennially snow bound, and a number of glaciers descend from this range.

Himachal

The range lying to the south of the Himadri forms the most rugged mountain system and is known as Himachal or lesser Himalaya. The ranges are mainly composed of highly compressed and altered rocks. The altitude varies between 3,700 and 4,500 metres and the average width is of 50 Km. While the Pir Panjal range forms the longest and the most important range, the Dhaula Dhar and the Mahabharat ranges are also prominent ones. This range consists of the famous valley of Kashmir, the Kangra and Kullu Valley in Himachal Pradesh. This region is well-known for its hill stations

Shiwaliks

The outer-most range of the Himalayas is called the Shiwaliks. They extend over a widthof 10-50 Km and have an altitude varying between 900 and 1100 metres. These ranges are composed of unconsolidated sediments brought down by rivers from the main Himalayan ranges located farther north. These valleys are covered with thick gravel and alluvium. The longitudinal valley lying between lesser Himalaya and the Shiwaliks are known as Duns. Dehra Dun, Kotli Dun and Patli Dun are some of the well-known Duns

(2) The Northern Plains

The Great plain of Northern India was formed by the sediments brought down by the Indus,Ganga-Brahmaputra and their tributaries and it is popularly known as the Indo-GangaBrahmaputra plain . Northern plains located between south of the Himalayas and north of the Peninsular plateau. These plains formed by the deposition of the sediments brought by three main river systems namely : the Indus, the Ganga and the Brahmaputra. It mainly includes the states of Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and Assam. Punjab plains, Ganga plains and Bramaputra plains are the major regional division of northern plains

Based on relief features the northern plain can be divided into following region:

i. **Bhabar**- after descending from the mountains, the rivers deposit pebbles in a narrow belt. The width of this belt is about 8-16 km and it lies parallel to the Shiwaliks. This region is known as bhabar. All the streams dissappear in this region.

ii. **Terai**: lies towards south of bhabar belt. In this regiaon, the streams reappear and make awet, swampy and marshy region.

iii. **Bhangar**: largest part of northern plainand is composed of the oldest alluvial soil. They lie above the flood plains and resemble terraces. The soil of this region is locally known as kankar and is composed of calcareous deposits.

iv. **Khadar**: the floodplains formed by younger alluvium are called khadar. The soil in this region is renewed every year and is thus highly fertile.

3) The Peninsular Plateau

Peninsular plateau is a triangular shaped table land. It is part of ancient land mass called Gondwana . It covers an area of nearly 5 lakh sq.km. It is spread over the states of Gujarat, Maharashtra, Bihar, Karnataka and Andhra Pradesh. River Narmada divides the peninsular plateau into two parts: (i) The central highlands and (ii)Deccan Plateau. The central Highlands extends from Narmada river and the northern plains. Aravallis is the important mountain which extends from Gujrat through Rajasthan to Delhi. The Malwa Plateau and Chhota Nagpur plateau are parts of the central highlands. Important River Betwa, chambal and Ken - Mahadeo, Kaimur and Maikal are the important hills of chhota Nagpur plateau.The valley of Narmada is lies between the Vindhyas and the satpura which flows east to west and joins the Arabian sea.

Deccan plateau is separated by a fault fromChota Nagpur plateau. - The black soil area in the Deccan plateau is known as Deccan trap, formed due to volcanic eruptions and good for cotton & sugarcane cultivation. The Deccan plateau is broadly divided into: (a) The Western Ghats (b) The Eastern Ghats. Western Ghats runs parallel to the western coast for about 1600 km. - average elevation of the Western Ghats is 1000 metres.Peaks:Doda Betta, AnaimudiamdMakurti. - Western ghats are continuous and can be crossed through passes like Pal Ghat, ThalGhot and BhorGhat. rivers :Godavari, Bhima and Krishna flow eastward while the river Tapti flows westward.

The Eastern Ghats discontinuous low belt. Elevation is 600 m. They run parallel to the east coast from south of Mahanadi valley to the Nilgiri hills. The famous hills are Mahendragiri hills, Nimaigiri hills in Orissa, Nallamallai hills in Southern Andhra Pradesh, Kollimalai and Pachaimalai in Tamilnadu. The area is drained by the Mahanadi, Godawari, Krishna and Kaveri river systems. The Nilgiri hills join Western & Eastern Ghats in the south

4. The Indian Desert:

Indian deserts lies towards the western margin of Aravali Hills. - called Thar Desert. It is the ninth largest desert in the world. Dotted with dunes and barchans. It spreads over the states of Gujarat and Rajasthan. This region has semi-arid and arid weather conditions. It receives less than 150 mm of rainfall per year. The vegetation cover is low with thorny bushes. Luni is the main river in this area

5. The Coastal Plains

The coastal plains in India run parallel to the Arabian Sea & Bay of Bengal along the Peninsular Plateau. The western coastal plain is a narrow belt along the Arabian sea of about 10-20km wide. It stretches from Rann of Kachchh to KanyaKumari. Western coastal plains comprises of three sectors (i) Konkan Coast (Mumbai to Goa), (ii) Karnataka coast from Goa to Mangalore (iii) Malabar Coast (Mangalore to KanyaKumari). The eastern coast runs along Bay of Bengal. It is wider than the western coastal plain. Its average width is about 120Kms. The northern part of the coast is called Northern Circar and the southern part is called Coromandal Coast. Eastern coastal plain is marked by Deltas made by the rivers Mahanadi, Godavari, Krishna amdKaveri. The Chilka largest salt water lake in India in Odisha is located to the south of Mahanadi Delta. The coastal plains are belts for growing spices, rice, coconut, pepper etc. They are centres of trade & commerce. The coastal areas are known for fishing activities, therefore large number of fishing villages have developed along the coasts. Vembanad is famous lagoon which is located at Malabar coast.

The Peninsular plateau is flanked by stretch of narrow coastal strips, running along the Arabian Sea on the west and the Bay of Bengal on the east. The western coast, sandwiched between the Western Ghats and the Arabian Sea, is a narrow plain. It consists of three sections. The northern part of the coast is called the Konkan (Mumbai – Goa), the central stretch is called the Kannad Plain, while the southern stretch is referred to as the Malabar coast.

The plains along the Bay of Bengal are wide and level. 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.

6. The Islands

India has two main groups of Islands. -There are 204 islands in Bay of Bengal called as Andaman and Nicobar islands -The Andaman & Nicobar island extend from north to south in Bay of Bengal. - They are bigger in size. An active volcano is located on the Barren Island in Andaman & Nicobar group of islands. - 43 islands in Arabian Sea called as Lakshadweep islands - Lakshadweep islands are located near Malabar coast of Kerala in the Arabian sea. - They cover an area of 32 sq km. -Kavarati is the capital of Lakshdweep. These islands are formed by corals and endowed with variety of flora and fauna.

Check your progress

(iii) What are the major physiographic divisions of India?

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(iv) Explain the Islands of India?

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17.4 Climate of the India

Climatically, the year is divided into the following four seasons in India: i. The cold weather season - December to February; ii. The hot weather season - March to May in the south and up to June in the north; iii. The advancing south west monsoon season - June to September; iv. The retreating southwest monsoon season - October and November.

During Summer, the north-western plains experience high temperatures around 45°C while areas of the Rajasthan desert may record day temperatures around 55°C. At the same time the temperatures around Gulmarg or Pahalgam in Kashmir are hardly around 20°C. Similarly, in December, the people of Kargil or Dras (in Ladakh, UT) experience biting cold because the night temperatures drop to -40°C, while the inhabitants of Thiruvananthapuram experience temperatures around 27° C.

Mechanism of Monsoon

The term "monsoon" describes a tropical wind pattern in which the direction of the wind entirely changes from summer to winter. In this system, the winds alternate between winter and summer directions, blowing from land to sea. As a result, the monsoon-influenced regions receive most of their rainfall throughout the summer, while the winter is often dry. According to traditional belief, the monsoon is caused by the differential heating of land and sea. Due to a higher temperature over the land in summer, a low-pressure area develops over the continents, and the winds blow from neighbouring oceans toward the land. These winds are of maritime origin and hence cause ample rainfall in summer. On the other hand, the continents become colder than the neighbouring oceans in winter. As a result, a high-pressure area is developed over the continents. Therefore, winds blow from land to sea in winter. These winds, being of continental origin, are dry and do not cause rain. This traditional theory of the monsoon has been criticised by the German meteorologist Flohn. He argues that the differential heating of land and sea is not enough to cause a seasonal reversal of winds at a global scale. He has explained the origin of the monsoon on the basis of the seasonal shift of the pressure and wind belts under the influence of the shift of the sun's vertical rays.

According to this theory, as the sun's vertical rays shift northwards over the Tropic of Cancer in the summer season, the Inter-Tropical Convergence Zone (ITCZ) also moves to the north. It forms a low-pressure area over the northwestern parts of India. The high temperatures in this region further intensify this low pressure. This low-pressure area sucks the air from the Indian Ocean towards the Indian landmass in the form of South west monsoons. In the winter, the ITCZ shifts southwards, and a mild high pressure is produced over northern parts of India. This high pressure is further intensified by the equatorward shift of the sub-tropical high-pressure belt. Due to high pressure over north India, the winds start blowing from the northeast as retreating monsoons. According to recent observations, the origin of the Indian monsoon is influenced by several other factors besides the differential heating of land and sea and the seasonal shifts of pressure and wind belts. One of the most important factors is the sub-tropical westerly and tropical easterly jet streams. The sub-tropical westerly jet streams blowing over India in winter cause high pressure over northern India. It thus intensifies the northeast monsoons. This jet stream shifts northwards beyond India in the summer season, and tropical easterly jets develop over India in this season. The behaviour of these jet streams is partly responsible for the variations in the time of onset of south west monsoons over India

Distribution of Temperature and Annual Rainfall

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 (in Laddakh) 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 rainfall distribution shows that northeastern parts of Jammu Kashmir and extreme western Rajasthan receive less than 20 cm. On the other hand, the western coastal plains, and Sub-Himalayan areas of northeast India, including the Shillong plateau, receive more than 200 cm. of annual rainfall. Mawsynram gets the most rainfall in India. Mawsynram has a world record of receiving 26,000 millimetres(1,000 in) of rain in 1985, making it the wettest place on the Earth. It receives 11,872 millimetres (467.4 in) of rain annually on average. The rainfall drops abruptly below 60 cm to the east of the Western Ghats over interior Maharashtra and Karnataka. Most parts of Punjab, Haryana, central and eastern Rajasthan, and western Gujarat also receive rainfall below 60 cm. Some parts of the Coromandel coast receive rainfall of more than 100 cm. The areas receiving less than 100 cm. of rainfall depend on means of irrigation for agricultural activities. In India, rainfall distribution, particularly of the south west monsoon, is closely related to the relief. Hence it is even described as "relief" or "orographic" rainfall. By and large, places with higher altitudes have a greater chance of catching more rain than places with less altitude. The direction of moist winds also matters. The distribution of annual rainfall in different parts of India shows the following trends: The rain decreases as one moves from Kolkata to Amritsar. It shows the declining trend towards the interior from the coastal areas on the Deccan Plateau. North eastern parts receive more rainfall than north western parts of India. Areas lying on the windward side receive more rain than those on the leeward side.

Factors Influencing the Climate of India

A**. Location and Latitudinal Extent** India is located roughly between latitudes 6°N and 37°N. The Tropic of Cancer passes through the middle of the country. Due to their proximity to the equator, the southern regions have hot temperatures all year round. On the other hand, the northern regions are located in warm temperate regions. They consequently endure cold conditions, especially throughout the winter. The climate is milder near the coast of peninsular India because of the water bodies surrounding it.

B. **Distance from the Sea** Southern or peninsular India is surrounded by the Arabian Sea, the Indian Ocean, and the Bay of Bengal. Hence the climate of coastal regions of India is equable or maritime. The climate of the regions in the country's interior is cut off from the oceanic influence. As a result, they have an extreme or continental type of climate.

C. **The Northern Mountain Ranges** India and the rest of Asia are divided by the Himalayan and nearby mountain ranges, which stretch from Kashmir in the north west to Arunachal Pradesh in the north east. During winter, these hills shield India from the savagely chilly and dry winds of Central Asia. Additionally, they serve as a strong physical barrier that prevents rain-bearing southwest monsoon winds from entering India's northern borders. These ranges act as a climate barrier between Central Asia and the Indian Subcontinent.

D. **Physiography** In various regions of the nation, physical characteristics affect the air temperature, atmospheric pressure, wind speed, and rainfall. Look at the physical feature map of India from the previous lesson, and using the climatic maps from this lesson, determine for yourself the link between the relief, temperatures, wind direction, and rainfall amounts. It will clarify why the interior regions of Karnataka and Tamil Nadu, located east of the Western Ghats, have less rainfall than the western coastal plains. Additionally, you will comprehend why the Bay of Bengal branch of the South west monsoon splits into two portions, one travelling down the Ganga Valley to the west and the other along the Brahmaputra Valley to the east.

E. **Monsoon Winds** The complete reversal in the direction of winds over India brings about a sudden change in seasons - the harsh summer season suddenly giving way to the eagerly awaited monsoon or rainy season. These winds, which change their direction completely, are called monsoon winds. The word 'monsoon' is derived from the Arabic word 'Mousim,' which means 'season.' These winds have such a far-reaching influence on India's climate. that it is termed a 'monsoon type of climate.' The nature of these winds can be described concerning the surface distribution of pressure in different regions of India during the winter and summer seasons.

(a) The North east Monsoon and its Effect: During winter, the weather conditions are influenced by high pressure developed over the Northw estern subcontinent. It results in blowing cold, dry winds from this region towards southern low-pressure areas lying over water bodies surrounding peninsular India. Since these winds are cold and dry, they do not cause rainfall, and weather conditions under their influence remain cold and dry. However, wherever these North east monsoon winds collect moisture while passing over the Bay of Bengal, they bring rain along the Coromandel Coast. Strictly speaking, these winds are planetary winds known as Northeast Trades. In India, they are essentially land-bearing winds.

(b) The South west Monsoon and its Effect: During summer, the northwestern parts of India become very hot due to high temperatures. It is ascribed to the apparent shift of the sun in the northern hemisphere. It results in the reversal of air pressure conditions in north western India and water bodies surrounding the peninsular plateau. As a result, North east Trade winds are replaced by South west monsoon winds. Since these winds are sea-bearing and blow over warm water bodies before reaching land, they are moisture-laden, causing widespread rain over most parts of India. This period of the south west monsoon, from June to September, is known as the rainy season for most parts of the country

F. Upper-Air Circulation The changes in the upper air circulation over the Indian landmass are yet another cause for the sudden outbreak of monsoons in India. Jet streams in the upper air system influence the climate of India in the following ways:

(a) **The Westerly Jet Stream and its Impact**: During winter, at about 8 km. above sea level, a westerly jet stream blows at a very high speed over the subtropical zone. The Himalayan ranges bifurcate this jet stream. This jet stream's northern branch blows along the northern edge of this barrier. The southern branch blows eastwards south of the Himalayan ranges along 25° N latitude. Meteorologists believe that this branch of the jet stream significantly influences India's winter weather conditions. This jet stream is responsible for bringing western disturbances from the Mediterranean region into the Indian subcontinent. Winter rain and hail storms in north western plains and occasional heavy snowfall in hilly regions are caused by these disturbances. Cold waves generally follow these in the whole of the northern plains

(b) **Easterly Jet and its Influence**: Due to the apparent shift of the sun in the northern hemisphere during the summer, the upper air circulation is reversed. The easterly jet stream, created due to the Tibetan plateau's heating, takes the place of the westerly stream. It caused the formation of an easterly, chilly jet stream that was blowing over peninsular India and was focused at 15°N latitude. It aids in the monsoons' quick arrival

G. **Western Disturbances and Tropical Cyclones** Westerly jet streams from the Mediterranean Sea impact the entrance of western disturbances. It affects most of the Northern Plains and Western Himalayan region's winter weather conditions. In the winter, it doesn't rain much. The northern plains' wheat harvests are thought to benefit significantly from this rain. Additionally, the Bay of Bengal is where tropical cyclones form. In October, November, and December, these cyclones' frequency and trajectory have an impact on the weather along the eastern coast

H. El - Nino Effect Weather conditions in India are also influenced by EI-Nino, which causes widespread floods and droughts in tropical regions of the world. El-Nino is a narrow warm current that sometimes appears off the coast of Peru in South America. It is a temporary replacement for the cold Peru current, which generally flows along this coast. Sometimes, becoming more intense, it increases the surface water temperatures of the sea by 10° C. This warming of tropical Pacific waters affects the global pattern of pressure and wind systems, including the monsoon winds in the Indian Ocean. It is believed that EINino caused the severest drought of 1987 over India

Southern Oscillation and its Effect

The southern oscillation is a pattern of meteorological changes often observed between the Indian and Pacific oceans. It has been noticed that whenever the surface level pressure is high over the Indian Ocean, it is low over the Pacific Ocean and vice-versa. When the pressure is increased over the Pacific Ocean and low over the Indian Ocean, the South west monsoons' in India tend to be weaker. In the reverse case, the monsoons are most likely to be stronger.

Check your progress

(v) What are the major factors influences climate of India?

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(vi) Explain El-nino effect ?

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17.5 Drainage system of India

The drainage systems of India are mainly controlled by the broad relief features of the subcontinent. Accordingly, the Indian rivers are divided into two major groups: the Himalayan rivers; and the Peninsular rivers. Apart from originating from the two major physiographic regions of India, the Himalayan and the Peninsular rivers are different from each other in many ways. Most of the Himalayan rivers are perennial. It means that they have water throughout the year. These rivers receive water from rain as well as from melted snow from the lofty mountains. The two major Himalayan Rivers, the Indus and the Brahmaputra originate from the north of the mountain ranges. They have cut through the mountains making gorges. The Himalayan rivers have long courses from their source to the sea. A large number of the Peninsular rivers are seasonal, as their flow is dependent on rainfall. During the dry season, even the large rivers have reduced flow of water in their channels. The Peninsular rivers have shorter and shallower courses as compared to their Himalayan counterparts.

The Himalayan Rivers

The major Himalayan rivers are the Indus, the Ganga and the Brahmaputra. These rivers are long, and are joined by many large and important tributaries. A river along with its tributaries may be called a river system.

The Indus River System

The river Indus rises in Tibet, near Lake Mansarowar. Flowing west, it enters India in the Ladakh. It forms a picturesque gorge in this part. Several tributaries, the Zaskar, the Nubra, the Shyok and the Hunza, join it in the Kashmir region. The Indus flows through Baltistan and Gilgit and emerges from the mountains at Attock. The Satluj, the Beas, the Ravi, the Chenab and the Jhelum join together to enter the Indus near Mithankot in Pakistan. Beyond this, the Indus flows southwards eventually reaching the Arabian Sea, east of Karachi. The Indus plain has a very gentle slope. With a total length of 2900 km, the Indus is one of the longest rivers of the world. A little over a third of the Indus basin is located in India Ladakh, Jammu and Kashmir, Himachal Pradesh and Punjab and the rest is in Pakistan.

The Ganga River System

The headwaters of the Ganga, called the 'Bhagirathi' is fed by the Gangotri Glacier and joined by the Alaknanda at Devaprayag in Uttarakhand. At Haridwar, the Ganga emerges from the mountains on to the plains. The Ganga is joined by many tributaries from the Himalayas, a few of them being major rivers, such as the Yamuna, the Ghaghara, the Gandak and the Kosi. The river Yamuna rises from the Yamunotri Glacier in the Himalayas. It flows parallel to the Ganga and as a right bank tributary meets the Ganga at Allahabad. The Ghaghara, the Gandak and the Kosi rise in the Nepal Himalaya. They are the rivers, which flood parts of the northern plains every year, causing widespread damage to life and property, whereas, they enrich the soil for agricultural use. The main tributaries, which come from the peninsular uplands, are the Chambal, the Betwa and the Son. These rise from semi-arid areas, have shorter courses and do not carry much water in them. Find out where and how they ultimately join the Ganga. Enlarged with the waters from its right and left bank tributaries, the Ganga flows eastwards till Farakka in West Bengal. This is the northernmost point of the Ganga delta. The river bifurcates here; the Bhagirathi-Hooghly (a distributary) flows southwards through the deltaic plains to the Bay of Bengal. The mainstream, flows southwards into Bangladesh and is joined by the Brahmaputra. Further downstream, it is known as the Meghna. This mighty river, with waters from the Ganga and the Brahmaputra, flows into the Bay of Bengal. The delta formed by these rivers is known as the Sundarban Delta. The length of the Ganga is over 2500 km

The Brahmaputra River System

The Brahmaputra rises in Tibet east of Mansarowar lake very close to the sources of the Indus and the Satluj. It is slightly longer than the Indus, and most of its course lies outside India. It flows eastwards parallel to the Himalayas. On reaching the Namcha Barwa (7757 m), it takes a 'U' turn and enters India in Arunachal Pradesh through a gorge. Here, it is called the Dihang and it is joined by the Dibang, the Lohit, and many other tributaries to form the Brahmaputra in Assam. In Tibet, the river carries a smaller volume of water and less silt as it is a cold and a dry area. In India, it passes through a region of high rainfall. Here the river carries a large volume of water and considerable amount of silt. The Brahmaputra has a braided channel in its entire length in Assam and forms many riverine islands. Do you remember the name of the world's largest riverine island formed by the Brahmaputra? Every year during the rainy season, the river overflows its banks, causing widespread devastation due to floods in Assam and Bangladesh. Unlike other north Indian rivers, the Brahmaputra is marked by huge deposits of silt on its bed causing the riverbed to rise. The river also shifts its channel frequently.

The Peninsular Rivers

The main water divide in Peninsular India is formed by the Western Ghats, which runs from north to south close to the western coast. Most of the major rivers of the Peninsula, such as the Mahanadi, the Godavari, the Krishna and the Kaveri flow eastwards and drain into the Bay of Bengal. These rivers make deltas at their mouths. There are numerous small streams flowing west of the Western Ghats. The Narmada and the Tapi are the only long rivers, which flow west and make esturies. The drainage basins of the peninsular rivers are comparatively smaller in size.

The Narmada Basin

The Narmada rises in the Amarkantak hills in Madhya Pradesh. It flows towards the west in a rift valley formed due to faulting. On its way to the sea, the Narmada creates many picturesque locations. The 'Marble rocks', near Jabalpur, where the Narmada flows through a deep gorge, and the 'Dhuadhar falls, where the river plunges over steep rocks, are some of the notable ones.

All tributaries of the Narmada are very short and most of these join the main stream at right angles. The Narmada basin covers parts of Madhya Pradesh and Gujarat.

The Tapi Basin

The Tapi rises in the Satpura ranges, in the Betul district of Madhya Pradesh. It also flows in a rift valley parallel to the Narmada but it is much shorter in length. Its basin covers parts of Madhya Pradesh, Gujarat and Maharashtra. The coastal plains between Western Ghats and the Arabian Sea are very narrow. Hence, the coastal rivers are short. The main west flowing rivers are Sabarmati, Mahi, Bharathpuzha and Periyar. Find out the states in which these rivers drain the water.

The Godavari Basin

The Godavari is the largest Peninsular river. It rises from the slopes of the Western Ghats in the Nasik district of Maharashtra. Its length is about 1500 km. It drains into the Bay of Bengal. Its drainage basin is also the largest among the peninsular rivers. The basin covers parts of Maharashtra (about 50 per cent of the basin area lies in Maharashtra), Madhya Pradesh, Odisha and Andhra Pradesh. The Godavari is joined by a number of tributaries, such as the Purna, the Wardha, the Pranhita, the Manjra, the Wainganga and the Penganga. The last three tributaries are very large. Because of its length and the area it covers, it is also known as the Dakshin Ganga.

The Mahanadi Basin

The Mahanadi rises in the highlands of Chhattisgarh. It flows through Odisha to reachthe Bay of Bengal. The length of the river is about 860 km. Its drainage basin is shared by Maharashtra, Chhattisgarh, Jharkhand, and Odisha.

The Krishna Basin

Rising from a spring near Mahabaleshwar, the Krishna flows for about 1400 km and reaches the Bay of Bengal. The Tungabhadra, the Koyana, the Ghatprabha, the Musi and the Bhima are some of its tributaries. Its drainage basin is shared by Maharasthra, Karnataka and Andhra Pradesh.

The Kaveri Basin

The Kaveri rises in the Brahmagri range of the Western Ghats and it reaches the Bay of Bengal in south of Cuddalore in Tamil Nadu. The total length of the river is about 760 km. Its main tributaries are Amravati, Bhavani, Hemavati and Kabini. Its basin drains parts of Karnataka, Kerala and Tamil Nadu.

Besides these major rivers, there are some smaller rivers flowing towards the east. The Damoder, the Brahmani, the Baitarni and the Subarnrekha are some notable examples

Lakes

India has many lakes. These differ from each other in size and other characteristics. Most lakes are permanent; some contain water only during the rainy season, like the lakes in the basins of inland drainage of semi-arid regions. There are some lakes which are the result of the action of glaciers and ice sheets, while others have been formed by wind, river action and human activities. A meandering river across a floodplain forms cut-offs that later develops into ox-bow lakes. Spits and bars form lagoons in the coastal areas, e.g. the Chilika lake, the Pulicat lake and the Kolleru lake. Lakes in the region of inland drainage are sometimes seasonal; for example, the Sambhar lake in Rajasthan, which is a salt water lake. Its water is used for producing salt. Most of the freshwater lakes are in the Himalayan region. They are of glacial origin. In other words, they formed when glaciers dug out a basin, which was later filled with snowmelt. The Wular lake in Jammu and Kashmir, in contrast, is the result of tectonic activity. It is the largest freshwater lake in India. The Dal lake, Bhimtal, Nainital, Loktak and Barapani are some other important freshwater lakes. Apart from natural lakes, the damming of the rivers for the generation of hydel power has also led to the formation of lakes, such as Guru Gobind Sagar (Bhakra Nangal Project).

Check your progress

(vii) Himalayan river system?

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____

(viii) Peninsular river system?

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____

13.7 Summary

India our country is located in the northern hemisphere between 8°4’N to 37°6’N latitudes and 68°7’E and 97°25’E longitudes. And, the Tropic of Cancer cuts the landmass halfway through, at 23°30’N latitude. India shares its border from Afghanistan and Pakistan to the north-west, China, Bhutan, and Nepal to the north, Myanmar to the far East, and Bangladesh to the east. Sri Lanka is separated from India by a narrow channel of sea formed by the Palk Strait and the Gulf of Mannar. There are six main physical divisions in India - The Himalayas, the Northern plains, the Great Indian desert, the Peninsular Plateau, the Coastal Plains, and the Islands. India has the climate of Tropical monsoon due to its peculiar position in the Asian continent and the Indian Ocean. The Indian subcontinent has hot summers and moderately cold winters. In the Himalayas, winters are extremely cold while summers are moderately hot. The Indian drainage system is made up of a huge number of minor and major rivers, for example the Ganga, Indus, and Brahmaputra river basins are part of the Himalayan drainage system. The peninsular plateau is drained by the Narmada, Tapi, Mahanadi, Godavari, Krishna, and Kaveri rivers

13.8 Check Your Progress – Model answers

(i) The Indian mainland extends between 8°4’N to 37°6' N latitudes and from 68°7' E to 97°25' E longitudes.

(ii) The neighboring countries of India are China, Nepal, Bhutan, Pakistan, Myanmar, Sri Lanka, and Bangladesh. India shares its coastline border with Sri Lanka and Myanmar.

(iii) There are six main physical divisions in India - The Himalayas, the Northern plains, the Great Indian desert, the Peninsular Plateau, the Coastal Plains, and the Islands

(iv) India has two main groups of Islands. -There are 204 islands in Bay of Bengal called as Andaman and Nicobar islands. 43 islands in Arabian Sea called as Lakshadweep islands - Lakshadweep islands are located near Malabar coast of Kerala in the Arabian sea.

(v) Factors Influencing the Climate of India are location and latitudinal extent , Distance from the Sea, The Northern Mountain Ranges , Physiography,Monsoon Winds , Upper-Air Circulation Western Disturbances and Tropical Cyclones, El - Nino Effect

(vi) EI-Nino, which causes widespread floods and droughts in tropical regions of the world. EI-Nino affects pressure and wind systems, including the monsoon winds in the Indian Ocean. It is believed that EINino caused the severest drought of 1987 over India

(vii) The major Himalayan rivers are the Indus, the Ganga and the Brahmaputra

(viii) Most of the major rivers of the Peninsula, such as the Mahanadi, the Godavari, the Krishna and the Kaveri flow eastwards and drain into the Bay of Bengal

13.9. Terminal questions

I. Essay Questions

(1) Explain the Himalayan Mountain ranges?

(2) Explain the Mechanism of Indian Monsoon System ?

(3) Discuss the Peninsular Rivers of India ?

(4) Describe the lakes of India ?

II. Short questions

(1) What is Gulf of Mannar ?

(2) Expalin about Indian Desert?

(3) what is Southern Oscillation ?

(4) Describe the Godavari Basin?

III. Very short questions

(1) what is Indira Point ?

(2) what are Duns ?

(3) what is the importance of Mawsynram?

(4) River Tapi

13.10 Further Reading

- Majid Hussain (2020), Geography of India, McGraw Hill

  H.M. Saxena (2016) , Indian And World Geography: Physical, Social and Economic, Rawat Publications

Chapter - 18

LAND RESOURCES AND SOILS

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18.0 Introduction

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18.2 Land Resources

18.3 Land use

18.4 Land Resources, Problems and Solutions

18.5 Soil Resources, Types, Soil Erosion, Soil Conservation

Introduction

The nation's strength, be it social, economic *or* political depends mostly on the available resources and their proper utilisation. Resource is the matter or substance which satisfies human wants at a given time and space. Before any element can be designated as resource three basic pre-conditions must be satisfied. They are the knowledge, technical skills and demand for the material or services produced. If one of these conditions is not satisfied the particular substance remains unutilised.

India has rich endowment of resources. An integrated effort is now being made by our country to make the best use of the existing resource potential. It helps to meet the demands of growing population and also provide opportunities for employment. Simultaneously, it acts as indicator for the levels of development.

Objectives:

After studying this lesson, you will be able to:

- Recognize the significance of land as a resource, identify the main uses of land; and explain some of the problems in land resource & their solutions;
- Recognize the significance of soil as a resource; .
- Recall the main characteristics of each major soil type in India; locate major soil regions on the map of India;
- Identify different factors that are responsible for the soil erosion in different parts of India; explain the problems created as a result of soil erosion;
- Establish the relationship between measures adopted for soil conservation with types of erosion in different parts of India.

Land Resources

Land is our basic resource. Throughout history, we have drawn most of our sustenance and much of our fuel, clothing and shelter from the land. It is useful to us as a source of food, as a place to live, work and play. It has different roles. It is a productive economic factor in agriculture, forestry, grazing, fishing and mining. It is considered as a foundation for social prestige and is the basis of wealth and political power. It has many physical forms like mountains, hills, plains, lowlands and valleys. It is characterised by climate from hot to cold and from humid to dry. Similarly, land supports many kinds of vegetation. In a wider sense, land includes soil and topography along with the physical features of a given location. It is in this context that land is identified closely with natural environment. However, it is also regarded as space, situation, factor of production in economic processes, consumption goods, property and capital.

Availability of Arable Land

India is well endowed with cultivable land which has long been a key factor in the country's socio-economic development. In terms of area, India ranks seventh in the world, while in terms of population it ranks second. Arable land includes net sown area, current fallow, other fallow and land under tree crops. Arable land covers a total area of 167 million hectares which is 51 % of the total area of the country.

However, the arable land-man ratio is' not as favourable as in many other countries like Australia, Canada, Argentina, the USA, Chile, Denmark and Mexico. Conversely, the land-man ratio is more favourable in India than Japan, the Netherlands, Egypt, United Kingdom, Israel and China. What is the land-man ratio? Land-man ratio is defined as the ratio between the habitable area and the total population of a country.

The physical features in India are diverse and complex. There are mountains, hills, plateaus and plains which produce varied human response to the use of land resources. About 30% of India's surface area is covered by hills and mountains. These are either too steep or too cold for cultivation. About 25% of this land is topographically usable which is scattered across the country. Plateaus constitute 28% of the total surface area but only a quarter of this is fit for cultivation. The plains cover 43% of the total area and nearly 95% of it is suitable for cultivation. Considering the differences in proportion of surface area, this allows us to conclude that taking the country as a whole, about two-third of it is usable. Moreover, soils, topography, moisture and temperature determine the limits of cultivability and the quality of arable land is determined by these factors. As a result of this, half of the surface area is cultivated. This proportion is one of the highest in the world.

- Land includes both soil and topography with the physical features of a given location. It is also regarded as space, factor of production in economic processes, consumption goods, situation, property and capital.
- Land-man ratio is defined as the ratio between the habitable area and the total population of a country.
- Land-man ratio in India is not as favourable as in many countries like Australia, Canada, Argentina, USA, Chile, Denmark and Mexico. Conversely, the land-man ratio is more favourable in India than in Japan, the Netherlands, Egypt, U.K., Israel and China.

Check Your Progress

1. Define land-man ratio.

2. Name four countries where land-man ratio is much more favourable than in India.

(i) ____________________

(ii) ____________________

(iii) ____________________

(iv) ____________________

3. Name four countries where land-man ratio is less favourable than in India.

(i) ____________________

(ii) ____________________

(iii) ____________________

(iv) ____________________

Land Use

Out of the total geographical area (328 million hectares), land utilisation statistics are available for 305 million hectares only. The balance 23 million hectares remains unsurveyed and inaccessible. The relevant statistic is given in Table.1. The significant features of land utilisation are :

(a) high percentage of area suitable for cultivation;

(b) limited scope for further extension of cultivation and

(c) small area under pastures despite a large bovine population.

Table.1 Land Utilisation in India

Category	Area in M. Ha	% of total reporting area
1. Net sown area	142.40	46.30
2. Current fallow	13.70	4.20
3. Other fallow	9.70	3.00
4. Pastures and groves	15.40	5.00
5. Cultivable waste	15.00	4.70
6. Not available for Cultivation		
(a) Barren and uncultivable land	19.60	6.20
(b) Land under non-arable use	21.20	8.60
7. Forest	68.00	22.00
Total	**305.0**	**100.0**

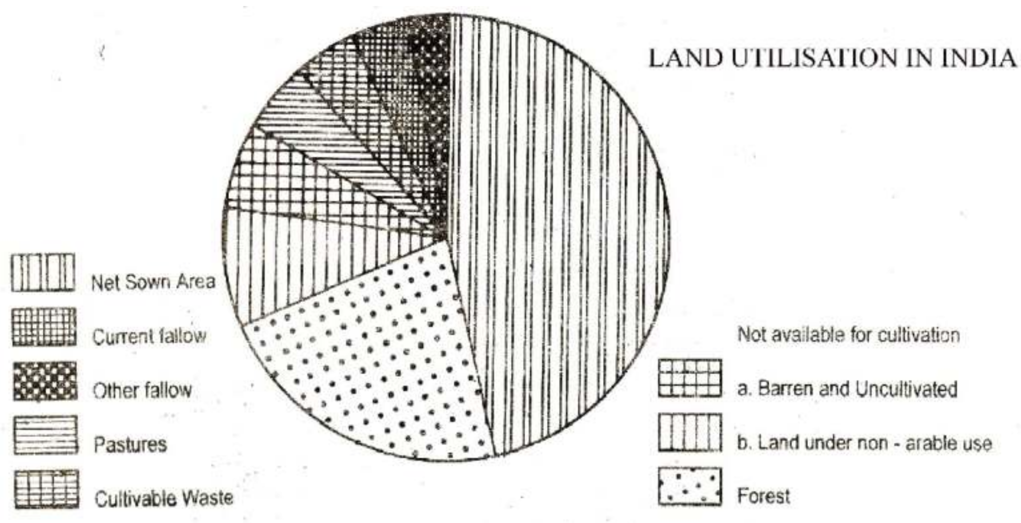


Fig. : Land utilisation in India

Presently, a little more than 40 million hectares of land is not available for cultivation. Area under this category has shown a decline from 50.7 million hectares in 1960- 61 to 40.8 million hectares in 1990-91. There has been a marginal decline in fallow land from 9.9% in 1950-51 to 7.5% in 1990-91. Cultivable wastelands also witnessed an appreciable decline of 34% between 1950-51 and 1990-91. During 1950-51 and 1990-91, the net sown area has witnessed notable increase of about 20%. This area in 1950-51 was 118.7 million hectares which increased to 142.4 million hectares in 1990-91. Only 14% of the net sown area or 41.7 million hectares produced two or more crops in 90-91. Surprisingly, only 5% of the land is under permanent pastures and grazing in a country with the largest bovine population of the world. Land under non-agricultural use has increased with the accelerated growth in economy. The process of industrialization and urbanization demands more land under roads, railways, airports, human settlements and industries not excluding huge multi-purpose dams. Essentially, on the limited total area all the cultural uses of land must be accommodated. Obviously, it can be realized mainly at the cost of land under agriculture. In 1950-51, the total area under non-agricultural use was 9.3 million hectares which increased to 21.2 million hectares in 1990-91. Contrary to general belief, the percentage of land under forest is one of the lowest in the world. Forests occupy not more than 22% of the total geographical area of the country, while the world average is 30%. According to land use statistics, area under forests has increased from 40 million hectares in 1950-51 to 68 million hectares in 1990-91. It is much below the desired national goal of one third of the total area.

Thus, land use is a dynamic process. It changes over time due to a number of factors, including increasing population, changes in cropping system and technology. As the various sectors of the economy develop, there may be a shift in the pattern of land use. However, the bulk of the land continues to be used for raising crops. With unabated population growth, the pressure of population on arable land is bound to grow. Indeed, it should be a matter of great national concern.

Land Problems

Out of the total land area, as many as 175 million hectares suffer from degradation. Land degradation is caused largely by soil erosion, but also by water logging and excessive salinity. The most serious threat to the soil is posed by deforestation. Heavy railfall during monsoon damages the soils. Steep slopes encourage rapid runoff leading to soil erosion especially on the southern slopes of the Himalayas and the western slopes of the Western Ghats. Major portions of the Himalayas are prone to landslides and erosion. Wind erosion is prevalent in Rajasthan, gully erosion in Chambal Valley, Chotanagpur, Gujarat, Submontane Punjab Himalaya. Water logging and salinisation which constitute the second major threat to soil have already consumed 13 million hectares and threaten many more. The lands affected are mostly situated in canal irrigated areas. They have suffered because of the absence of adequate drainage. Land is also degraded due to mining operations in many parts of the country. The total land area affected is about 80 thousand hectares by mining. Urban encroachment on good quality agricultural land is another problem by which the amount of land used for agriculture is steadily declining. In other words, there is a tough competition between agriculture, urban and industrial development. There are social conflicts that are arising out of the rights to occupy and transfer of land. The tenant cultivators face major disincentives such as the fear of eviction, the insecurity of tenure, high rents and inadequate surplus to invest. Land ceiling laws have not been implemented with adequate strictness.

Solutions for the Land Problems

To deal with these problems, the country has adopted a two-fold approach; physical and social. Physical reclamation of land is achieved through chemical treatment of water-logged soils and is followed with scientific rotation of crops. Similarly, land rendered useless by river action and river floods are also reclaimed after necessary freatment to restore their fertility and texture. Physical reclamation of desert lands calls for more sustained efforts. It requires introduction of suitable natural vegetation and canal or well irrigation or even both. It helps to raise water table. Social approach on the other hand is reflected through state legislation aiming at overall rural reconstruction, promoting agriculture and its productivity in particular. Consolidation of land holdings is one measure among many. It provides necessary motivation and empowerment of a tiller by confirming on him the rights of land tenure/ownership. Elements of social exploitation are promptly. removed e.g. absentee landlords. Thus legislation is used to ensure social justice.

India does not have shortage of land. But, land reform policies need to be reoriented for further increase in food production.

- Land use is a dynamic process. It changes over time due to a number of factors including increasing population, changes in cropping system and technology. As various sectors of the economy develop, there may be a shift in the pattern of land use.
- The major land problems include land degradation due to soil erosion, water logging, salinisation, mining operations and urban encroachment on good quality agricultural land.
- India has adopted two ways to develop land:

  (a) physical (reclamation of land) and (b) social (land reforms)

Check Your Progress

1. Name three areas where gully erosion is much more prominent.

   (i) ____________________

   (ii) ____________________

   (iii) ____________________

2. What is the most serious threat posed to the soil?

   ____

3. Name two methods adopted to develop land.

   (i) ____________________

   (ii) ____________________

4. Which is the area where wind erosion is more prominent?

   ____

Soil Resources

Soil is defined as upper layer of the earth composed of loose surface material. It is a mixture of many substances including endless variety of minerals, remnants of plants and animals, water and air. It is the end product of continuing interaction between the parent material, local climate, plant and animal organisms and elevation of land. Since each of the elements varies over space, soils also differ from place to place. Soil is an important segment of our ecosystem, as it serves an anchorage for plants and source of nutrients. Thus, soil is the seat, the medium and fundamental raw materialfor plant growth. Through its relative fertility, it affects man's economic activities and shapes the destiny of our country. When the soil is lost, property and culture are also lost. Therefore, it is a valuable national and fundamental earth resources of the country.

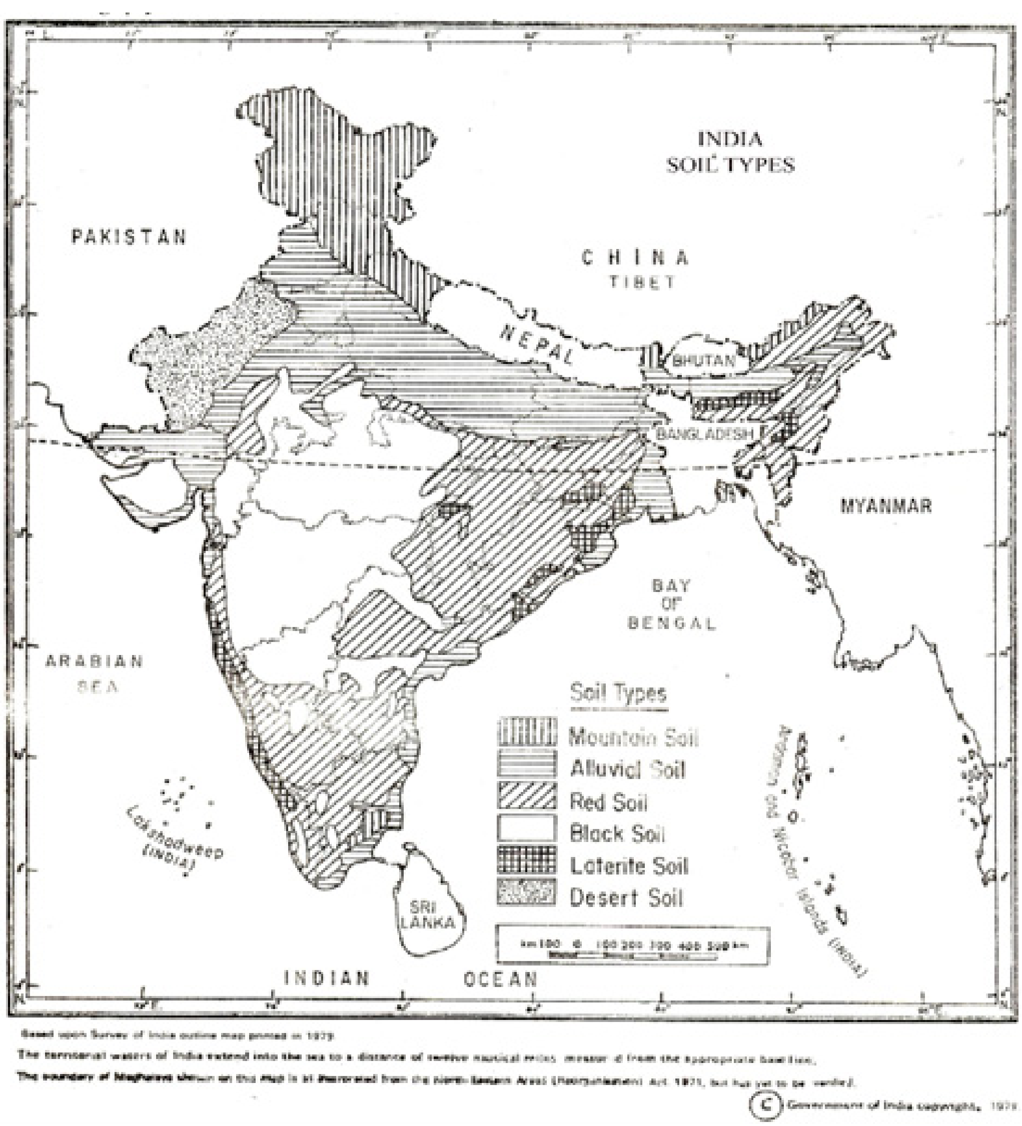


Fig. : Soil types

Major Soil Types

The soils of India are broadly divided into following six types:

1. Alluvial Soils

Alluvial soil is the most important soil type of India. It covers the vast valley areas of the Sutlej, Ganga and Brahmaputra and the fringes of the southern peninsula. It is thin near the fringe of the plateau. The alluvial soils occupy 64 million hectares of the most fertile land. The soils vary from sandy loam to clay in texture and are rich in potash but deficient in nitrogen and organic matter. Generally, the colour varies from grey to reddish brown. Based on geographical considerations, this soil can be subdivided into two divisions: newer alluvium (khadar) and older alluvium (bangar). Both are different in texture, chemical composition, drainage capacity and fertility. The newer alluvium is a light friable loam with a mixture of sand and silt. It is found in river valley, the floodplains and deltas. On the other hand, the older alluvium lies on the inter fluves. The higher proportion of clay makes the soil sticky and drainage is often poor. Almost all crops are grown on these soils.

2. Black Soils (Regur)

The black soils are found mainly on the Deccan lava region covering large parts of Maharashtra, some parts of Gujarat and Madhya Pradesh and small parts of Karnataka, Andhra Pradesh and Tamil Nadu. The soils are formed by disintegration of volcanic basaltic lava. The colour of the soil is generally black due to presence of compounds of aluminium and iron. The soil is locally known as regur which extends roughly to 64 million hectares. It is generally clayey deep and has low permeability and impregnable. But it's depth varies from place to place. It is very thick in lowlands but very thin on highlands. This soil is favourable for the cultivation of crops like sugarcane, wheat, onion and fruits.

3. Red Soils

Red soils cover large part of the Peninsular upland in Tamil Nadu, Karnataka, Goa, South east Maharashtra, Tealangana, Andhra Pradesh, Orissa, Chotanagpur Plateau and Meghalaya Plateau. They encircle the black cotton soil zone. They have developed on the crystalline rocks like granite, gneisses and cover roughly 72 million hectares of the arable land. Iron compounds are abundant making the soil reddish in colour but they are deficient in organic matter. The red soils are generally less fertile and are not as important agriculturally as the black and alluvial soils. But the productive capacity can be raised through irrigation and use of fertilizers. This soil is suitable for rice, millet, maize, groundnut, tobacco and fruits

4. Laterite Soils

The laterite soils are commonly found in area of high altitude and heavy rainfall in Karnataka, Tamil Nadu, Madhya Pradesh, Jharkhand, Orissa, Assam and Meghalaya extending over 13 million hectares. They generally form under hot and humid climatic conditions. The lateritic soils are particularly found on high flat erosion surfaces in areas of high and seasonal rainfall. Loss of nutrients by accelerated leaching is the most common feature which renders the soil infertile. The pebbly crust is the important feature of laterites which is formed due to alteration of wet and dry periods. As a result of weathering, laterite becomes extremely hard. Thus, their characteristics include complete chemical decomposition of the parent rock, complete leaching of silica, a reddish brown colour given by the oxides of aluminium and iron and lack of humus. The crops which are generally grown are rice, millets, sugarcane on lowland and tropical plantation such as rubber, coffee and tea on uplands.

5. Desert Soils

The desert soils occur in western Rajasthan, Saurashtra, Kutchchh, western Haryana and southern Punjab. The occurance of these soils is related to desert and semi-desertic conditions and is defined by the absence of water availability for six months. The soil is sandy to gravelly with poor organic matter, low humus contents, infrequent rainfall, low moisture and long drought season. The soils exhibit poorly developed horizons. Plants are widely spaced. Chemical weathering is limited. The colour of the soil is either red or light brown. Generally, these soils lack the basic requirements for agriculture, but when water is available, variety of crops like cotton, rice, wheat etc. can be grown with proper dose of fertilizers.

6. Mountain Soils

The mountain soils are complex and extremely varied. The soils vary from deep alluvium in the river basins and lower slopes to highly immature residual gravelly on higher altitudes. Because of complex topographic, geologic, vegetation and climatic conditions, no large areas of homogenous soil groups are found. Areas of steep relief are mostly devoid of soil. Various types of crops are grown in different regions like rice in valley, orchards on slopes and potato in almost all areas.

Soil Erosion

Soil erosion is described as the carrying away of soil. It is the theft of the soil by natural elements like water, wind, glacier and wave. Gravity tends to move soil down slope either very slowly as in soil creep or very rapidly as in landslides. The present shape of land has been carved through thousands of years. Soil erosion has become now one of the major environmental problems and a serious constraint for agricultural production. There are many physical and social factors which determine the extent and severity of soil erosion. The principal physical factors are erosivity of rainfall, erodibility of soil, severity of periodic floods, length and steepness of the slope. The important social factors are deforestation, overgrazing, nature of land use and methods of cultivation. Ravines, gullies and landslides are most serious and highly visible forms of land erosion. On the other hand, sheet erosion caused by rains and erosion due to winds are least visible but equally serious as they too take a heavy toll of our precious top soils. Soil erosion by ravines and gullies is widespread in India, It has been estimated that 3.67 million hectares of soil surface is damaged. There are four major areas of ravines and gullies in India. They are (1) Yumuna-Chambal ravine zone, (2) Gujarat ravine zone, (3) The Punjab Siwalik foothills zone and (4) Chhotanagpur zone. There are other areas of substantial ravine erosion in the Mahanadi valley, upper Son valley, upper Narmada and Tapi valleys, Siwalik and Bhabar tract of the western Himalayan foothills and edges of Ganga Khadar in western Uttar Pradesh. The relatively less affected areas are whole of Deccan south of the Godavari, the Ganga-Brahmputra plains, east of Varanasi, Kutch and western Rajasthan. Sheet erosion is widespread over sloping deforested terrain, un-terraced uplands of Peninsular region, Sutlej-Ganga plains, Coastal plains, Western Ghats and North- Eastern hills.

The occurrence of landslides is common in earthquake sensitive belts, particularly the Siwaliks. Heavy rainfall and cutting of slopes for roads, buildings and mining activities trigger landslides. In the last 50 years, the Rajasthan desert has encroached upon 13000 hectares of land in Rajasthan, Gujarat, Haryana and Uttar Pradesh. Glacial erosion is limited to high Himalayas and sea erosion is confined to coastal areas only. Soil erosion and soil exhaustion due to loss of soil nutrients pose serious threats to our efforts of increasing the productivity of soil faster than the population growth.

Soil Conservation

Methods by which soil is prevented from being eroded constitute soil conservation. If the soil is wasted or blown away, it is not easy to replenish it. Therefore, the most important step of soil conservation is to hold the soil in place. This is possible by improved agricultural practices in different regions. Contour ploughing and terracing are generally practised on the hill slopes. They are the simplest conservation methods. Rows of trees or shelter belts are planted to protect the fields in desert regions from wind erosion. Afforestation of the catchment areas and slopes in the Himalayas, the Upper Damodar valley in Jharkhand and the Nilgiri hills in the south has been implemented. It reduces the surface runoff and binds the soil. Ravines are noted for their enormous size and depth with vertical sides. The Central Soil Conservation Board has established 3 research stations: (1) Kota in Rajasthan, (2) Agra in Uttar Pradesh and (3) Valsad in Gujarat to suggest methods of reclamation of ravine lands. Overgrazing by sheep, goat and other livestock has been partly responsible for soil erosion. Erosion due to these factor has been reported from Jammu & Kashmir, Himachal Pradesh, Rajasthan and Karnataka. Soil exhaustion can be prevented by the application of manure and fertilisers.

- The six major types of soil found in India are alluvial, black, red, laterite, desert and mountain soil.
- Both physical and social factors cause soil erosion. The physical factors are erosivity of rainfall, erodibility of soil, severity of periodic floods and length and steepness of the slope. The social factors are deforestation, overgrazing, nature of land use and methods of cultivation.
- Major forms of soil erosion are ravines, gullies, landslides and sheet erosion.
- Contour ploughing, terracing, planting of shelter belt afforestation checking of overgrazing and application of manures and fertilizers are the methods of soil conservation.

Check Your Progress

1. (a) Name the two important regions of alluvial soils.

   (i) ______________________________

   (ii) ______________________________

   (b) Which element are responsible for red colour in red soils?

   ____

   ____

2. (a) Name three major types of soil erosion:

   (i) ______________________________

   (ii) ______________________________

   (iii) ______________________________

   (b) Name four methods of soil conservation adopted for preventing soil erosion.

   (i) ______________________________

   (ii) ______________________________

   (iii) ______________________________

   (iv) ______________________________

What you have learned

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.

Terminal Questions

1. Differentiate between these:
   (a) Laterite soil and red soil
   (b) Soil erosion and soil conservation
   (c) New alluvium and old alluvium
2. Locate and label the following on an outline map of India::
   (i) Alluvial soil.
   (ii) Laterite soil.
   (iii) Desert soil.

Answer to the Intext questions

1. Land-man ratio is defined as the ratio between the habitable area and the total population of a country.
2. Australia, Canada, Argentina, USA, Chile, Denmark and Mexico (Any four)
3. Japan, Netherland, Egypt, U.K., Israel and China. (Any four)
1. Chambal valley, Chotanagpur, Gujarat, Sub-mountane Punjab Himalaya (Any four)
2. Deforestation
3. (i) Physical (land reclamation), (ii) Social (land reforms)Rajasthan
1. (i) Valley areas of Sutlej, Ganga, Brahmaputra, (ii) Fringes of the southern peninsula.
   (b) Compounds of Iron
2. (a) gully erosion, sheet erosion, landslides, ravine erosion (any three)

(b) Contour ploughing, terracing, shelter belt formation, afforestation.

1. (a) Natural vegetation, (b) Forest
2. (i) Mahogony, Cinochona and Plam

   (ii) Sal and Shisham

   (iii) Ebony and Rosewood
3. (i) Moist Tropical Evergreen

   (ii) Moist Tropical semi-evergreen

   (iii) Moist Tropical Deciduous
4. (i) The trees shed their leaves once in a year in dry season

   (ii) This belt consists of a number of commercially important species of trees such as teak, sal, shisham, bamboos and sandalwood.

Essay 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?

Sort Questions

3. Explain about soil erosion
4. Importance of soil conservation

Very Short Questions

5. Land use
6. Desert soils
7. Mountain soils

Further Readings

- https://www.nios.ac.in/online-course-material/sr-secondary-courses/Geography-(316).aspx
- Bharatadesham Pranteeya Bhoogolashastram, Telugu Academy, Hyderabad, 2019.
- India, Physical Environment, NCERT Class XI text book

Chapter - 19

NATURAL VEGETATION

Contents

19.0 Introduction

19.1 Objectives

19.2 Significance of forests

19.3 Major Vegetation types

19.4 Check Your Progress

19.5 What you have learned

Introduction

The assemblage of plant species, e.g. trees, shrubs, grasses, creepers and climbers and the like living in association with one another in a given environment is known as natural vegetation. Contrary to this, a forest denotes a large tract covered by trees and shrubs which has an economic significance for us. Thus, a forest has a different connotation than what the Natural Vegetation has.

The variations in climatic conditions in India have resulted in having various types of natural vegetation in different parts of the country. It is so because each plant needs a definite range of temperature and precipitation for its growth. This justifies the growth of tropical evergreen vegetation confined mainly to the Western Ghats, on account of hot and wet climatic conditions. The same is true for temperate evergreen vegetation of northeast India and thorny or arid or semi-arid vegetation of Rajasthan desert and adjoining areas. Deciduous vegetation grows in central parts of India owing to moderate climatic conditions prevailing over there.

Objectives:

After studying this lesson, learner can:

- describes the importance and use of forest resources
- identify major constituents of vegetation
- recognize major vegetation types
- analyses the methods of forest conservation

Forest resources are of paramount importance for all living beings. Forests provide us with food, shelter, livelihood, fuel security and water. Over 2 billion people rely on forests either directly or indirectly in the world. Major parameters used for measuring forest resources are forest cover, species composition, timbre and non-timber products, annual increment, growing stock, biodiversity etc.

Significance of forest

Forest have very significance role on the earth. You can find its significance as:

- Forests are the world's second largest storehouse of carbon after oceans. They are also the source of oxygen. They provide services like absorbing greenhouse gases, protecting watersheds and reducing or slowing the soil erosion etc.
- Forests are like giant sponges where trees and soil help in ground water recharge; and feeds rivers, ponds, lakes and springs; reduces runoff and chances of floods.

- Forests are natural cooling systems as trees use solar energy to evaporate moisture and have a cooling effect on the environment.
- Forests near urban settlements help in reducing the 'heat island' impact of urban activities and transportation.
- Forests control many disasters like controlling river floods especially flash floods and Mangrove forests act as wind breakers in cyclone prone areas.
- They also help in reducing risk from landslides, avalanches and sand storms. It helps in preventing droughts
- Forests provide habitats to diverse animal species. They are home for more than 80% of world terrestrial biodiversity and livelihood for different types of settlements including 60 million indigenous people.
- Forests are of great economic value worldwide; it is estimated at 16.2 trillion dollars. Forests create jobs for 13 million people in the world.
- Forests play an important role in tourism. Third of the world's population still depends on forests and trees for their daily needs, especially for heating and cooking.
- Forests are also vital for health; they provide a treasury of medicinal plants and pharmaceutical ingredients and fresh air for oxygen-rich walks.

MAJOR VEGETATION TYPES

Natural vegetation cover in India is generally divided under the following heads:

i. Moist Tropical Evergreen and Semi–evergreen Vegetation

ii. Moist Tropical Deciduous Vegetation

iii. Dry Tropical Vegetation

iv. Tidal Vegetation and

v. Mountain Vegetation.

1. Moist Tropical Evergreen Vegetation

These are the tropical rain forests which are further divided into two sub-types on the basis of their characteristics as under:

(a) **The Wet Tropical Evergreen Vegetation** is found in regions of very high annual rainfall exceeding 300 cms. with a very brief dry season. Southern parts of Western Ghat of Kerala and Karnataka are very wet. Northeastern Hills are known for this type of vegetation. It resembles the equatorial vegetation. This type of vegetal cover has been badly depleted due to over cutting of trees. The major characteristics of this type of vegetation are:

(i) These forests are dense and have lofty evergreen trees, often as high as 60 metres and above.

(ii) The number of vegetal species per unit area is too large to exploit them commercially.

(iii) Mahogony, cinchona, bamboos and palms are typical species of plants found in these forests. Undergrowth is very dense and thick. Grass is almost absent.

(iv) The wood of these trees is very hard and heavy to work with.

(b) Moist Tropical Semi-evergreen Vegetation is found between wet ever- green vegetation and moist temperate deciduous vegetation. This type of vegetation is found on the Meghalaya plateau, Sahyadris and Andaman and Nicobar Islands. This vegetation is confined to areas receiving annual rainfall of about 250 to 300 cms. Its important characteristics are:

(i) The vegetation cover is less dense than the wet evergreen forests.

(ii) Timber of these forests is fine textured and of good quality.

(iii) Rosewood, aini and telsur are important trees in Sahyadris, champa. joon and gurjan in Assam and Meghalaya and ironwood, ebony and laurel grew in other regions.

(iv) Shifting agriculture and over exploitation of forests have depleted this vegetal cover to a great extent.

2. Moist Tropical Deciduous Vegetation

This is the most wide spread vegetal cover of India. This type of vegetation is found in areas receiving annual rainfall of 100 to 200 cms. These include the Sahyadris, the northeastern plateau of the peninsula, the Himalayan foot hills in the Siwaliks, the bhabars and terai. The important characteristics of this vegetation are:

(i) The trees shed their leaves once in a year in dry season.

(ii) This is a typical monsoon vegetation consisting of larger number of commercially important species than the evergreen forests.

(iii) Teak, sal, sandalwood, shisham, cane and bamboo are important trees of these forests.

(iv) Large scale cutting of trees for timber has depleted these forests hopelessly.

3. Dry Tropical Vegetation

This type of vegetation is divided into two groups as under:

(a) **Dry Tropical Deciduous Vegetation** is found in regions receiving annual rainfall between 70 to 100 cms. These regions include parts of Uttar Pradesh, northern and western Madhya Pradesh, parts of Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. These areas experience a long dry season and a moderate rainfall limited at best to four months. The important characteristics of this vegetation are :

i. Stretches of open grass are most common between group of trees. Teak is the dominant tree of this type of vegetation.

ii. The trees shed their leaves during the long dry season.

(b) **Dry Tropical Thorny Vegetation** is found in areas receiving annual rain- fall less than 70 cms. These areas include north and northwestern parts of India and leeward side of the Sahyadris. The important characteristics of this type of vegetation are:

(i) Vast, poor and coarse grasslands are interspersed with widely spaced trees and bushes.

(ii) Acacia, euphorbias, cactus etc. are true representatives of this type of vegetation. Wild palm and spiny and thorny varieties are also found here and there.

4. Tidal Vegetation

This type of vegetation grows mainly in the deltaic regions of the Ganga, Mahanadi, Godavari and Krishna which are flooded by tides and high sea waves. Mangrove is the representative of this type of vegetation. Sundari is the typical tree of tidal forests. It is found in abundance in the lower Ganga delta of West Bengal. This is the reason why it is popularly known as Sunderban. It is known for its hard and durable timber.

5. The Mountain Vegetation

Due to the difference in temperature and other weather conditions of northern and peninsular mountain ranges, there exists difference in the vegetal cover of these two groups of mountain ranges. Hence, the mountain vegetation can be classified as the mountain vegetation of Peninsular plateau and the mountain vegetation of the Himalayan ranges.

(a) **The Mountain Vegetation of Peninsular Plateau:** The high altitude area of the plateau region include Nilgiri, Annamalai and Palni hills, Mahabaleshwar in Western Ghats, Satpura and Maikal hills. The important characteristics of vegetation of this region are:

(i) Stretches of open rolling grass plains with undeveloped forests or bushes are found.

(ii) The wet temperate forests below 1500 metres are less dense than those found above this height.

(iii) The forests have thick undergrowth, epiphytes, mosses and ferns.

(iv) Magnolia, laurel, elm are common trees.

(v) Cinchona and eucalyptus have been introduced from outside the country.

(b) The Mountain Vegetation of the Himalayan Ranges: In the Hima- layan mountain region, the vegetation is different at increasing altitudes. This can be divided into following types:

1. Moist Tropical Deciduous forests are found along the foot hills in the Siwaliks, up to the height of 1000 metres. We have already learnt about these forests.

2. The Wet Temperate Evergreen forests are found in the areas lying between 1000 to 3000 metres. The important characteristics of these forests are:

(i) These are very thick forests of lofty trees.

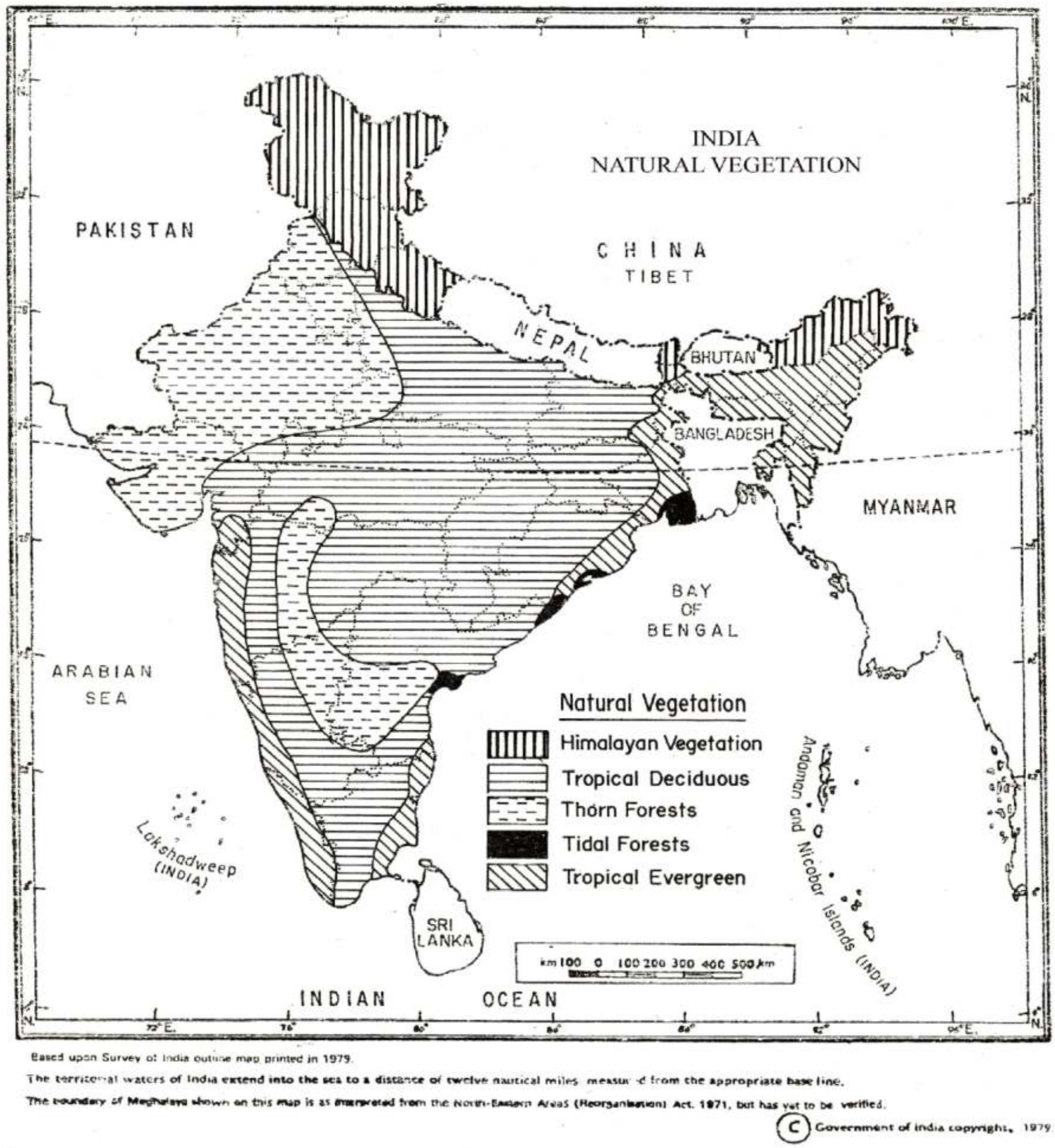
(ii) Oak and chestnut are the predominant trees of the eastern Himalayan region while chir and pine are in the western part.

(iii) Sal is the important tree in lower altitudes.

(iv) Deodar, silver fir and spruce are predominant trees between the height of 2000 and 3000 metres. These forests are less dense as compared to the forests at lesser elevations.

(v) These forests are of great economic importance to the local population.

3. Dry Temperate Vegetation is found on the higher hilly slopes of this moun- tain region which has moderate temperatures and rainfall between 70 cms and 100 cms. Important characteristics of this type of vegetation are:



(i) This vegetation resembles the Mediterranean vegetation.

(ii) Wild olives, acacia are important trees along with hard, coarse and thick savanna grass.

(iii) Oak and deodar are found here and there.

4. Alpine Vegetation is found between the altitude 3000 and 4000 metres. The important characteristics of these forests are:

(i) These are far less dense,

(ii) Silver fir, juniper, birch, pine and rhododendron are important trees of these forests. However, all of them have only a stunted growth.

(iii) Alpine pastures are found at still higher altitudes.

(iv) The trees get progressively stunted as they approach the snow line.

- Natural vegetation is the assemblage of plant species living in association with one another in a given environment.
- Variations in temperature and rainfall conditions have a clear impact on vegetation of different regions.
- The major vegetation belts include the moist tropical evergreen, the moist tropical deciduous, dry deciduous, the tidal and the mountain vegetation. Mountain vegetation spans almost from the tropical to Alpin types.

Check Your Progress

1. Give suitable technical terms for the following statements:

(a) The assemblage of plant species living in association with one another in a given environment .

(b) A large area densly covered by trees and shrubs generally with a com-mon crown or canopy .

2. Classify the following species of trees into the types of vegetation given below :Mahogony, Ebony, Shisham, Cinchona, Sal, Palm, Rosewood

(i) Moist Tropical Evergreen .

(ii) Moist Tropical Deciduous .

(iii) Moist Tropical Semi-evergreen .

3. Name the type of vegetation found in the regions of annual rainfall

(i) exceeding 300 cms. .

(ii) between 200 and 300 cms. .

(iii) between 100 and 200 cms. .

4. Give two most important characteristics of the moist tropical deciduous vegetation.

(a) ____

(b) ____

What you have learned

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

Terminal Questions

Essay Questions

1. Define natural vegetation. How is a forest different from it?
2. Discuss about the significance of forest resources
3. Explain about the major vegetation types in India
4. Distinguish between Tidal vegetation and Mountain vegetation

Sort Questions

5. Write about Moist Tropical Evergreen Vegetation?
6. Dry tropical vegetation

Very Short Questions

7. Tidal vegetation
8. Mountain vegetation

Further Readings

- https://www.nios.ac.in/online-course-material/sr-secondary-courses/Geography-(316).aspx
- Bharatadesham- Pranteeya Bhoogolashastram, Telugu Academy, Hyderabad, 2019.
- India, Physical Environment, NCERT Class XI text book

Chapter - 20

WATER RESOURCES AND IRRIGATION

Contents

20.0 Introduction

20.1 Objectives

20.2 Water Resources, Sources, Utilization Pattern

20.3 Means of Irrigation

20.4 Rainwater harvesting

20.5 National Water Policy

20.6 Watershed development, National River Linking Programme

20.7 Methods of Water Conservation

Introduction

Water is one of the basic resources for human beings as well as all other life forms on earth. Water is so important for life that we cannot imagine life without it. The evolution of life itself took place in the water. In the evolution of all kinds of life, water has played an important role. The amount of water found in living beings is 65 percent and 65 to 99 percent in plants. This clearly shows the need and utility of water. Water, which is a precious gift of nature, has several uses. Water is very essential for development. Although it is available in abundance e covering 3/4 of the earth, yet it is a scarce resource; and the fact is that only 3 % is potable. Hence its utilisation and conservation is the most challenging task for mankind. The demand for water continues to rise whereas the supply and availability of water resources is limited as far as human use is concerned. Thus, an efficient planning and implementation programme of water resource appraisal, development, conservation, and management is required.

From the point of view of availability and suitability, the potable water is limited in India. Moreover, it has highly uneven geographical distribution. Another disturbing issue is day by day deteriorating quality of water. It is a matter of great concern for all of us. Besides coordinating the demand and supply of the water, there is a need to keep the balance among different sources of water along with the balance among different uses of water. Hence conservation of water resources is an essential requirement.

Objectives

After studying this lesson, learner:

- states the significance of water resources; different sources and its utilisation pattern;
- explains the uneven distribution of water; asseses the issues and suggest solutions
- analyses methods of Water Resource conservation and Management

Water Resources: Significance for Life

Water is the most valuable resource of nature. This is a renewable and inexhaustible resource but is in trouble these days. Demand for water has been increasing continuously and its supply decreasing. If we look at the water resources of India in the global context, India has 4 percent water where as she is housing 16 percent of the world's population. It means the per capita availability of water is quite low in our country. One-eighth area of the country is flood prone and one-sixth area is under the grip of drought. Nature of the monsoon is mostly responsible for uneven distribution of water. Food grains and other agricultural products are required in large quantities for the growing population. For this reason, the use of water for irrigation of crops has been increasing. India ranks first in the world in terms of irrigated area. The demand for water has increased in the cities due to rapid urbanisation, industrialization, and modernization. In addition, the demand for water has been increasing for sewerage and for removing all kinds of wastes.

Sources of Water

There are four main sources of water:

A. Surface water

B. Underground water

C. Atmospheric water

D. Oceanic water.

In our daily life we use only surface water and underground water.

A. Surface water

The main source of surface water is precipitation. About 20 percent of the precipitation evaporates and becomes atmospheric water. Apart of the running water goes underground. The large part of surface water is found in rivers, rivulets, ponds, and lakes. Remaining water flows into the seas, oceans. Water found on the surface is called surface water. About two - third of the total surface water flows into three major rivers of the country - Indus, Ganges and Brahmaputra.

The water storage capacity of reservoirs constructed in India so far is about 17400 billion cubic metres. At the time of independence, the water storage capacity was only 180 billion cubic metres. Hence water storage capacity has increased about ten times. The storage capacity of usable water in the Ganges basin is the maximum. Despite maximum annual flow, these storage capacity of usable water is the least in the Brahmaputra basin. The storage capacity in Godavari, Krishna, Mahanadi and Indus is sufficient. Annual water flow in the three major rivers of India - Indus, Ganga and Brahmaputra are very high. Hence water storage capacity of these rivers can be increased.

Source: Basin wise distribution of surface and groundwater resources in India (Central Water Commission and Central Ground Water Board)

Rain water percolates into the earth's surface and becomes underground water. The process of percolation also takes place from the surface water. Large amount of water gets collected under the Earth's surface by these two methods. This is called underground water.

According to the Central Underground Water Board, the annual replenishable underground water resource in India is 433 billion cubic metres. Out of this about 399 billion cubic meter water is available for various uses.

The distribution of underground water is not the same everywhere. Availability of underground water depends upon the amount of rainfall, nature of rainfall, nature of land and its gradient. In the areas of high rainfall where the land is almost flat and has porous rocks, the water easily percolates and reaches the aquifers. Therefore, underground water is available in plenty at shallow depths in these areas. In the areas like Rajasthan where the land is flat and has porous sandy soil, the underground water is less in amount and is available at greater depths due to lack of rainfall. In the North-Eastern regions of the country, in spite of adequate rainfall, underground water is available in less quantity at greater depths. It is because the land is sloppy and the conditions are not suitable for percolation of water. There are large reserves of underground water in the plains of Ganga - Brahmaputra and in coastal plains. The availability of underground water is less in peninsular plateau, Himalayan region and desert areas.

Underground water is used on a large scale in the areas where the rainfall is comparatively less. The use of groundwater is more in Punjab, Haryana, Rajasthan, Tamil Nadu, Gujarat and Uttar Pradesh. Andhra Pradesh, Madhya Pradesh, Maharashtra, Karnataka and Chhattisgarh are such states where in spite of rainfall, the use of underground water is less. There is a dire need to develop underground water resources in these states.

Water Budget

Water Budget means the balance between the available water in the country and the water under use. There is a great variation in the availability of water resources in India. The availability of water also varies according to the season. Water is available in sufficient quantities during the rainy season. As the dry season sets in, there is a shortage of water. Likewise water is available plentily in areas having flat surface, porous soil in comparison to the areas having sloped land and non-porous soil. The use or demand on water resources is increasing day by day with the increase of population. The reserves of our surface and underground water are a bout 23840 billion cubic metres. Out of this only 10860 billion cubic metre water is required for use. The unit of measurement of the amount of water is cubic metre and hectare metre.

In simple terms, Water budget means the rate of change in water stored in a region. For example, a watershed is balanced by the rate at which water flows in and out of the region. After thorough understanding of water budgets and underlying hydrologic processes, a foundation for effective water-resource and environmental planning, conservation and management could be formulated. The Observed changes in water budgets of an area over time thus can be used to assess the effects of changes in the climate and as a result of human activities on water resources. Comparison of water budgets from different areas helps in assessing the factors such as geology, soils, vegetation, and land use on the hydrologic cycle.

The natural hydrological cycle is affected in many ways by human activities. Modifications carried out on the land to accommodate large scale agriculture, such as installation of drainage and irrigation systems, manya times alter infiltration, runoff, evaporation, and evapotranspiration rates. Similarly, Buildings, roads, and parking lots in urban areas tend to increase runoff and thus decrease infiltration. Dams reduce flooding in many regions. Water budgets thus provide a basis for assessing how a natural or human-induced change in one part of the hydrologic cycle may affect various other aspects of this cycle.

Check Your Progress

1. What is the ranking of India in the World in terms of irrigated area

2. The surface water storage capacity of which river basin is maximum in India?

3. Name 5 states of India where underground water is used on a large scale.

Utilization Pattern

Population in India has been increasing rapidly. It has increased about three times since independence. Due to this increase in population, the demand for water has increased in all the spheres for eg. for domestic use, irrigation and industries. On the other hand, per capita annual availability of water has been decreasing over the years. In 1951 per capita annual availability of water was 5177 cubic metre per person which has decreased to 1829 cubic metre per person annually in 2001. In the coming years by 2025 per capita availability of water is expected to become 1342 cubic metres annually. It is to be noted that the water crisis arises when the per capita availability of water falls below 1000 cubic metres annually. Today many countries are facing the water crisis and have to import water to sustain.

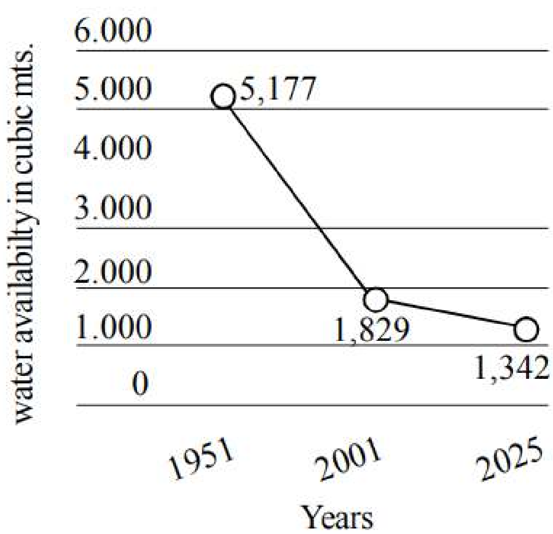


Fig.2 : Water Availability in India

Water is used for many direct and indirect purposes. Direct purposes include mostly domestic i.e. bathing, drinking, cooking and irrigation while examples of indirect purposes are in processing wood to make paper and also in producing steel for automobiles. The major bulk of the world's water use is for agriculture, industry, and electricity. Even one cannot imagine fishing, forestry and water sports without huge amounts of water resources. In this way, water is essential for all kinds of developmental work. It is essential in all spheres of life. Due to rapid growth of urban population, the demand for water in urban areas has increased tremendously.

The most common water uses include:

- Domestic (drinking and Household) Needs;
- Recreation (Sports activities such as River Rafting, Kayaking etc);
- Industry and Commerce;
- Agriculture (Irrigation);
- Hygiene and Public Health;
- Hydroelectricity Generation (Energy)

We humans require fresh water. Only 2.5% of total water on the Earth is freshwater, and over two-thirds of this is frozen in the glaciers and polar ice caps. The Water demand already exceeds its supply in many parts of the world, and many more areas are expected to experience this imbalance in the very near future. It is estimated that 70% of world-wide water use is for irrigation purposes in agriculture. Climate change will have significant impacts on the water resources. Due to the ever increasing human population the demand for water is growing day by day and many of the world's major aquifers are getting depleted. Pollutants from industries threaten the water quality, but the most widespread, especially in the less developed countries, is the discharge of raw sewage into natural waters.

Table.2 India: Changing pattern of use of water 1990-2050 (Figures in billion cubic metere)

Use	1990	2000	2010*	2025*	2050*
Domestic	25	33	42	52	60
Irrigation	460	536	653	770	800
Industry	15	30	79	120	130
Energy	19	27	44	71	120
Others	30	33	35	37	40
Total	549	659	853	1050	1150

*Estimated

India is an agricultural country. Hence plenty of water is needed for irrigation. 536 billion cubic metre water was used for irrigation in the year 2000. It is 81 percent of the total water used. The remaining percentage of water was used for domestic, industrial and other purposes.

There has been a rapid increase in the irrigated area in India since independence. Total irrigated areas in 1999-2000 was 8.47 crore hectare. The maximum capacity of the use of water for irrigation in India is 11.35 crore hectare metre. But about three-fourth water of this capacity is being used. The demand for irrigation in India has been increasing continuously.

The reasons for the increasing demand of irrigation are as follow:

1. Regional and seasonal variations in the distribution of rainfall.
2. Wide and uncertain gaps in rainfall season.
3. Growing demand for water for commercial crops.
4. Changing cropping pattern.

MEANS OF IRRIGATION

There are three main means of irrigation in India:

A. Wells and Tube wells;

B. Canals; and

C. Tanks.

A. Wells and Tube-Wells

Irrigation by wells is an old practice in India. It has increased tremendously with the use of diesel and electric pumping sets. Irrigated area by wells and Tube wells in 1950- 51 was only 59 lakh hectares which has increased to 30 million hectares in 1997- 98. During this period total irrigated area has increased from 30 percent to 57 percent. From 2001- 02 to 2014-15 there is 20% increase in net irrigation, due to extensive extraction of groundwater. In the said period i.e. 2001-02, nearly 41% of Net irrigated area got water from Tube Wells whereas this increased to 46% in 2014-15. but Irrigation declined from 21% to 16% only. Uttar Pradesh has the largest area under Well irrigation followed by Rajasthan, Madhya Pradesh, Punjab, Gujarat, Maharashtra and Bihar. There are large reserves of underground water in the alluvial plains of north India. Digging and constructing wells and tube wells is easy and the cost of their construction is also comparatively less. Therefore, irrigation by wells and tube wells is popular among farmers. In states like Gujarat, Goa, Rajasthan and Maharashtra, only about 60 percent irrigation is carried on by wells and tube wells.

B. Canals

Canals were the main means of irrigation upto 1960. Canals contributed about 40 percent in the total irrigated area of the country. In 1996-97 it came down to about 31 percent. About 1.74 crore hectare area was irrigated by canals in 1996- 97. Half of this area (52.5 percent) is limited to the states of North India. Haryana, Odisha, Karnataka, West Bengal, Andhra Pradesh and Punjab are worth mentioning for canal irrigation. Jammu-Kashmir, Mizoram, Assam and Tripura are such states which greatly depend upon canal irrigation because there is lack of other means of irrigation in these states. Mizoram which has the least irrigated area is completely dependent upon canals for irrigation. Canal irrigation declined from 27% in 2001-02 to 24% in 2014-15.

C. Tanks

The contribution of tanks in irrigation has reduced. About 3 percent of the irrigated area is irrigated by tanks. Irrigation by tanks is popular in the peninsular plateau area. Tamil Nadu is the leading state in irrigation by tanks. About 22 percent of the area is irrigated by tanks here. In Odisha, Maharashtra, Karnataka, Kerala and West Bengal tank irrigation is prevalent.

Check Your Progress

1. What are the various means of irrigation in India?

____

____

2. Name the states where irrigation is done mainly by tanks?

____

____

3. Give reasons for the increase in demand for irrigation.

____

____

Rain Water Harvesting

Rain water harvesting generally means collection of rainwater where it falls. Where there is shortage of water, groundwater can be recharged by harvesting rainwater. In this process, water is made to go underground after collecting rain water locally, without polluting the same.

Why we need rainwater Harvesting?

Three main reasons are responsible for this:

1. Scarcity of surface water
2. Growing dependence on underground water.
3. Increasing urbanisation.

There can be two Scenarios of Rain water harvesting:

A. Urban Scenario

Total amount of rain water recovered in an area is called 'rain water reserve'. Effective management of rain water reserves is called 'potential water harvesting'.

B. Rural Scenario

The tradition of rainwater harvesting is very old in India. But the utility ofwater harvesting has never been felt so much as it is today. Even today the people living in the areas of water scarcity try to do their domestic work by adopting old methods. Deepening and dredging of wells, tanks and ponds are included in these methods. Water harvesting in the small channels (locally known as bawli) is an important traditional method in the areas of water scarcity..

Fig. : ATraditional Method of Rainwater Harvesting

METHODS OF RAINWATER HARVESTING

We can adopt different methods for rainwater harvesting according to need, available facilities and environmental conditions. The following methods are worth mentioning-

1. Construction of potholes - We can harvest water in small ditches constructed in those areas where there is not much underground water. These ditches may be constructed 1-2 metres wide and 2-3 metres deep. Their shape could be anything. These ditches are filled with rubbles and sand. Rainwater can easily percolate through these.
2. Construction of trenches - In the lower regions where porous rocks are found after making trenches of 0.5 to 1-metre width, 1 to 1.5-metre depth and 10 to 15-metre length, these are filled with rubbles. These trenches should be made parallel to the slope of the land.
3. Use of wells - The wells which have become dry and are not being used at present can be used for water harvesting.
4. Handpump - Stored rainwater can be made underground with the help of a filter by running handpumps in the areas of lack of underground water.

Check Your Progress

1. Why do we need to harvest rainwater?

   ____

   ____

2. Name any two methods of rain water harvesting.

   ____

   ____

3. How is water being conserved and channels recharged in Ufrakhal, Uttarakhand?

   ____

   ____

Issues of Water Resources

There are many issues related to water resources. The list is exhaustive. There is scarcity, pollution, depletion of water. We can list them as follows:

- Intense urbanisation leads to increasing demand for water,
- Pollutants in water due to release of untreated industrial water and urban sewage to water bodies
- Tremendous demand for water for drinking and economic and social development.
- Water stress and scarcity in many regions of the planet due to alterations in availability and ever increasing demand.
- Problems of stress /pressure and scarcity due to global changes with extreme hydrological events
- Problems caused by the lack of articulation and lack of consistent actions of governability of water resources as well as environmental sustainability.

National Water Policy

The main Objective of National Water Policy is to take cognizance of the existing situation of country's water resource, and to propose a framework for creation of a system of laws and institutions and further for a plan of action with a unified national perspective.

Water is a national valuable reserve. It is essential for the Government to evolve policy for the development and management of water resources so that surface and underground water is not only properly used but also conserved for the future. Nature of rainfall has also compelled us to think in this direction. 'National Water Policy' was formulated and accepted in September 1987. It was revised in 2002 and presented as 'National Water Policy' 2002 and again updated in 2012 as problems arose in the previous policy during the course of time.

Water is an important constituent of the ecosystem. It should be considered essential for all kinds of life. It should be developed, conserved and managed in a planned manner. It is essential to think about its social and economic aspects of water as large areas of the country suffer due to drought and floods every year. It causes not only the loss of property and human life but the wheel of development is also stopped. The problems of floods and drought are not limited to the boundaries of a particular state. This requires thinking at the national level. Several problems arise in planning and management of water resources. More exploitation of underground water in many areas of the country have posed serious challenges such as dried up aquifers as well as lowering of water table. The demand of water is on increase for domestic use, industries, energy production etc. Water resources are already scarce, and with ever increasing demand by the growing population there shall be a worrisome future of water. Quality of water is also an important aspect. Pollution of surface and underground water has been increasing. Main sources of water pollution due to human activities include domestic wastewater, industrial effluents and chemicals used in agriculture. Sometimes water pollution is also caused by natural factors. Erosion, landslides, decomposition of plants and animals are the main natural sources of water pollution. Three fourths of the total surface water in our country is polluted.

IMPLEMENTATION OF NATIONAL WATER POLICY

National Water Board should prepare a plan of action, based on the National Water Policy, as approved by the National Water Resources Council, to regularly monitor its effective implementation. The State Water Policies may need to be drafted/revised in accordance with this policy keeping in mind the basic concerns and principles in a unified national perspective.

Watershed Development Programme

Watershed is defined as an area where the runoff resulting from rainfall is collected and drained out through a common point. Watersheds are composed of a number of streams and creeks that drain into progressively larger streams to eventually form a river. Each of the streams or creeks have their own watersheds, or sub-basins, that flow from higher elevations to lower elevations. The adjacent watersheds are separated by ridges which are called water divides. Within a watershed, water may come from various directions, but it drains out at a single point. Therefore, it is easier to manage water, soil and forest and other related resources within small watersheds by checking water at outlet points. By growing forests in the upper reaches of the watershed, the water flow through streams slows down, groundwater gets recharged and soil erosion gets reduced. The drained out water at the outlet point can be checked easily. Therefore, small watersheds are the ideal units to manage the natural resources like land, soil, water, forest etc.

The Watershed Development Programme was originally initiated by the National Wasteland Development Board, Ministry of Environment and Forest. Now the programme is placed under the Department of Land Resources under the Ministry of Rural Development. The Department of Land Resources is implementing the Integrated Watershed Development Programme (IWMP) from 2009-10 with an objective to cover 55 million hectares of rain fed land by 2027.

Benefits of Watershed Development Programme:

- Water storage, flood control, checking sedimentation
- Erosion control and prevention of soil
- Recharging groundwater to provide regular water supply
- Minimising over-exploitation of resources
- Increase in the agricultural production and productivity

- Decrease in deforestation
- Wildlife preservation
- Pollution control

The success of Watershed Development Programme is possible by:

a. More scientific thinking;

b. perfect techniques;

c. Participation of local population;

d. coordination among various departmental agencies, and

e. An independent ministry to follow up.

National River Linking Programme

The Inter-Linking of Rivers (ILR) programme is aimed at linking water surplus river basins with water deficit river basins so that the excess water from surplus regions could be diverted to deficient regions. The idea behind the interlinking of rivers is to reduce flood and drought havocs in water surplus and water deficit areas respectively. Thirty-seven rivers are identified to be interlinked by a network of about 3000 storage dams.

Benefits of River Linking Programme

- The irrigation of about 250 lakh hectare additional agricultural area is possible by surface water after the success of this programme.
- Underground water will be available to irrigate additional agricultural areas of about 100 lakh hectares.
- Additional hydro-electricity of about 340 lakh kilowatt will be generated.

Besides these benefits, many other benefits like flood control, water transport, water supply, fishing, removal of acidity from the soil and control on water pollution will also be achieved.

Challenges in River Interlinking

- **Project feasibility:** The estimated cost of the Project is very high which requires huge structure and great engineering capacity.
- **Environmental impact:** The wildlife, flora and fauna of the river systems would be affected because of large scale displacements and modifications.
- **Impact on society:** The displacement of people for building of dams and reservoirs

would create agony among local people.

- **Inter-state disputes:** The dispute among states coming under particular projects may arise for sharing of water and other resources.

Methods of Water Conservation

If we do not conserve water today, future generations may have difficulty surviving due to scarcity of water. The participation of an individual, society and the Govt. is essential for water conservation.

The following methods can be adopted for water conservation -

1. Dams and reservoirs should be constructed on rivers so that river water does not go waste into the seas and oceans.
2. The water of rivers should be saved from pollution by urban waste at all costs.
3. Mass awakening should be around for water conservation.
4. Solicit active participation of the people in all the activities related to water conservation and efficient management.
5. Potable water should not be used for gardening, washing of vehicles and cleaning of households.
6. Broken pipelines of water should immediately be repaired.
7. Every drop of water is precious, this should be popularised among the masses.
8. Such crops should not be grown in rain fed areas which require more water.
9. There should be stress on afforestation.

Check Your Progress

1. Mention any four problems related to water resources.

   a.

   b.

   c.

   d.

2. What is the main objective of the National Water Policy?
3. What are the challenges in interlinking rivers? Any two

Terminal Questions

Essay Type

1. Mention the main sources of surface water?
2. Describe the means of Irrigation?

Short Answers

3. What is the meaning of water resources?
4. State the meaning of rain water harvesting?
5. Describe main methods of rainwater harvesting

Very Short Answers

6. Meaning of watershed
7. Surface Water
8. Underground water
9. River linking

Answers for the Inext Question

1. 1. First 2. Ganga

3. Punjab, Haryana, Rajasthan, Tamil Nadu, Gujrat, UP (Any Five)

2. 1. Wells and tube wells, Canals, Tanks

   2. Tamilnadu, Odisha, Maharashtra, Karnataka etc.

   3. Regional and seasonal variations in rain, growing demand for commerical crops etc

3.

1. Scarcity of Surface water, dependancy on underground water, increasing urbanisation.

2. i) Construction of Potholes ii) Construction of trenches

   iii) Use of wells iv) Use of handpump

3. Water Pits

4.

1. a) Increasing demand of water for urbanisation b) Pollution

   c) Demand for economic activity d) Scarcity due to global change

2. To take cognizance of existing situatin of country's water resources

3. i) Project Feasibility

   i) Environmental impact

   iii) Impact on society (Any 2)

Chapter - 21

LAND USE AND AGRICULTURE

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21.12 Further Reading

21.0 Introduction

We have already focused on climate, soils, different kinds of resources, and human activities. In this lesson we look into agriculture in India. Land is a very significant resource for agriculture. India has diverse land uses due to its vast territory and socio-cultural and physical diversity. In India, the majority of the working population is employed in agriculture, making it the country's most important economic activity. Even though the agricultural sector's contribution to the GDP has significantly decreased to roughly one-fourth of the total, it still plays a significant role in providing jobs for the labour force, particularly in rural areas. Clearly, agriculture is the backbone of the Indian economy since it provides raw materials to a great deal of other businesses. Agriculture includes fishing and animal ranching in addition to the cultivation of crops.

21.1 Objectives

After studying this lesson, you will be able to understand:

- Recognise the land availability and land use pattern
- Study the factors responsible for the development of agriculture in India
- Explain the types of crops grown and areas under different crops in India
- Understand the strategies adopted for the agricultural development in India and

21.2 Land Use Pattern

The most important resource of a nation is its land. Since it is a fixed asset, growing populations cannot be served by expanding it. As a result, it needs to be used wisely and effectively. The total geographical area of India is 32.88 lakh square kilometres. The major land use categories in India are as the following:

(i) Net Sown Area (NSA): This represents the total area sown with crops and orchards. Area sown more than once in the same year is counted only once. The net sown area and the area sown more than once together are called gross cultivated area. In India, about 46.18 per cent of total reporting area is under the net sown area (as of 2020-21). The States sharing high proportional net sown area than national average includes Punjab, Haryana, West Bengal, Uttar Pradesh. Against this, the share of NSA is less than one half of the national average in states of Himachal Pradesh, Uttarakhand, Meghalaya, Manipur, Nagaland, Mizoram, Sikkim and Arunachal Pradesh. All these states suffer from physical infirmities such as undulating terrain due to hilly topography, limiting the availability of plain land and fertile soils, important for cultivation.

(ii) Forest Area: Approximately 72 million hectares, or 23.45 % of the country's total area, are covered by forests. The forest area has grown from 40 million hectares in 1951 to 72 million hectares in 2021. A nation's forest cover should make up at least 33% of its entire geographical area in order to maintain ecological balance. Mizoram, Arunachal Pradesh, Meghalaya, Manipur and Nagaland states have comparatively higher percentages of their land covered by forests.

Table 21.1: Particulars of Land Use Statistics in India (2020-21)

Category	**Area (in thousand hectares)**	**Percentage**
Forests 71978.56	23.45	
Area put to non-agricultural uses	27725.52	9.03
Barren & unculturable land	16683.89	5.43
Permanent pastures & other grazing lands	10326.68	3.36
Land under Misc. tree Crops	3012.25	0.98
Culturable Wasteland	11905.35	3.88
Fallow Land Other than Current Fallows	10818.25	3.52
Current Fallow	12985.98	4.23
Net Area Sown	141544.18	46.11
Total Cropped Area	216106.92	70.39
Area sown more than once	74562.74	—
Reporting area for land utilisation statistics	306981	—
Total Geographic area	328747	

Source: https://desagri.gov.in

(iii) Land Not Available for Cultivation: This category includes arid areas as well as the area beneath towns, highways, quarries, and mines. A few examples of arid regions are the sandy wastelands of Rajasthan, the marshy regions of Kutchh (Gujarat), and the rough, eroded regions of the northeast and northern Himalayas. As of 2021, this category includes about 14.46 percent of the total reported area. The states Assam, Manipur, and Nagaland comprising extremely high percentages of land that could not be used for farming.

(iv) Fallow Lands: Fallow land is defined as land that has not been exploited to restore its fertility naturally. The following usability criteria allow for the division of lands into two groups: current and old. Land that has not been planted with crops this year is considered current fallow. Old fallow land is left fallow for a year or more, but no longer than five. This is caused by a number of small and marginal farmers' poor ability to invest in cutting-edge technology, ignorance, soil fertility loss, insufficient rainfall, a lack of irrigation facilities, etc. The fallow land occupies about 7.75 per cent of the total reported area (as of 2021). The states of Mizoram, Tamil Nadu, Meghalaya, Bihar, Andhra Pradesh and Rajasthan have a high percentage of area under fallow land. It is to be noted here that old fallow land may not be economically important but from ecological point of view fallow land is important category of land.

(v) Cultivable Waste: It is the land in which crops were raised for some period of time but has not been cultivated for the last five years due to certain deficiencies such as alkalinity and salinity in the soils. Such cultivable waste is locally known as reh, bhur, usar, and khola in some parts of North India. The land under cultivable waste accounts 3.88 percent (as of 2021). The states Maghalaya, Himachal Pradesh and Rajasthan have a very high share of cultivable waste land in total land use.

(vi) Permanent Pastures and Grazing Lands: Nevertheless, the highest livestock population in the world, India has only less than 3.36 per cent of the country under pastures and grazing lands (as of 2021). The states with more than 5 percent of area under this category include Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Gujarat and Rajasthan.

21.3 Agriculture Land Use

The agricultural land use includes the net sown area, current fallows and land under tree crops and groves. The agricultural land in India is more than 60 per cent of the total geographical area in the country. The area under arable land accounts 52.8 per cent, while land under permanent crops is 4.2 per cent. This is the highest share of land in any country in the world. But due to large size of population in India, per capita arable land is available only 0.10973 hectares in 2021 (according to World Bank Estimations), which is lower than the world average (0.24 hectares). As per the latest information available from Agriculture Census, the average size of operational holdings has decreased from 2.28 hectares in 1970-71 to 1.84 hectares in 1980-81, to 1.41 hectares in 1995-96 and to 1.08 hectares in 2015-16. In selected nations, they have substantially more per capita agricultural land than India. It is 2.8 hec in Australia, 1.35 hec in Canada, and 0.33 hec in Brazil. The lower per capita availability of land is an indicator of high pressure of population on land resources.

Increasing land productivity is the best option to feed the expanding population, as there is little room for expanding the area under cultivation. The area that has been sown more than once has increased with time, amounting to around 15%. Cropping intensity is the number of seeding times that is sowed on the same plot of land more than once in a year. This represents the proportion of net sown area to gross cropped area. Increasing agricultural intensity requires the employment of innovative technology, fertilisers, high-quality seeds, and irrigation systems. The so-called "Green Revolution," which includes HYV seeds, synthetic fertilisers, and artificial irrigation, is likewise nothing more than a technology package. Following India's adoption of the Green Resolution in 1966, there has been a notable shift in the utilisation of agricultural land.

21.4 Major Types of Agriculture

At present, India has the second largest crop production worldwide, and over 60% of the labour force works in agriculture related activities. But as the nation's population rises, India finds it more challenging to provide the nation's growing need for staple foods like paddy and wheat.

On basis of water supply or rainfall, land availability, purpose of production and market, agriculture in India can be classified into different types. Several agriculture types can be identified on the basis of above parameters.

On the basis of water supply or rainfall, agriculture can be divided into three types as the following:

(i) Dry Land Agriculture: This kind of agriculture is done in regions where the annual precipitation is less than 80 cms. Farmers in these areas typically depend on rainy seasons. The earth has low moisture content here. As a result, a year can only have one harvest. Important crops grown under this method of agriculture include millets such as pulses, ragi, jawar, and bajra. This category of agriculture is practicing in the states of Rajasthan, Maharashtra, Southern Haryana, Madhya Pradesh, sections of Gujarat, and Karnataka. In order to boost their limited farm incomes, farmers in these areas turn to subsidising industries like dairy and cattle farming.

(ii) Wetland Agriculture: this type of agriculture is done in alluvial soil regions with annual average rainfall above 200 cm. Here, there is enough moisture in the soil to support the growth of multiple crops in a given year. The principal crops grown in this form of agriculture are rice and jute. This agriculture is practicing in the states of West Bengal, Assam, Nagaland, Meghalaya, Tripura, Manipur, Mizoram, and the Malabar coast.

(iii) Irrigation Agriculture: This kind of agriculture is practiced in regions with an 80–200 cm average rainfall, which is insufficient for some crops. Only places with year-round access to sufficient subsurface or surface water supplies, such as lakes, rivers, and tanks, are suitable for this type of agriculture. Steamrolled agricultural land must be available as a prerequisite for this agriculture. The principal farming regions include the deltas of peninsular rivers, northwestern Tamil Nadu, Punjab, Haryana, and Uttar Pradesh. There are other significant areas of irrigation agriculture in the Deccan Plateau, specifically in the states of Maharashtra, Karnataka, and Andhra Pradesh. The three principle crops grown in this agriculture are sugarcane, paddy, and wheat.

Based on the land availability, agriculture can be classified into two types, (a) Intensive agriculture and (ii) Extensive agriculture.

(a) Intensive Agriculture: This type of farming is practised in India's heavily populated areas. It is an endeavour to maximise the land's productivity by making every effort possible. It can raise more than one crop annually, but it takes a significant amount of effort and capital.

(b) Extensive agriculture: This type of agriculture is modern farming that can be seen mainly in the developed countries and in few regions of India. This agriculture mainly depends on modern machines as opposed to a human labour force and produce a single crop per year.

Agriculture practice can be categories into four groups, on the basis of purpose of production and market, as in the following:

(1) Subsistence Agriculture: In many regions of India, this is one of the most widely used agriculture methods. The farmer grows grains for their own consumption or to sell at the neighbourhood market with his family. The majority of the agricultural labour on the farm is done by hand, and the whole family is employed there. The farmers in their modest farms use traditional farming techniques. Poor farmers typically lack access to resources like irrigation and electricity, so they don't utilise high-yielding seed kinds and fertilisers in their fields as much as they might.

Shifting Agriculture: This way of farming is widely used by the tribal groups to grow crops. Firstly, the land is obtained by clearing a forested area and then crops are planted. While the land loses its fertility, another area of land is cleared and the crops are shifted there. The commonly grown crops in this type of farming are dry paddy, maize, millets and vegetables. This practice is known by different names in different regions of India. For example, it is called Jhum in Assam, Ponam in Kerala, Podu in Odisha, Bewar, masha, penda, and bera in Madhya Pradesh. But since it causes extensive soil erosion, the government has tried to discourage this practice of cultivation by tribal population.

(2) Commercial Agriculture: In this type of agriculture, the farmers produce crops mostly for the market. Generally, in this agriculture those crops are grown which are used as raw materials for industries. The examples of this agriculture, cultivation of sugarcane in Uttar Pradesh and Maharashtra; cotton in Gujarat, Maharashtra and Punjab; and Jute in West Bengal etc.

(3) Plantation Agriculture: Plantation agriculture refers to the carefully planned and supervised large-scale production of a single crop. It necessitates significant expenditure on cutting-edge technology and effective administration. Rubber, tea, and coffee are a few crops grown on plantation agriculture. This type of agriculture is predominant in Assam, West Bengal, and the slopes of Nilgiri hills.

(4) Mixed Agriculture: It refers to a system of raising agricultural crops and the rearing of livestock. Contrarily, multiple farming describes the practise of cultivating various crops in one field. Typically, two distinct crops that are at various stages of maturity are displayed in order to compete with one another for nutrients and growing time. For instance, wheat and mustard, wheat and gramme, etc. This kind of farming strategy is practised in areas with adequate irrigation infrastructure and high rainfall forecasts. This agricultural method reduces the overall loss caused by drought, illness, and pests. Because of nitrogen fixation, it also aids in preserving the fertility of the soil.

21.5 Cropping Pattern in India

It refers to the proportion of area under diverse crops at a point of time, changes in this distribution overtime and factors influencing the changes. Cropping pattern in India is determined primarily by soil type and climatic factors i.e. rainfall and temperature. They are reflected India's cropping patterns and agricultural practises. Owing to its large geographical area, India has three main agricultural seasons: Rabi, Kharif, and Zaid. A variety of food and non-food crops are grown in these seasons in India.

(i) **Kharif Crops**: The crop south-west monsoon seasons are called kharif crops. They are also known as monsoon crops. These crops are usually seeded at the beginning of July's first rain and are harvested in October. Major Kharif crops in India include Millets (Bajra and Jowar), Cotton, Soja, Sugarcane, Turmeric, Paddy (Rice), Maize, Moong (Pulses), Groundnut, Red Chillies etc.

(ii) **Rabi Crops**: The crops sown in north-east monsoons or grow in winter are called rabi crops or winter crops in India. They are sown in October and harvested in March every year. The main crops grow in rabi season includes wheat, barley, mustard, sesame, peas etc.

(iii) **Zaid Crops**: These are the crops that grown between rabi and kharif seasons i.e. from March to June in some parts of the country. The important crops grown in this season includes Muskmelon, Watermelon, Cucurbitaceous family vegetables such as bitter gourd, pumpkin, ridged gourd and other crops.

21.6 Major Crops in India

In India, a variety crops are grown in different regions, based on the variations in soil, climate and cultivation practices. The major crops grown in India can be classified into four categories, as the following:

(A) Food Crops – they include wheat, paddy, maize, millets and pulses.

(B) Cash Crops – they are also known as industrial or commercial crops. they encompass cotton, jute, sugarcane, tobacco and oilseeds.

(C) Plantation Crops- they are tea, coffee, coconut and rubber.

(D) Horticulture crops – fruits, vegetables and floriculture.

A. Food Crops

Food crops are those that are cultivated with the intention of feeding human population. Numerous food crops are cultivated across India. Now let's discuss a few of the main food grains.

(i) Paddy: Paddy is a tropical crop. India ranks second in the production of paddy in the world, next only to China, contributing one-fifth of global output. This crop covers over 23% of all the country's cropped land. This crop is grown in kharif season. Paddy is cultivated, in regions which receive more than 125 centimetres of rainfall annually. It requires high temperatures ranging between 20^0–25^0 C degrees. With the use of irrigation, it is even produced in regions with less than 125 cm of annual rainfall. Ideal soils to grow paddy are deep fertile loamy or clayey soils. It requires skilled and cheap labour for sowing and transplantation.

Currently, irrigation covers 51% of the land used to grow rice. Paddy crop is produced in almost all parts of country, the leading producing states are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Tamil Nadu, Telangana, Bihar, Orissa and Assam. Total production of paddy during 2019-20 is estimated at record 117.94 million tons. It is higher by 8.17 million Tons than the five years' average production of 109.77 million tons. Major paddy producing states are shown in the given Map.

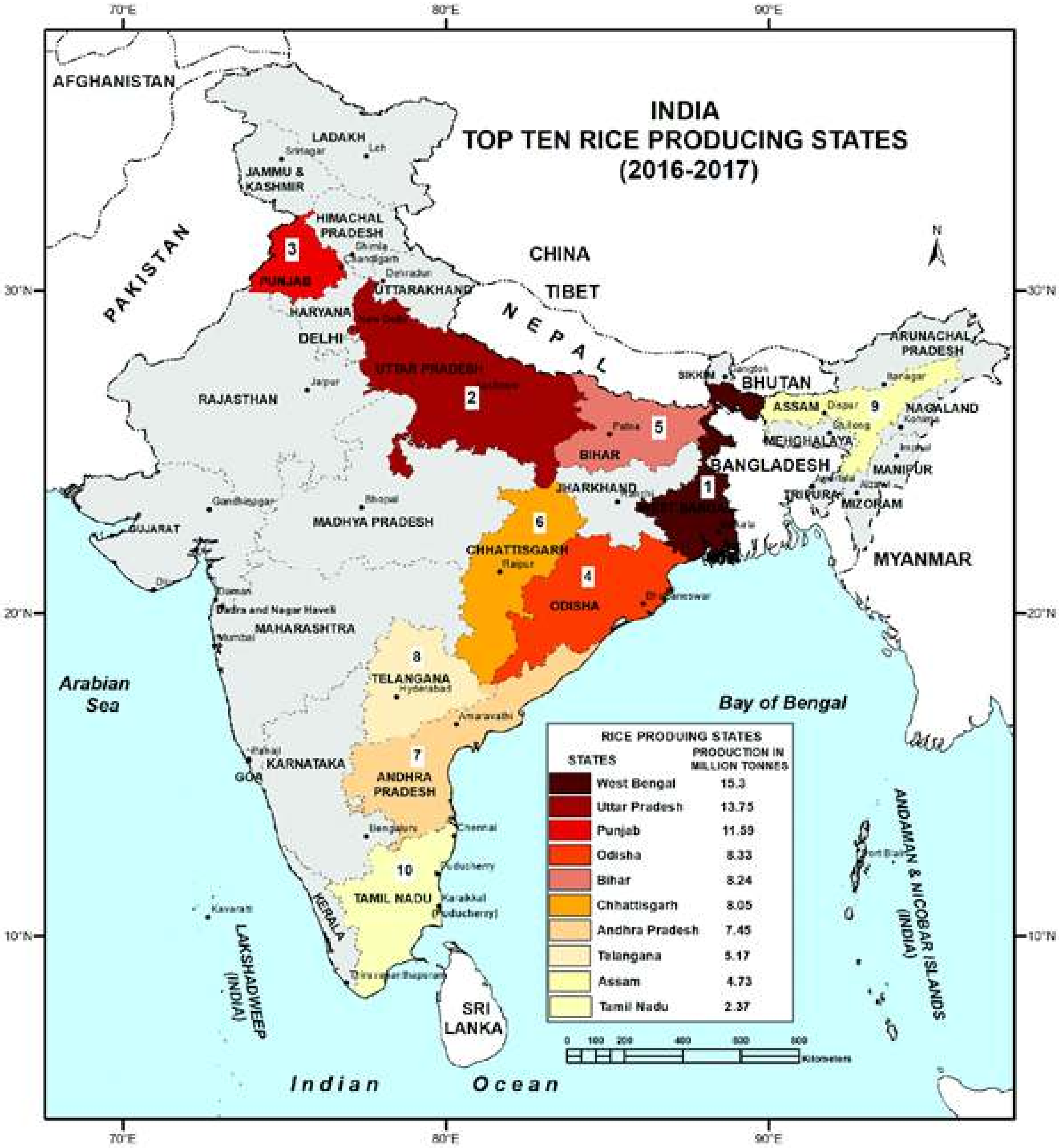

Fig21.1 Major Paddy Producing States of India

(ii) Wheat: Wheat is the main cereal crop of India. Basically, this is subtropical crop grown in the winter season in India. It is grown in rabi crop season, while paddy is sown in kharif season. In India, wheat crop stands second position after Paddy among food crops. About 29.8 million hectares of land is under this crop cultivation in India.

Cool weather with moderate rainfall is ideal for wheat crop. It grows well in the northern plains of India during winter season when the mean temperature is between 10^0 and 15^0 C. Well drained loamy soil is ideal for wheat cultivation.

Major wheat producing states in India are Uttar Pradesh, Punjab and Haryana. They accounted for 60 per cent of total area under wheat. Other important wheat growing states are Rajasthan, Bihar, Madhya Pradesh and Maharashtra. After Green Revolution introduced in 1966, the wheat production in the country showed maximum increase. Wheat production in India during 2019-20 was estimated at 107.18 million tons. It has grown by 3.58 million tons as compared to wheat production during 2018-19.

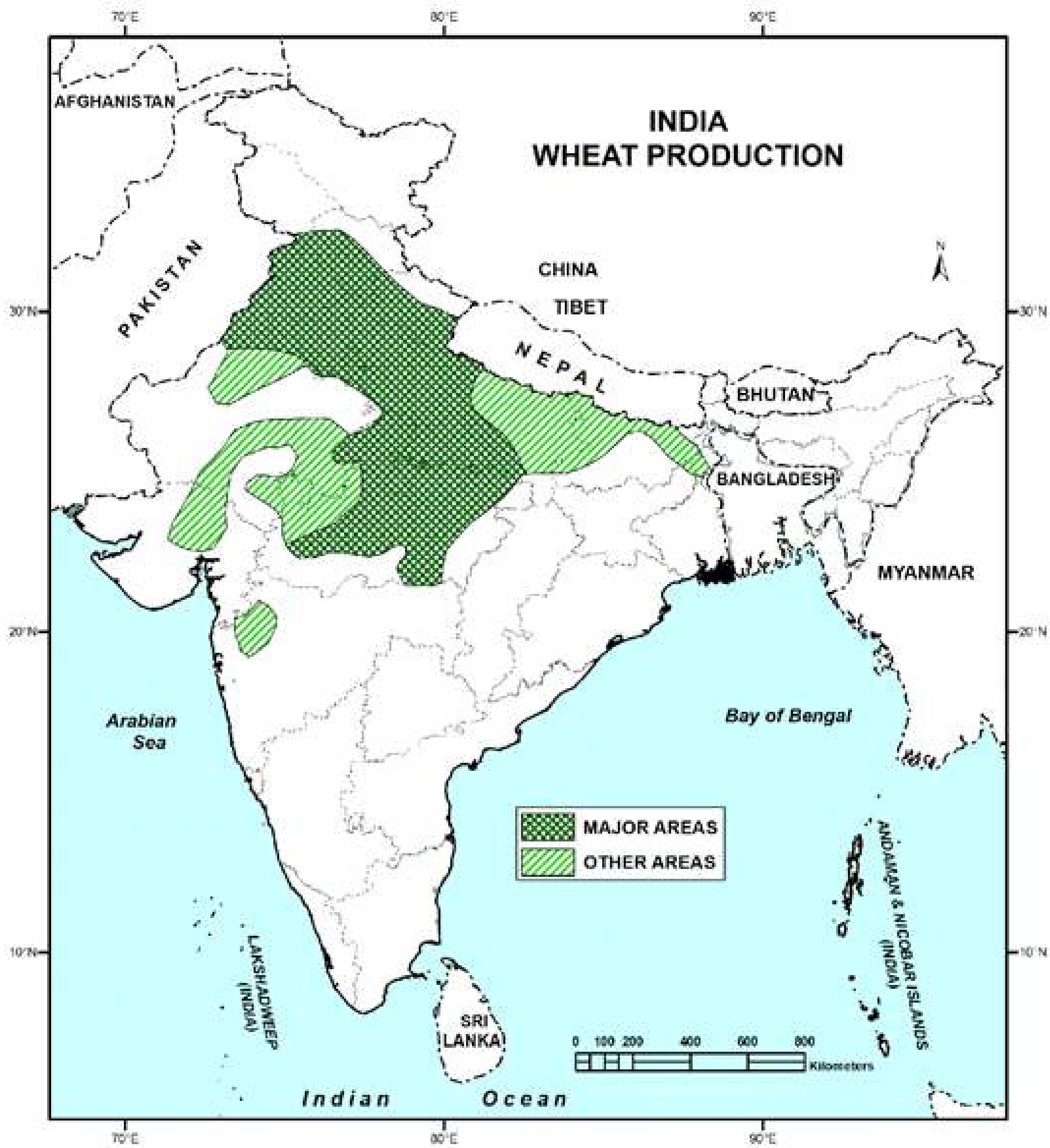

Fig 21.2: Wheat Producing Areas in India

B. Cash Crops

(a) Cotton: India stands among the world's top producers of cotton. While the oil derived from the cotton crop's seeds is used in the vanaspati industry, the crop's fibre is used as a raw material for the textile industry. Cotton seeds are also used as a cattle feed.

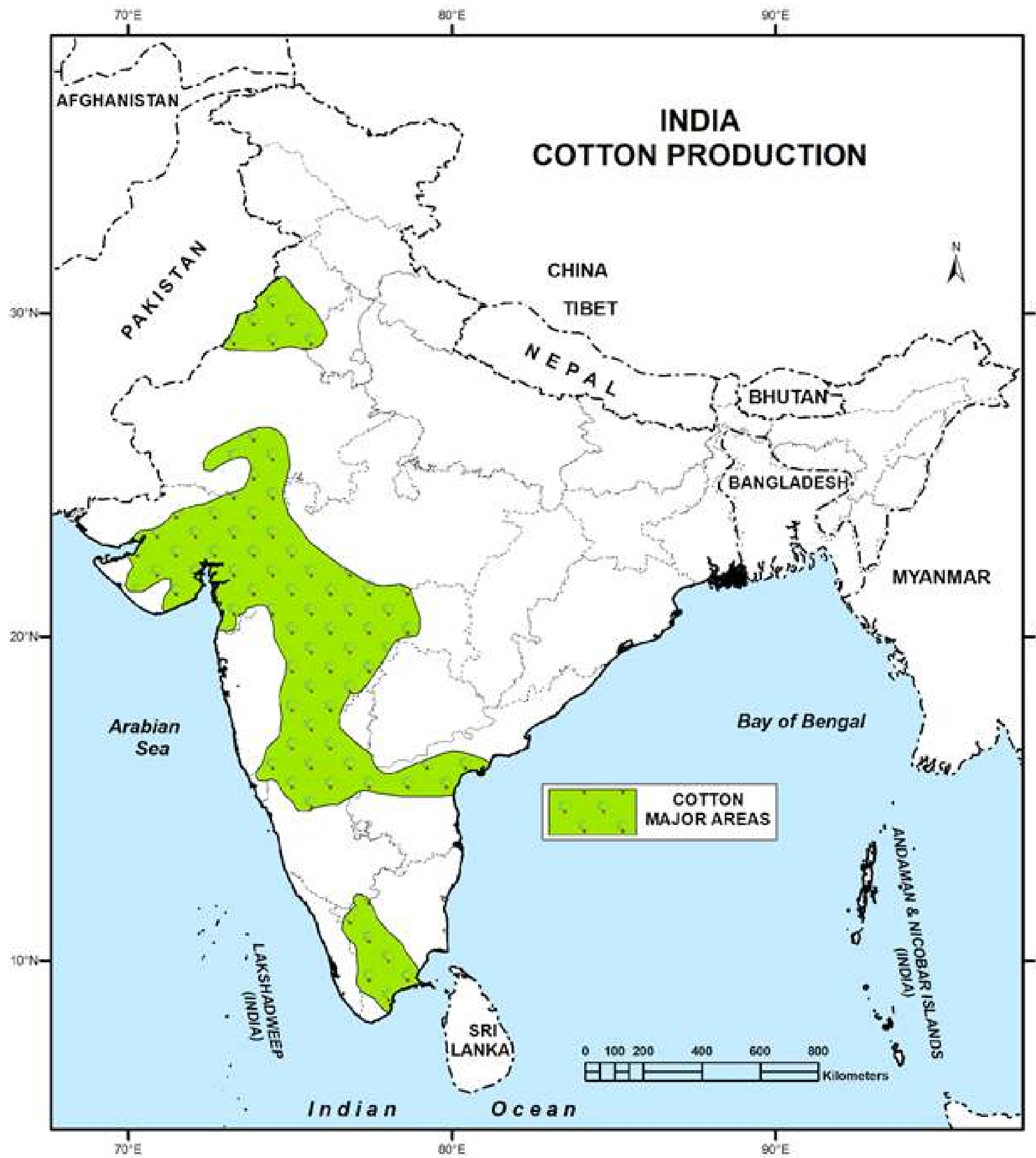

Fig.21.3: Cotton Producing Areas in India

Cotton crop grow in the areas with moderate rainfall of 75 cms. It needs a cloud free weather for about 150 days at the time of flowering and ball opening. It grows in areas with a minimum of 210 frost free days in a year. The well drained black soils of the Deccan Plateau ware considered ideal for its cultivation, though it is also grown on alluvial soils of the northern plains. Cotton grows well in black soils of Deccan and Malwa plateau and also in Satluj-Ganga plain having red and laterite soils of the peninsular region. Leading producers of cotton in India are Gujarat, Maharashtra and Telangana.

(b) Sugarcane: Sugarcane is the native plant of India.

The world's largest area cultivated under sugarcane crop is situated in India. This crop needs sub-humid and humid climates. If there is insufficient rainfall, an irrigation system is necessary. Black soils and fertile loamy soils are best for this crop.

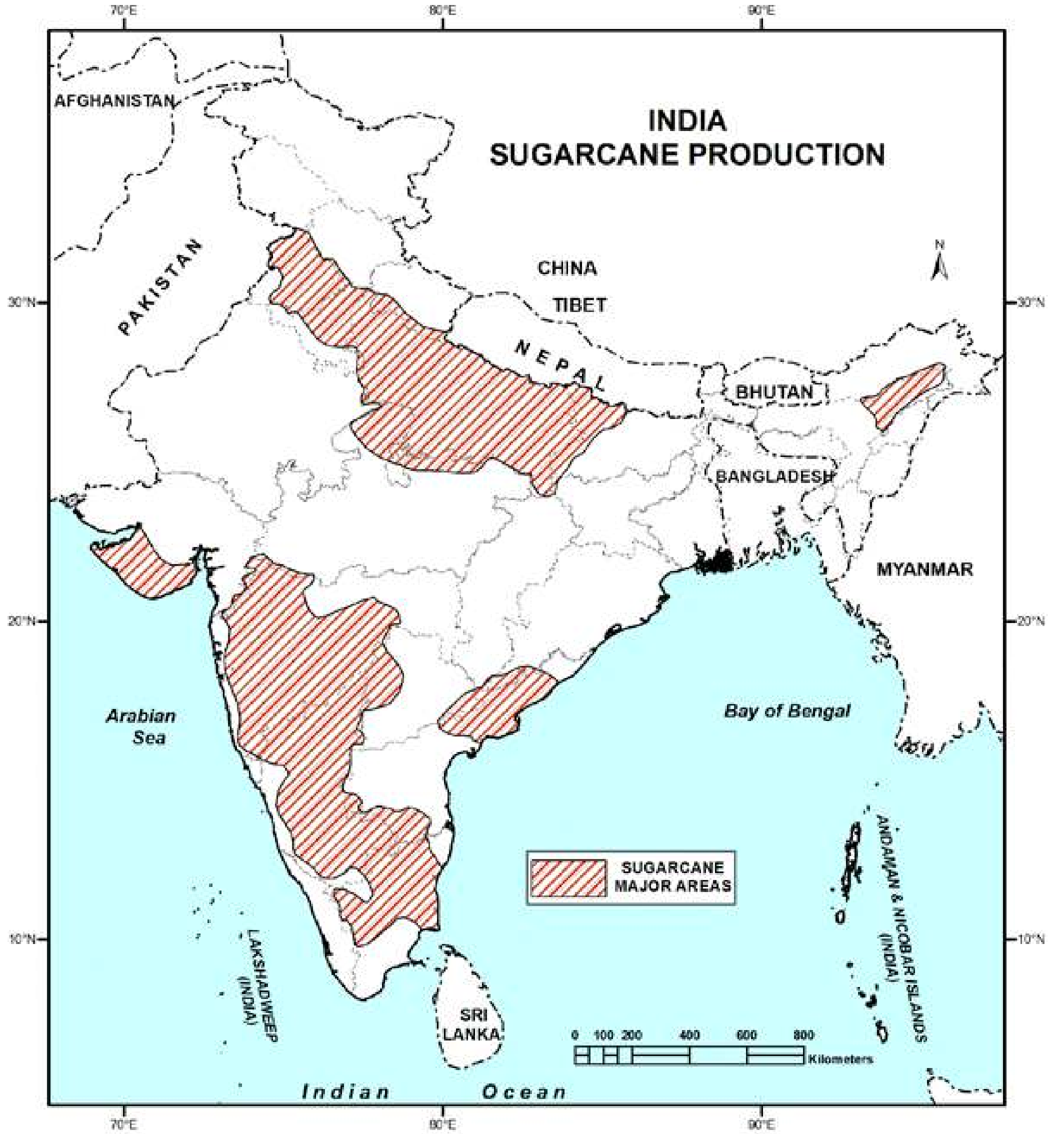

Fig.21.4 Sugarcane Producing Areas in India

In India, sugarcane is grown in two belts; (i) in Northern Plains from Punjab to Bihar, and (ii) in Peninsular India from Gujarat to Tamil Nadu, Maharashtra, Karnataka, Telangana and Andhra Pradesh. The North Plains include more than 60% of the total area under sugarcane cultivation. In comparison to North India, South India has a larger sugarcane yield per unit area. India is the second largest producer of sugarcane after Brazil in 2015. It accounts for about 19 percent of the world production of sugarcane. But it occupies only 2.4% of the total cropped area in the country.

C. Plantation Crops

(i) Tea: Tea is a plantation crop which is used as a beverage. India is the leading producer and consumer of tea in the world. By exporting tea, India earns a substantial amount of foreign exchange. The mountain slopes are ideal for tea plantation, which are receiving large amount of rainfall i.e. above 150 cms. Tea plantation grow much in well drained deep loamy soils and rich in humus.

Major producing areas are on the hilly slopes of Surma and Brahmaputra valleys in Assam and Darjeeling and Jalpaiguri districts of West Bengal. In south India, tea plantation is restricted to the Annamalai and the Nilgiri mountains.

(ii) Coffee: It is a tropical plantation crop. The seeds of coffee are roasted, ground and are used for preparing a beverage. This crop grows in hot and humid climates. Coffee grows in areas with temperatures ranging from 15°C to 28°C. Ideal soils for coffee plantations are rich loamy soil with humus and minerals. Major coffee producing areas in India are the highlands of Western Ghats in Karnataka, Kerala and Tamil Nadu.

D. Horticulture

(a) Fruits: Approximately 10% of the world's fruits production is formed in India. India is leading producer of Mango, banana, sapota, and lemon in the world. In India, a wide range of fruits are produced. Tropical and subtropical fruits include mangoes, bananas, citrus fruits, pineapple, papaya, guava, sapota, jack fruit, lichi, and grapes. Apple, pear, peach, plum, apricot, almond, and walnut are fruits of temperate regions that are primarily grown in the mountainous regions in India. The important fruits of the arid zone of India are Amla, ber, pomegranate and figs.

(b) Vegetables: India is the world's second-largest producer of vegetables, next to China. It makes up roughly 13% of the world's total vegetable production. India ranks first in the world for producing cauliflowers, second for onions, and third for cabbage. Potatoes, peas, tomatoes, and bringal are some other important vegetable crops of our country. In India, more than fifty types of vegetables are produced.

(c) Floriculture: International trade in fruits, vegetables, and flowers has increased in profitability as trade restrictions have been lifted in the post-globalization period. India is able to export flowers and make a substantial quantity of foreign exchange. Large areas of Karnataka, Tamil Nadu, Andhra Pradesh, Rajasthan, West Bengal, Maharashtra, Delhi, Uttarakhand, Assam, and Manipur are producing various flowers including roses, jasmine, marigold, chrysanthemum, tuberose, and asters.

Check Your Progress

(i) Classify the agriculture based on availability of land?

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(ii) What are the three agricultural seasons in India? Explain.

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21.7 Agriculture Development in India

Development of agricultural is essential for the economic growth of India, because it is not only contributing an important share to the national income but also a major source of livelihood for major working population in our country. Besides, agriculture provide raw materials for industrial production and saving and tax revenue to support development of the rest of the economy, to earn foreign exchange and to provide a growing market for domestic manufactures. Development of agriculture indicates generous support to farmers by providing them various agricultural supports. Agriculture development includes security, helping in the research area, usage of advanced techniques, checking pests and giving support to cropping diversity.

At the time of Independence, partition of Indian sub-continent on communal lines, resulted among others in acute shortage of food and raw material for her industries. During British India, there was neither progress in the agricultural division nor equity. The agriculture in India during five-year plans has registered a phenomenal growth. In order to solve these issues, the leadership and decision-makers of independent India promoted the adoption of "High Yielding Variety" (HYV) seeds and implemented land reforms, which helped spark an agricultural revolution in India.

(i) Agricultura Development during Five Year Plans: In the first five-year plan (1951-56) the important priority was accorded and 31.1 % investment of total plan funds were allocated to agriculture sector. River valley projects were initiated, irrigational facilities and fertilizer plants had been started. The second Five Year Plan (1956-61) was given second priority after industrial sector and only 20.6 % of total investment of the plan allocation was given to agriculture. In third Five Years Plan (1961-66), 20.5 % of total plan outlay was allocated to agriculture. The priorities were on self-sufficiency in food grains, meeting the raw material needs of industries. In this plan period, Green Revolution programme on small scale, Intensive Agricultural District Programme (IADP), and Intensive Agriculture Area Programme (IAAP) were stated. The Fourth Plan (1969-74) allocated 24 % investment of the total plan outlay to agriculture sector and this plan aimed at 5 per cent annual growth in food grains. High Yielding Variety (HYV) of seeds, fertilizer use, new agriculture techniques and irrigation facilities provided to expand area of Green Revolution. In the Fifth Plan Period (1974-79), 20.5% of the plan outlay was allocated to agriculture and the stress was laid on the extension of irrigation, expansion in cultivated area under HYV seeds and grant of loans and subsidies to farmers. The Sixth Plan (1980-85) allocated 23.65 % of the total plan outlay and the main focus was on land reforms, use of HYV seeds, chemical fertilisers and groundwater resources and improving post-harvest technology as well as marketing and storage facilities.

Agriculture sector was allocated a 22% the total plan outlay and the highest growth in food-grain, pulses and coarse cereals was recorded in the Seventh Plan (1985-90).

Foodgrain output showed a tendency towards stagnation during the Eighth Plan (1992–1997), but oilseed production increased quickly. The Nineth Plan (1997–02) had varying degrees of success. There were variations in the yield of cereal grains. The National Agricultural Policy, 2000, was developed during this plan period, and a number of initiatives were unveiled, including agricultural credits, horticultural development, watershed control, and a crop insurance programme. Sustainable management of water and land resources, rural infrastructure development to assist agriculture, technology dissemination, finance flow to the agriculture sector, and agricultural marketing reforms are the main areas of concentration for the Tenth Plan (2002-2007).

(ii) Land Reforms: Land reforms refer to agricultural equality, which includes in landholding ownership. Redistribution of land from the rich to the poor is typically associated with land reform. In a deeper sense, it encompasses land ownership, sales, leasing, operating control, and inheritance. The idea of land reforms has evolved in recent years to recognise the strategic importance of land and agriculture to development. As a result, land reform is now synonymous with agricultural transformation or the quickening evolution of the agricultural system. The land tenure system, farm organisation, farming practises, farming scale, tenancy periods, and rural credit, marketing, and education systems are all part of this structure. It covers cutting-edge technology as well.

(iii) Green Revolution : It refers to "a period when **Indian Agriculture was converted into an industrial system** due to the **adoption of modern methods and technology** such as the use of HYV seeds, tractors, irrigation facilities, pesticides and fertilizers". After independence, economy of India had to be rebuilt. More than 75% of people were reliant on agriculture in one manner or another. However, there were a number of issues with Indian agriculture. First of all, the lack of irrigation and other infrastructure made Indian agriculture dependent on the monsoon and resulted in extremely low grain output. India had experienced catastrophic famines in the past when the British government pushed cash crops above food crops. The plan was to never rely on another nation for enough food. Thus, the Green Revolution was started in 1965 by the government with assistance from Indian geneticist M.S. Swaminathan, who is regarded as the founder of the movement. The movement was a huge success and contended from 1967 to 1978. Because obsolete technology was being used, relatively little was produced in the agricultural sector. When High Yielding Variety (HYV) seeds were introduced to Indian agriculture in 1965, the Green Revolution officially began. This was combined with more effective and efficient irrigation as well as the proper use of fertiliser to accelerate crop development. The production of food grains in India rose as a result of this agricultural development plan. This encouraged the growth of several small-scale companies, agro-processing industries, and agricultural inputs. With regard to the production of food grains, India became self-sufficient thanks to this approach to agricultural growth.

Impact of Green Revolution

a) **Increase in Agricultural Production:** The yield of food grains increased significantly in India. It was an impressive rise. The wheat crop was the plan's main benefit. The production of wheat increased from 11 million tons in 1960 to 55 million tons in 1990.

b) **Increase in Per Acre Yield:** In addition to increasing agricultural output, the Green Revolution also raised yield per hectare. The production of wheat increased from 850 kg/hectare in 1960 to 2281 kg/hectare in 1990.

c) **Less Dependence on Imports:** Following the green revolution, India was at last headed towards economic independence. The people were fed adequately, and there was also a reserve of food for emergencies. We didn't have to rely on other nations for our food supply or import cereals. In actuality, India was allowed to begin exporting its farm products.

d) **Employment:** Many people in the labour sector were worried about becoming unemployed as a result of commercial farming. However, we did witness an increase in employment in rural areas. This is as a result of the employment opportunities generated by the supporting industries. The industries of marketing, food processing, irrigation, and transportation all produced new jobs for labourers.

e) **Benefit to the Farmers:** Farmers were the main beneficiaries of the Green Revolution.

Their earnings increased significantly. They were not just making it through, they were thriving. It made it possible for them to move from solely sustenance farming to commercial farming.

(iv) White Revolution

The White revolution in India, commonly referred to as "Operation Flood," is the movement linked to a dramatic rise in milk output in the nation. India was supposed to become a milk-producing nation independent during the White Revolution. India is currently the world's leading milk producer, and Dr. Verghese Kurien is regarded as the founder of the White Revolution in that country. In order to support the white revolution in India, the Intensive Cattle Development Programme was implemented in 1964–1965. Under this programme, cattle owners received a range of better animal husbandry practises. The National Dairy Development Board subsequently unveiled a brand-new initiative called "operation flood" in an effort to quicken the nation's white revolution.

The goal of Operation Flood, which was launched in 1970, was to establish a national milk grid. The National Dairy Development Board of India (NDDB) launched this rural development initiative. The operation flood was started by the cooperatives of village milk producers. With the optimum use of modern technology and management, they procured milk and provided the services. White Revolution had the objectives as stated below:

- Creating a flood of Milk by Increase production
- Increase the incomes of the rural population
- Provide milk to consumers at fair prices

Importance of Operation Flood Project

(a) The White Revolution in India helped in reducing malpractice by traders and merchants. It also helped in eradicating poverty and made India the largest producer of milk and milk products.

(b) Operation Flood empowered the dairy farmers with control of the resource created by them. It helped them in directing their own development.

(c) To connect milk producers with the consumers of more than 700 cities and towns and throughout the country, a 'National Milk Grid' was formed.

(d) The revolution also reduced regional and seasonal price variations ensuring customer satisfaction and at the same time. Also, it ensured that the producers get a major share of the price that customers pay.

(e) Improved the living standards of the rural people and led to the progress of the rural economy

(v) Blue Revolution

The Central Government of India, has sponsored the Fish Farmers Development Agency (FFDA) during the 7th Five Year Plan (1985–1990), which marked the beginning of the Blue Revolution in India. The Intensive Marine Fisheries Programme was then started during the 8th Five Year Plan (1992–1997), and over time, fishing harbours were also created in Visakhapatnam, Kochi, Tuticorin, Porbandar, and Port Blair. Through the expansion of fisheries, the Nili Kranti Mission sought to improve India's economic standing and so provide food and nutritional security. The utilisation of the water resources for the development of fisheries was done by the Neel Kranti Mission in a sustainable manner.

New methods of fish breeding, selling, exporting, and rearing have been introduced by the Fish Farmers Development Agency (FFDA) and the Blue Revolution in India, which has improved the aquaculture and fisheries industry. The following is a list of some of the principal results of the Indian Blue Revolution:

- Currently, the Indian Fisheries Sector reached a production of 4.7 million Tons of fish from a limit of 60,000 tons including 1.6 million tons of fish from freshwater aquaculture.
- India is recorded to achieve an average annual growth of 14.8% as compared to the global average percentage of 7.5% in the production of fish and fish products.
- The fishery has become India's largest agricultural export over the last five years with a growth rate of 6% - 10%.
- India has become the world's second-largest producer of fish with exports worth more than 47,000 crore rupees.
- The fisheries and aquaculture production contributes 1% and 5% to India's GDP and Agricultural GDP respectively.

21.8 Globalization and Agriculture in India

Globalisation refers to the process of integrating a nation's economy with the global economy. This refers, in the Indian context, to opening up the economy to foreign direct investment in various economic fields, removing barriers to Multi National Companies' (MNCs') entry into India, permitting Indian businesses to engage in international collaborations, promoting the establishment of joint ventures overseas, lowering import duties, and opening up the Indian market to the rest of the world.

Impact of Globalization on Agriculture: The professionals have divided on the influences of globalization on agriculture. They claim that as a result of rising agricultural commodity prices globally, a decline in the large farm subsidies given by Western nations, and the removal of trade barriers, India will gain from more export opportunities. Given that many significant programmes, including subsidies for the Public Distribution System (P.D.S.) and agriculture, are excluded from the W. T. O. Agreement's control, it is unlikely that the prices of agricultural products in India will rise. The primary reason for this is that India's agricultural subsidies fall short of the ten percent threshold for the value of the items they support. India is also among the world's lowest-cost producers of agricultural products due to its skilled workforce force and low labour costs. As such, there will be a sizable global market for these goods. Furthermore, it's also claimed that higher agricultural expansion in India will result from improved trade conditions favouring agriculture.

These assertions, however, are questionable on the following reasons:

(i) Due to globalization, the Indian farmers might have to face much unstable prices of agricultural products as world prices for these products fluctuate largely on year-to-year basis.

(ii) The impact of trade liberalizations on the prices of agricultural products at international level and domestic level depends on what policies other countries follow. For example, developed countries are not willing to reduce subsidies on their agricultural products, to keep these still cheaper to benefit their farmers.

(iii) Due to liberalization, MNC's engaged in agro-business would operate freely in India. For their strong financial background, they could produce hybrid varieties of seeds and the specialised agro-chemicals, using advance biotechnology. These hybrid seeds cannot be regrown or reproduced by the farmers as they are genetically modified to terminate after first use. Therefore, these seeds will have to be purchased every year from the MNCs for the monopoly they have over it under IPR (Intellectual Property Rights) regime.

(iv) There would be uneven distribution of income across social classes and geographical region due to effect of globalization on agricultural practices and trade. Rich regions or social groups will be richer in the country.

Check Your Progress

(iii) Define Green Revolution in India?

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(iv) What do you mean by Globalization?

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21.9 Summary

In India about 46.2 % per cent of its total area is under cultivation leaving very little scope for brining further land under cultivation. The agricultural land in India is more than 60 per cent of the total geographical area in the country. The area under arable land accounts 52.8 per cent, while land under permanent crops is 4.2 per cent**.** *There is need of increasing forest land for ecological balance. 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.*

In this lesson, we have attempted to learn about the land use pattern of India, cropping patters, types of crops and major crops grown in India. We have also focused on agricultural strategies adopted by government of India. Globalization has impacted economy of our country.

21.10 Check Your Progress – Model Answers

(i) Based on the land availability, agriculture can be classified into two types, (a) Intensive agriculture and (ii) Extensive agriculture.

(ii) Owing to its large geographical area, India has three main agricultural seasons: (a) Rabi, (b) Kharif, and (c) Zaid.

(iii) Green revolution in India refers to "a period when **Indian Agriculture was converted into an industrial system** due to the **adoption of modern methods and technology** such as the use of HYV seeds, tractors, irrigation facilities, pesticides and fertilizers".

(v) Globalisation refers to the process of integrating a nation's economy with the global economy.

21.11 Terminal Questions

Essay questions

1. Describe the land use pattern of India?
2. Describe the major food crops grown in India?
3. Explain the development of agriculture in India?

Short questions

4. Bring out the different types of crops grown in India?
5. Write a short note on White Revolution in India?
6. Give an account on impact of globalization on Agriculture in India?

Very short questions

7. Floriculture
8. Blue revolution
9. Father of green revolution in India
10. Expand HYV
11. Mention Cropping seasons in India

21.12 Further Readings

- D. R. Khullar, 2022, India A Comprehensive Geography, Kalyani Publications, India.
- India People and Economy, Text Book in Geography for Class XII, NCERT, 2022-23.
- Anil Keshri, 2023, Geography of India through maps, S Chand Publishing, New Delhi.
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Chapter - 22

MINERAL AND ENERGY RESOURCES

Contents

22.0 Introduction

22.1 Objectives

22.2 Role, importance and spatial distribution of minerals

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22.4 Energy and power resources

22.5 Conservation of mineral and energy resources

22.6 Summary

22.7 Check Your Progress – model answers

22.8 Terminal questions

22.9 Further Readings

22.0 Introduction

In the previous chapter you have learned about the agricultural resources of India and how farming aims in providing food security to human populations and determines the. Prosperity of a country. We have also learned about the natural resources of India. The development of a country cannot be attained without optimum use of resources. Of these resources Mineral resources like land and water are invaluable, industrialization is not possible without utilization of these resources and hence the development of our economy can be achieved by exploration and sustainable utilization of these resources. The overall development of a country depends on its capacity to utilize its natural resources. We need to understand the fact that minerals resources are not permanent and can get exhausted with time after use. These resources are non-renewable. Hence, the present generation should utilize these resources more judiciously, to safeguard them for future generations.

In this chapter, we will learn about some of the important mineral and energy resources, their significance and distribution and means of conservation of these minerals.

22.1 LEARNING OUTCOMES

Learning this lesson will enable students:

- To state the importance of mineral and energy resources in the development of country's economy;
- To gain the knowledge of the spatial distribution of different types of mineral resources;
- To be able to differentiates between conventional and non-conventional sources of energy;
- To describe the spatial distribution of various types of energy resources and
- To assess the sustainable development of non-conventional energy resources.

22.2 ROLE AND IMPORTANCE OF MINERAL AND ENERGY RESOURCES

India is a country with rich mineral deposits. It possesses great variety of minerals but all minerals are not economically significant. Only about 30 minerals have significance. Some of the major minerals are iron ore, coal, manganese, bauxite, mica etc. Felspar, fluorides, lime-stones, dolomite and gypsum etc. are other important minerals. Few minerals such as petroleum and some non-ferrous metallic minerals such as copper, lead, zinc, tin and graphite. are found abundant in Country.

India is a storehouse of more than 90 minerals, which are suitable for the growth of the industrial sector. India ranks 3rd in Chromite, 5th in Bauxite, 4th in Iron ore, 7th in manganese ore and the list goes on. The presence of huge reserves of minerals and their production in large quantities has made India not only self-sufficient but also enable the nation to earn huge foreign income by exporting them.

The same is true with energy resources. With technological advancement the production of energy resources has increased manifold. we cannot think about industrial development without optimum availability of energy resources. The total installed power generation capacity of India in 2022 was 410,339 MW. It includes 2,35,809 MW (57.5%) from fossil fuels and 1,74,530 MW (42.5%) from non-fossil fuels.

SPATIAL DISTRIBUTION OF MINERALS

Mineral resources are not equally distributed in India, due to its varied geological formation. For instance, the Gondwana formation is known for its coal deposits, metallic minerals are associated with Dharwad and Cuddapah. Most of the mineral rich states are found in the Southern plateau region of India. The three specific belts of mineral distribution in peninsular plateau region:

- **The North eastern plateaus:** It comprises of parts of chota nagpur plateau, Odisha plateau and eastern Andhra plateau. It has rich deposits of a variety of minerals, especially iron ore, manganese, mica, bauxite, limestone, dolomite etc. used for metallurgical industries. This region also has vast deposits of coal, along Damodar, Mahanadi, Son valleys.
- **South-western plateaus:** It comprises of parts of Karnataka plateau and Tamil Nadu plateau and has vast deposits of metallic minerals such as iron ore, manganese and bauxite and some non-metallic minerals. The three gold mines of India are found in this region.
- **North-western region:** It comprises of the gulf of Khambhat in Gujarat and extends to the Aravalli range in Rajasthan. Petroleum and natural gas are found in abundance

22.3 Classification of Minerals

Minerals are broadly classified into two types metallic and non-metallic minerals.

A. Metallic Minerals

These minerals sufficiently contain metal content. This group is further sub-divided into ferrous and non -ferrous minerals.

(i)Ferrous Metallic Minerals: Ferrous minerals are most important mineral groups. Iron, manganese, chromite, pyrite etc. are some of the important minerals in this group. The metallurgical industries, most significantly iron, steel and alloy industries are mostly dependent on these minerals.

Iron Ore: India has great reserves of excellent quality iron ore and it is one of the top countries of the world in iron ore production. It is estimated that India produces over 20 % of the world's total reserves of iron ore. The quality of iron ore depends on the iron content present in it. India possesses a very high grade of ore, which contains more than 60% iron content. Iron ore obtained in India is of three types: Hematite, magnetite, and limonite.

Hematite, also known as 'red ore' due to its red color, contains up to 68% of iron. The magnetite ranges from dark brown to blackish in color,' contains up to 60 % of the iron. limonite has an iron content of 35-50 % and is yellow in color.

We can find Iron ore deposits in almost every state of India. However, 96 percent of the total reserves are in Odisha, Jharkhand, Chhattisgarh, Karnataka and Goa. These states also account for 96 percent of the total production of iron ore in the country. About 3 percent of the country's total production comes from Tamil Nadu, Maharashtra and Andhra Pradesh.

Iron ore deposits are found in almost every state of India. Nevertheless, 96 percent of the total reserves are obtained in Odisha, Jharkhand, Chhattisgarh, Karnataka and Goa. These states account for 96% of the total production of iron ore in the country. About 3 % of the country's total production comes from Tamil Nadu, Maharashtra and Andhra Pradesh.

Distribution of Iron ore

S. No	STATE	PRODUCING AREAS
1.	Chhattisgarh	Bailadilla in Dantiwada and Durg District
2.	Jharkhand	Chiria in Singhbhum district and Palamau district
3.	Odisha	Keonjhar, Mayurbhanj, Sambalpur, Sundergarh, Cuttack, Koraput
4.	Karnataka	Bababudan hills in chikmanglur district, Bellary and Hospet, Shimoga and Chitradurg districts.
5.	Goa	North Goa
6.	Andhra Pradesh	Anantapur, Kurnool, Cuddapah and Nellore
7.	Maharastra	Ratnagiri and Chandrapur

Fig. .1 INDIA: Distribution of ferrous metallic minerals

(ii) Manganese Ore: India ranks seventh in the world (in 2019) in the production of manganese contributing about 5.13% of total world production, a major portion of which is exported. Manganese is one of the raw materials for manufacturing steel. It is also used for making dry batteries, in photography, leather and match industries.

Distribution

S. No	State	Producing Areas
1.	Odisha	Keonjahar, Mayurbhanj,Talcher, Sundergarh
2.	Madhya Pradesh	Balaghat and Chhindwara district
3.	Maharashtra	Nagpur and Bhandara districts
4.	Karnataka	Sandur, Shimoga, Chitradurg, Bellary
5.	Andhra Pradesh	Vishakapatnam, Vijayanagaram, Adilabad, Srikakulam
6.	Goa	Sanguem
7.	Rajasthan	Banswara, Udaipur, Pali

B. Non-Ferrous Metallic Minerals: The category of minerals which do not contain iron are non-ferrous minerals. These minerals include Gold, silver, copper, tin, lead, zinc etc... India is quite poor in production of such minerals.

Bauxite: Bauxite is a non-ferrous metallic mineral. It is the core of aluminium. India has self sufficient reserves of bauxite. Aluminium is used in making aeroplanes, electrical appliances and goods, household fittings, utensils etc.

Distribution

S. No.	State	Producing Areas
1.	Goa	Mopa , Pernum
2.	Odisha	Kalahandi, sambalpur
3.	Gujarat	Surat, kaira, Kutch
4.	Madhya Pradesh	Jabalpur, Balaghat
5.	Chattisgarh	Durg, Bilaspur

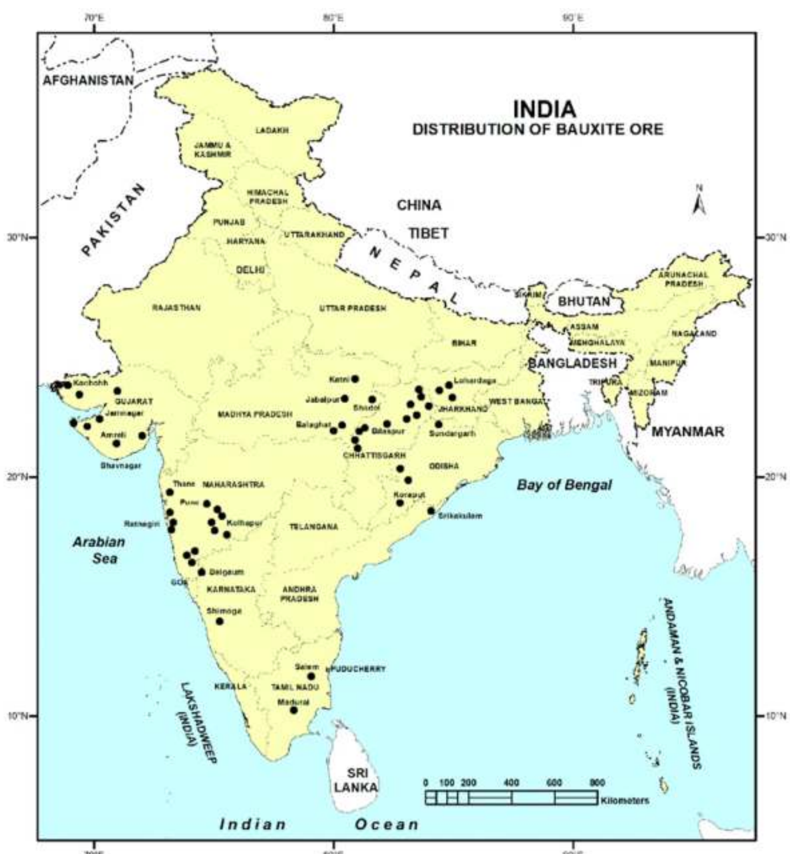

Fig. 18.2 INDIA: Distribution of Bauxite ore

India also has reserves of non-metallic minerals of which only a few are commercially important. Some of the important non-metallic minerals are limestone, dolomite, mica, kyanite, sillimanite, gypsum, and phosphate. These minerals are used in a variety of mineral based industries such as cement, fertilizers, and electrical goods.

Check Your Progress

(i) Mention the important mineral belts of India?

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(ii) What are the types of minerals?

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22.4 ENERGY AND POWER RESOURCES

Energy resources are quite essential for economic development and improving the standard of life. They aid modern living. The utilization of energy has been increasing. It is available in various forms in India.

There are several sources of energy. They are classified in different types. Mineral resources such as coal, petroleum etc are all non-renewable or exhaustible resources while water, the sun, wind, tides, hot springs, and biomass are all inexhaustible or renewable sources of energy. On the basis of its source and utility, energy can be categorised into two broad groups: (a) Conventional energy and (b) Non-conventional energy.

A. Conventional Sources of Energy

Conventional energy resources include coal, petroleum, natural gas etc

(i) **Coal:** Coal is the primary source of energy in India. It is utilized as fuel in industries, thermal power stations and for domestic use in some parts of the country. It is also used as a raw material in chemical and fertilizer industries.

Distribution

Indian coal occurs in two important types of coal fields. They are the Gondwana coal fields and Tertiary coal fields. Of these Gondwana coal fields contribute 98% and the rest 2% is produced by tertiary coal fields. Coal is distributed chiefly in the river valleys of the Damodar (Jharkhand - West Bengal); the Son (Madhya Pradesh-Chhattisgarh); the Mahanadi (Odisha), the Godavari (Andhra Pradesh and Telangana) and the Wardha (Maharashtra).

Tertiary coalfields are present in the extra-peninsular areas which include Assam, Meghalaya, Nagaland, Arunachal Pradesh, Jammu & Kashmir and Sikkim.

(ii) Petroleum: Petroleum is one of the most important minerals in our civilized world It is also referred to as liquid gold because of its value. All our sectors of economy are dependent on petroleum in several ways. The crude oil is a mixture of combustible hydrocarbons in solid, liquid, and gaseous forms. Petroleum and its by-products are used as fuel, lubricant, raw-material for manufacturing synthetics and chemicals required in industries. Petrol, kerosene, diesel, detergents, synthetic fibers, plastics, cosmetics etc. are important products derived from petroleum.

Distribution

Petroleum occurs in anticlines and fault traps. In India, it is found in the sedimentary rock formation. Most of such areas lie in the Assam, Gujarat and off shore areas along the western coast.

Most of the production comes from the Assam belt, Gujarat- Cambay belt and Bombay High. The Assam belt extends from Dehang basin in the extreme north-east of Assam along the outer flanks of hill ranges forming the eastern border of Bhitra and Surma Valley. The Gujarat-Cambay belt extends from Mehsana (Gujarat) in the north to the continental shelf off the coast right up to Ratnagiri (Maharashtra) in the south. It covers Bombay High which is the largest producer of petroleum in the country. In Assam, the oil producing area is in the Lakhimpur and Sibsagar districts. The oil wells are located mainly around Digboi, Naharkatiya. Sibsagar and Rudrasagar. In Gujarat, the oil producing area covers Vadodara, Broach, Kheda, Mehsana and Surat Districts. Recently petroleum reserves were discovered in the state of Rajasthan covering major areas of Bikaner, Barmer and Jaisalmer and gas has been discovered along the east coast in the Godavari and Krishna deltas. The prospective areas lie in the Bay of Bengal, which covers the coastline along the state of West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Andaman and Nicobar Islands.

(iii) Natural Gas: Natural gas is an important source of commercial energy. It is found in association with petroleum. But this quantity may be increased as more and more reserves are being discovered. Production of natural gas in 2020-21 was 23,579.54 MMSCM. The gas used for running vehicles is known as compressed natural gas (CNG). The gas used for household use is called LPG (liquified petroleum gas.

Distribution:

Over three-fourths of India's natural gas comes from Mumbai High; The rest is obtained from Assam, Tamil Nadu, Rajasthan, and Tripura.

B. Non- Conventional Sources of Energy

Conventional sources of energy like coal, petroleum and natural gas are likely to exhaust soon. Therefore, there is a need to find alternative sources of energy. Hydel power is also a non-conventional source of energy. However, it needs to be utilized sustainably. Sun, wind, tides, bio-wastes, and hot springs are some sources which can be developed as the alternative sources of energy. They are called the non-conventional sources of energy. These sources of power are renewable and are pollution free. Around 40% generation capacity in India was from non-conventional sectors in 2022.

(1) Hydroelectric Power: Development of hydroelectric power started in the 19th century. In 1902, hydropower plant was established at Shiva samudram waterfall on Kaveri River in Karnataka. Later, hydel power projects were established in the Western Ghats to provide power to Mumbai. Hydropower plants were also developed in Uttar Pradesh, Himachal Pradesh in the north, and Tamil Nadu and Karnataka in the south in the 1930s. Total generation capacity was 508 MW in 1947. Off late several projects were commissioned to develop economical and sustainable power to save fossil fuels and reduce cost of production and protects environment.

India has impressive shares of hydel electricity generation capacity in total installed capacity in India. The total installed capacity of hydel power in 2022 was 46,850 MW which was approximately 11.4% in total installed capacity.

Despite being a cheaper, it is pollution-free, and renewable source of power, the significance of hydroelectricity has reduced post-independence period. Its production declined from 49% in 1950-51 to only 11.4 % in 2022-23. Nevertheless, hydroelectricity plays a very significant role in northern, western, and southern parts of India.

(2) Solar energy: The Sun is the primary source of all energy. India lies in the torrid zone and experiences plenty of sunshine, for longer period during daytime and has extensive possibilities to develop solar energy. Solar energy is tapped through the system of Solar Photo Voltaic (SPV) cells. The thermal heating system can be utilized for water heating, solar cookers for cooking food and drying food grains etc. Solar energy can be developed in almost every part of the country but can be harnessed to greater extent in hot, dry and cloud free areas. Karnataka ranks first, with most installed capacity. Other important states are Rajasthan, Madhya Pradesh, Telangana, Andhra Pradesh, Tamil Nadu etc. India has 63,894 MW installed capacity sharing 15.1% of total installed capacity.

(3) Wind Energy: Wind energy can be harnessed in those regions, where wind is strong and constant and blow throughout the year. Wind energy can be used for providing water for irrigation and for generating electricity. India has about 41,983 MW installed generation capacity in

2022-23. Tamil Nadu ranks first, with installed capacity followed by Gujarat, Maharashtra, Karnataka, and Andhra Pradesh.

22.5 Conservation of Energy Resources

Every sector of the national economy – agriculture, industry, transport, commercial and domestic – needs inputs of energy. There is an urgent need to develop a sustainable path for energy development. Here are some ways that each one of us can contribute to saving energy resources:

- Using public transport systems instead of individual vehicles
- Switching off electricity when not in use
- Using power-saving devices.
- Using non-conventional sources of energy
- Recycle metals, use scrap metals and search for substitutes.
- Use minerals in planned and sustainable manner.

Check Your Progress

(iii) Mention the sources of energy in India?

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(iv) Where are the deposits of Petroleum normally located? Why is it called liquid gold?

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22. 6 Summary

An essential infrastructure resource for a nation's economic growth is energy. Coal, oil, natural gas, nuclear power, and water power are the main energy sources. These sources are collectively referred to as conventional energy sources. These energy sources are non-renewable and finite. Thermal power stations that run on coal are situated either close to consumption centres or close to coal reserves. In the southern states, hydel electricity has sufficiently advanced. About half of India's potential for water power has been realised. The sun, wind, tides, hot springs, biogas, and so forth are examples of alternative energy sources. They are referred to as unconventional energy sources. They are affordable, non-polluting, and renewable. Due to a lack of appropriate and profitable technologies, the use of these sources is progressing slowly.

22.7 Check Your Progress – Model Answers

(i) The three specific belts of mineral distribution in peninsular plateau region: The North eastern plateaus, South-western plateaus, North-western region.

(ii) Minerals are broadly classified into two types metallic and non-metallic minerals.

(iii) On the basis of its source and utility, energy can be categorised into two broad groups: (a) Conventional energy and (b) Non-conventional energy.

(iv) The Sun is the primary source of all energy. India lies in the torrid zone and experiences plenty of sunshine, for longer period during daytime and has extensive possibilities to develop solar energy.

22.8 Terminal Questions

1. Why are mineral and energy resources significant for the Indian economy?
2. Describe the distribution and production of the following minerals and mineral fuels in India:

(a) Bauxite

(b) Iron ore

(c) Petroleum

3. Differentiate between conventional and non-conventional energy with suitable examples.
4. Give any two reasons why we should prefer non-conventional energy resources.
5. Write a note on solar energy?
6. Explain about wind energy?

22.9 Further Readings

- D. R. Khullar, 2022, India A Comprehensive Geography, Kalyani Publications, India.
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Chapter - 23

INDUSTRIES : AGRO-BASED, MINERAL BASED AND FOREST BASED

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23.1 Objectives

23.2 Role and Importance of Industries in Development

23.3 Classification of Industries

23.4 Spatial Distribution of Industries

23.5 Types of Industries

23.6 Major Industrial Regions

23.7 Government Initiatives

23.8 Summary

23.9 Check Your Progress- Model Answers

23.10 Terminal Questions

23.11 Further Readings

23.0 INTRODUCTION

Many things that we find around in our house do not occur naturally and are manufactured with the help of machines in Industries. Products such as clothes, utensils, paper, plastic boxes, notebooks, books, pens, and pencils, etc. are made in industries. Manufacturing units also known as Industries are the places where goods are manufactured in huge quantities. Industrial sector which is the secondary sector of economy includes mining and quarrying, manufacturing, gas, electricity, construction, and water supply. Many of these resources are used as raw materials in industries to manufacture goods. Industrial sector also provide employment to many people.

23.1 Objectives

After learning this lesson, the student will be able to:

- Highlight the role of industries in development of economy;
- Identify the agro-based, mineral based and forest-based industries in India;
- Describe spatial distribution of major and minor industries and their production patterns and
- Identify the major industrial regions of the world.

23.2 Role and Importance of Industries in Development

Industries are considered as the backbone of National development especially, economic development, because of the following reasons:

- Industries aid in modernizing farming which is the backbone of the Indian economy. Industries lessen the dependence of people on agriculture by providing jobs.
- As industries employ many people, industrial development is one of the preconditions for eradication of unemployment and poverty from our country.
- Industrial development in backward areas also aims at bringing down regional imbalances.
- Export of manufactured goods helps in expanding trade and commerce and inviting foreign investment.
- Transformation of raw material into finished goods adds value to the product and the skilled labor.

In India, industries provide employment to around 12 % of the total population. This sector has contributed 29.8 %, 29.3 % and 29.1% in GDP (Gross Value Added or GVA) for 2015-16, 2016-17 and 2017-18, respectively. The contribution of agriculture and related activities was 17.7 %, 17.9 % and 17.1 % for the same three time periods.

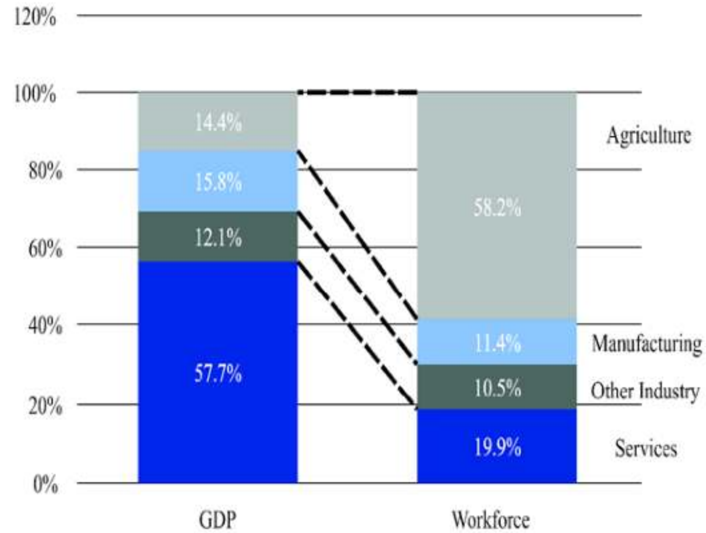

Fig. 23.1: Distribution of labour in different sectors of India and the share in GDP of economy 2017-18
Source: https://www.indiabudget.gov.in/budget, 2019-20

In addition to its direct contribution to the economy, the secondary sector has a multiple effect for job creation in the service sector. According to National Manufacturing Policy 2011, every job created in the industrial sector creates two or three additional jobs in related fields. Industries require different types of labor based on their skills. Some industries such as, textile, leather and food processing industries require a larger number of labors as compared to machinery industry and are hence, called labor intensive industries.

Industrial sector is considered as a transformational sector. In India, where the primary sector i.e. Farming is burdened with a large amount of surplus labor, the industrial sector is a good option for absorbing this surplus. As can be seen in Figure manufacturing and other industries have a larger share in the GDP as compared to the percentage of workforce employed in it as compared to the agricultural sector.

The demography of India having an ever-increasing population i.e., large percentage of population in the working age-group adds to the importance of the industrial and service sector other than primary sector. The importance given to the industrial sector in several Five-Year Plans and future growth of this sector, can provide a potential for employment to a large number of the people in the coming years.

23.3 Types of Industries

Industries utilize different raw materials and produce different types of goods and in different quantities, because of which, industries can be of different types.

On the basis of raw materials used in production process, the industries can be of three types as the following:

(a) **Agro-based Industries**: These are the industries that primarily rely on agriculture and allied activities as their source of raw materials. The majority of the materials come from plants and animals. A few examples include the cotton textile industry, the sugar industry, the food processing business, the dairy sector, and the leather industry.

(b) **Mineral Based Industries**: These are the sectors whose primary raw materials are mineral ores. For example, iron & steel, cement, and other industries. These industries' products are utilised as raw materials by other industries to produce different finished goods. For example, heavy machinery, railway carriages, and other items use iron produced in the iron-steel sector.

(c) **Forest Based Industries**: These are the sectors that use forest products as their primary source of raw materials. As an illustration, consider the paper & pulp, furniture, and lac industries etc.

Check Your Progress

(i) Classify the industries on the basis of utilization of raw materials?

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23.4 Spatial Distribution of Industries

After learning how important industries are in the national development, it is important to know whether industries can be set up anywhere or is there any certain requirements for establishing them. For establishing an industry, it is important to keep in mind profit maximization, by reducing costs.

The factors that determine location of industries are the following:

- **Raw material -** Raw materials are the prerequisite for any type of industry and they should be available at cheap prices and easy to be transported to the site of industry. Industries which use bulky, weight- loosing, perishable raw materials are located near to the source of raw materials such as, agro-based industries and dairy industries, etc.
- **Market –** Easy access to markets for selling of produced goods is very important factor. Remotely located or secluded areas with low population and lower purchasing power are considered as small markets and vice-versa.

- **Labor supply -** In recent years, mechanization of industries has reduced the importance of labour supply as a determining factor but, still there are many industries which are labour intensive or require large amounts of labour.
- **Source of energy -** Those industries which are dependent on heavy supply of power are located near its source. Earlier coal was the source of power for industries therefore; industries were located near the source of coal. Later, hydroelectricity and petroleum became the source of energy.
- **Transportation and communication facilities -** An efficient and speedy transportation is required for transferring raw material from its source to the factories.
- **Government policies -** Favorable policies of the government aid in industrial growth.

23.4.1 AGRO-BASED INDUSTRIES

Agriculture is primary sector of the Indian economy. Both agriculture and industrial sectors complement and supplement each other in boosting the national economy. Agricultural products are used as raw material in industries to produce various goods whereas, industries provide agricultural tools and fertilizers, etc. for growing crops and for making processed items like jams and jellies, etc..

(i) Sugar industry:

India stands second position in the world in production of sugar and first place in the production of gur and khandsari. The raw material used in the sugar industry is sugarcane which is a bulky raw material. The sugar mills are located very near to the growing areas, as sucrose present in sugarcane gets reduced during transportation. These mills churn out sugarcane juice from sugarcane and produce sugar, gur and khandsari .

Factors responsible for distribution of sugar industry-

Sugarcane growing area in India may be broadly classified into two agro-climate regions:

i) Sub-Tropical region comprising Uttar Pradesh, Bihar, Punjab, and Haryana

ii) Tropical region comprising Maharashtra, Gujarat, Tamil Nadu, Andhra Pradesh

Fig. 23.2: Distribution of Sugarcane mills in India

(ii) Cotton textile industry:

Cotton industry has been an important part of Indian Agro-based industry. Mumbai is referred to as cotton polis of India, this was because the cotton growing belt was in Gujarat and Maharashtra. It was in Mumbai in 1854 was the first mill established.

Distribution

Apart from the climatic and soil conditions required for growing cotton crops, this region of India had a market, transportation facilities including port facility and labor supply, etc. All these conditions favored establishment of the cotton textile industry in this region. Presently, cotton textile industries are located mostly in western India: Gujarat, Maharashtra western part of Madhya Pradesh; Tamil Nadu, West Bengal and Uttar Pradesh.

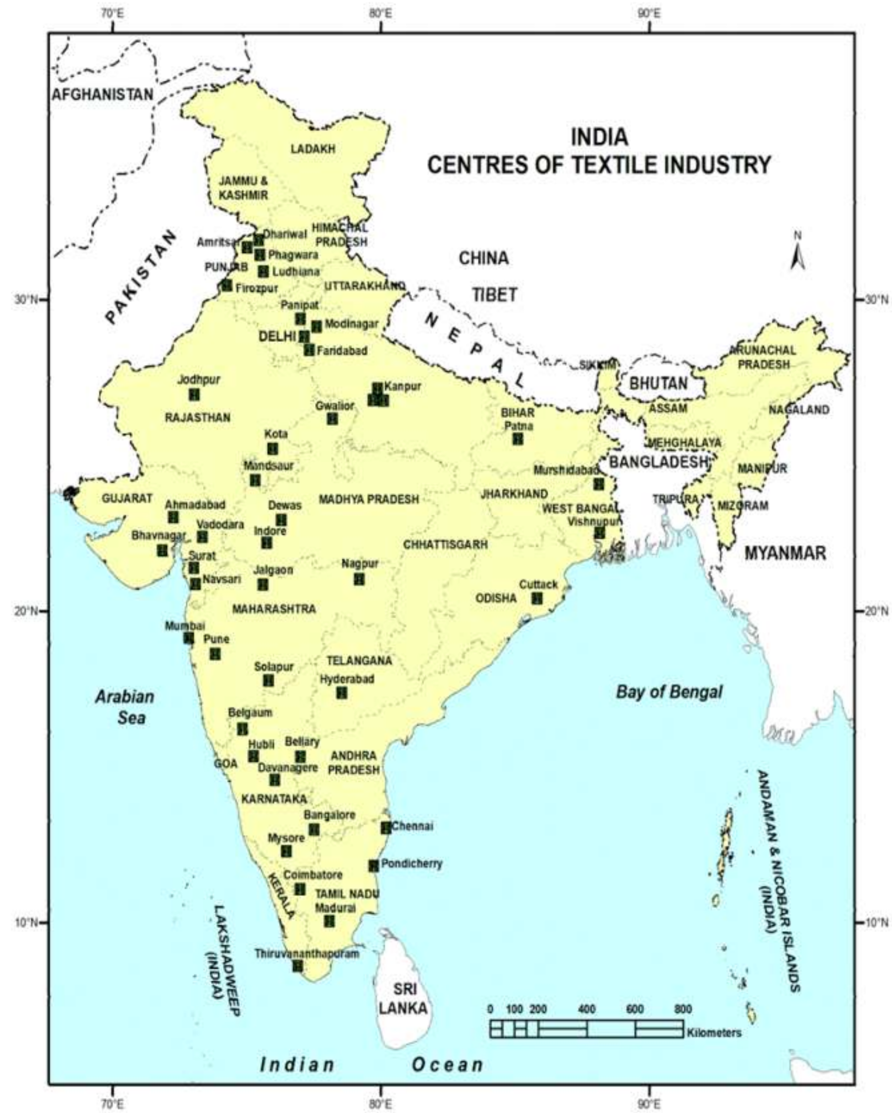

Fig. 23.2: Centre of textile industries in India

2.4.2 MINERAL BASED INDUSTRIES

The industries that use minerals as raw materials are called mineral-based industries.

Iron and steel industry- Iron and steel is also known as the basic industry. This is because all other industries depend on it and the products manufactured in this industry form the basis of other industries. Steel is used in manufacturing of various industrial goods, equipment, machinery, automobiles, and scientific equipment, etc.

Iron and steel industry is also a heavy industry, as the raw materials used and the finished goods manufactured both are heavy and bulky. The raw materials used in the iron and steel industry are iron ore, coking coal, limestone, and manganese.

Distribution-

The first modern steel plant in India was set up at Kulti, Bengal in 1870 and production began in 1874. Modern iron and steel industry started with the establishment of 'Bengal Iron and Steel Works' at Kulti in West Bengal in 1817. Tata Iron and Steel company was established at Jamshedpur in 1907. This was followed by 'Indian Iron and Steel plant' at Burnpur in 1919. All the three plants were established in the private sector. The first public sector iron and steel plant, which is now known as 'Visvesvarayya Iron and Steel works', was established at Bhadrawati in 1923.

Fig 23.4: Distribution of major steel plants in India

After independence, three new integrated Iron and Steel plants were started namely, Bhilai at Chhattisgarh in 1957, Durgapur at West Bengal in 1959 and Rourkela at Odisha in 1959. During the Third Five Year Plan, Bokaro Iron and Steel Company was started at Bokaro of Jharkhand in 1964 with production capacity 17 lakhs tonnes. Again during the Fifth Five Year Plan, decision was taken to set up four more iron and steel plants at Vishakapatnam (Andhra Pradesh), and Salam (Tamilnadu), Vijayanagar (Karnataka). The Steel Authority of India Limited (SAIL) was set up in 1973 as a public sector undertaking to coordinate the development of the Iron and Steel Industry in both public and private sectors. The IISCO, VISL, Bhilai, Bokaro, Rourkela, Durgapur and Salem came under the SAIL.

Most of the steel plants are located in and around Chhota Nagpur plateau which is endowed with rich deposits of iron ore, coal, manganese and limestone. Surrounded by the existing large mother plants of Iron and Steel, a National Investment and Manufacturing Zone (NIMZ) is being developed at Kalinganagar, Odisha. Spread over 160 sq km, the zone is envisaged to become a self-contained ecosystem along with residential, commercial and social amenities and will enable the potential investors for setting up value added downstream facilities. It is expected that the Kalinganagar industrial complex in Odisha can contribute 20 percent of the country's targeted 300 million tons steel capacity by 2030.

23.4.3 FOREST BASED INDUSTRIES

The forest-based industries include paper industry, match industry, silk industry, lac industry, handicrafts and sports goods industry etc.

Paper & Pulp Industry:

In India, the pulp and paper industry is a sizable manufacturing sector. There are a lot of fascinating details regarding the raw ingredients and manufacturing processes used in the Indian paper industry. Over the years, India's paper industry has experienced enormous growth, with production rising from 20.37 million tonnes in 2017–2018 to 25 million tonnes in 2019–2020. As a result, the paper sector is growing at a pace of about 10% annually. Paper is used for many different things, such as writing, newspapers, packing, tissue paper, face wipes, and paper cups. The article provides a few key facts about the paper industry and how it is made.

The first attempt to make paper using contemporary methods was carried out at Tanjavur in Tamil Nadu, in 1816. It was unsuccessful in paper production. In Lucknow, the first profitable paper mill was established in 1879. Paper mills were established in Titagarh (West Bengal) once more in 1881. It is regarded as the inception of the contemporary paper industry. The paper business is one that promotes weight loss. A tonne of paper is made from roughly 2.5 tonnes of raw ingredients. Thus, the raw material areas are where this sector is primarily localised. The following raw materials are used to make paper in India:

Soft wood: The Himalayan area of India is the source of soft wood from coniferous trees. Soft wood provides seven percent of the raw materials needed in India's paper industry.

Bamboo: In India, bamboo is the most common raw material used to make paper. 70% of the raw materials used in the paper industry come from bamboo. Assam and Karnataka are the two states that generate the most bamboo.

Sabai grass: 15% of the raw material comes from this source. These fibres are used to make the highest grade paper. The state that produces the most sabai grass is Madhya Pradesh. Other significant states that produce sabai grass are Maharashtra, Andhra Pradesh, and Odisha.

Bagasse: it is the leftover material of sugarcane. 7% of the pulp used in the paper industry comes from bagasse. It is used to make packaging paper, rigid board paper, industrial paper, and so forth.

Rags: Rags and leftover paper are also used to make Pulp. Paper that is handcrafted is made with it. India leads the world in handcrafted paper production. India exports it as well. The paper used to create university certificates is this one. Puducherry is home to the biggest handmade paper mill in Asia.

In addition to rags, paper is also made from the straw of wheat, maize, and paddy crops.

Distribution:

the important paper industrial centres are as the following:

West Bengal: Tatagarph, Rankijangj, Naihati, Bansbaria, Howrah, Kolkata, Dumdum etc.

Maharashtra: Ballarpur, Kalyan, Khopoli, Chnchbud, Sangli, Kampati, Jalgaon etc.

Karnataka: Bhadravati, Mysore, Bengaluru, Ramnagr, Dandoli etc.

Andhra Pradesh: Rajamandry, Tirupati etc

Madhya Pradesh, Bhopal, Indore, Ratlam and Amlai etc.

Telangana: Sirpur Kagaz nagar, Khammam, Patancheru etc.

Uttar Pradesh: Meerut, Saharanpur, Modinagar etc.

Check Your Progress

(ii) Mention the factors responsible for location of Industries?

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(iii) What are the raw materials used for paper industry?

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23.6 MAJOR INDUSTRIAL REGIONS

Industries in India are not evenly located rather they are concentrated regions forming complexes, because of favorable conditions such as availability of raw material, market, labor, power supply and various other infrastructures at those places. Certain indicators that are used to recognize any industrial regions are the following:

i. Number of industrial units

ii. Number of industrial workers

iii. Amount of power being used for industrial purposes

iv. Total industrial output

v. Value added by manufacturing

Based on these indicators any concentration of industrial units is called an industrial region. In India, there are differences in the relative levels of industrial development. In certain places, Indian industries have clustered together. The majority of India's industrial areas have grown up in the hinterlands of some of the country's largest ports, like Kolkata, Mumbai, and Chennai. These industrial areas have every benefit, including easy access to markets, electricity, raw resources, and finance.

Fig.23.5 Major industrial regions of India

India has several major and minor industrial regions and complexes. Three of the six major industrial regions that arose are located in port hinterlands.

The six major industrial regions are as follows:

(i) Hooghly Industrial region

(ii) Mumbai – Pune Industrial region

(iii) Ahmedabad – Vadodera region

(iv) Madurai – Coimbatore – Banglore region

(v) Chhota Nagpur plateau region

(vi) Delhi and Adjoining region

Besides these major industrial regions, there are 15 minor industrial regions and 15 industrial districts.

23.7 GOVERNMENT INITIATIVES

Industries play an important role in the national economy of any country. There have been several initiatives taken up by the government of India for growth of industries and to enhance industrial production especially from the Second Five Year Plan (1956-61). In the recent past also the Government of India has taken several initiatives to promote manufacturing sector in the country.

Some of these initiatives are.

Skill India campaign: It was launched by the Prime Minister of India, on 15 July, 2015 to train over 40 crore people in India in different skills by the year 2022. Various initiatives under this campaign are:

- National Skill Development Mission
- National Policy for Skill Development and Entrepreneurship, 2015
- Pradhan Mantri Kaushal Vikas Yojana (PMKVY)
- Skill Loan scheme
- Rural India Skill

Pradhan Mantri Kaushal Vikas Yojana (PMKVY): PMKVY is the flagship scheme of the Ministry of Skill Development & Entrepreneurship (MSDE) implemented by National Skill Development Corporation. The objective of this Skill Certification Scheme is to enable a large number of Indian youth to take up industry-relevant skill training that will help them in securing a better livelihood. During PMKVY 1.0, 19.85 lakh candidates were trained, out of which 2.62 lakh (13.23 per cent) got placements. PMKVY(2016-2020) was launched in October 2016 and by June 2019 about 52.12 lakh candidates have received training and about 57% of them reported placement Startup India is another flagship initiative of the Government of India which was launched in2016, to build a strong ecosystem that is conducive for the growth of startup businesses, to drive sustainable economic growth and generate large-scale employment opportunities.

Check Your Progress

(iv) What are the indicators used to determine industrial regions?

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(v) What are the initiatives taken under skill India campaign?

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23.8 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. Before independence, India was industrially less developed. Industries can be classified into different categories on the basis, such as of sources of raw material, ownership as (a) agro-based industries (b) mineral based industries and (c) forest based industries. Agro-based industries includes cotton textile, woolen textile, jute textile and sugar industry. (b) mineral based industries such as iron and steel, heavy engineering, automobiles, chemicals and petro chemical industry, and (c) forest-based industries encompasses paper and pulp industry, lac industry, match industry, lumbering industry etc. Industries play an important role in the national economy of any country. There have been several initiatives taken up by the government of India for growth of industries and to enhance industrial production especially from the Second Five Year Plan. The Government of India framed policies which have made India self-reliant in various sectors of industries.

23.9 Check Your Progress – Model Answers

(i) On the basis of raw materials used in production process, the industries can be of three types as the following: (a) Agro-based Industries, (b) Mineral Based Industries and (c) Forest Based Industries.

(ii) The factors that determine location of industries are the following: Raw material, Market, Labour supply, Source of energy, Transportation and communication facilities, Government policies & Agglomeration economies.

(iii) The following raw materials are used to make paper in India: Soft wood, Bamboo, Sabai grass, Bagasse, and Rags etc.

(iv) Certain indicators that are used to recognize any industrial regions are the following: Number of industrial units, Number of industrial workers, Amount of power being used for industrial purposes, Total industrial output, and Value added by manufacturing etc.

(v) In the recent past also the Government of India has taken several initiatives to promote manufacturing sector in the country. Some of these initiatives are: National Skill Development Mission, National Policy for Skill Development and Entrepreneurship, 2015, Pradhan Mantri Kaushal Vikas Yojana (PMKVY), Skill Loan scheme, and Rural India Skill etc.

23.10 Term Questions

Essay Questions

(1). In what manner industries contribute to the national economy of India?

(2). Location of specific industries has specific factors responsible for their location. Explain?

(3). How many major and minor industrial regions are present in India?

Short Questions

(4). Classify Industries?

(5). What are Non-ferrous minerals?

(6). Explain the growth of Iron-steel Industry in India?

Very short Questions

(7). What are agro-based industries?

(8). Expand SAIL

(9). Expand PMKVY

(10). Define Industrial Region?

23.11 Further Questions

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Chapter - 24

TYPES OF TRANSPORT AND TRADE

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24.2 Modes of Transport

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24.5 Water Ways

24.6 air ways

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24.7 Summary

24.8 Check Your Progress – Model Answers

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24.10 Further Readings

24.0 Introduction

You have already learned about minerals and energy as a crucial component of infrastructure. Trade and transportation are other crucial services. They enable the full development of industry and agriculture. People and things are transported from one location to another. It facilitates the processes of production, distribution, and consumption. Sending and receiving massages between two people or organisations that are located in different locations is known as communication. Trade is the exchange of things between individuals who reside in various parts of the world. It is essential for quickening the development of a nation's industry and agriculture. This chapter deals about the relative significance of trade and transportation in India. Additionally, it studies about the density and distribution of transportation networks.

24.1 Objectives

After studying this lesson, you will be able to:

- define the term "infrastructure;"
- explain the role of infra-structure in area development;
- establish relationship between needs and mode of transport system; l identify the pattern and networks of important roads, railways, airways and water ways;
- describe the role of different modern means of communications; l appreciate the role of transport and communication changing the way of life in rural and urban areas;
- explain the significance of trade in day to day life, inter-regional dependence, and national integration;
- interpret data, graphs, diagrams showing changing patterns of trade;

24.2 Modes of Transport

India is a vast, geographically large country with great distances, from Kashmir in the north to Kanyakumari in the south and from Kandla in the west to Kohima in the east. In order to guarantee security and territorial integrity, foster social cohesion, and drive economic success, a dense and effective transportation network is necessary. The need to move objects from their availability location to their utilisation location determines whether or not we use transportation. Humans use a range of methods to move commodities and things. Modes of transport are the various ways that distinct objects can be moved from one location to another. There are four modes of transport: Road ways, Railways, Airways and Water Transport.

Modes of Transport

- Road Ways
- Rail Ways
- Water Ways
- Air Ways

There are three modes of transportation: land, water and air. Each one of them has some advantages and disadvantages. They all compete with one another. More importantly they complement each other and in the process constitute a single integrated network. The transportation system connects the production and consumption zones. It makes it easier for people, products, and services to move locally, regionally, nationally, and internationally.

24.3 Road ways

The roadways are old mode of transport. It is essential to the movement of people and goods throughout the nation. The rural economy is especially reliant on road transit. The development of autos has raised the significance of roadways. Roads are far more important than railroads in terms of proportional importance.

(i) Door-to-door services are provided by roadways

(ii) Roads are able to cross mountainous areas and handle steeper slopes. In hilly terrain, building railway lines is costly and challenging.

(iii) Road transport is dependable, efficient, and adaptable.

(iv) It works better for transporting perishable items like fruit, vegetables, and milk.

(v) Compared to the railway, it requires significantly less money for construction and maintenance.

(vi) Roads are a better option for short trips. By connecting the interior regions with railway heads, they serve as an addition to the railways. The best way to promote tourism in the nation is through roads.

Growth and Development of Roadways

The length of the route has changed significantly since independence. India, currently has the second-largest road network in the world, after the United States of America. In the past 70 years, India's road network has grown by more than 15 times. The total roadwork of India was

3,99,942 km in 1950–51; and it had grown to 62,15,797 km by 2020-21. There are 1,44,634 kilometres of National Highways in the country (as of November 30, 2022).

Growth of Road Network by Categories (km) from 1950-51 to 2020-21

Road Category	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2010-11	2020-21
National Highways	19,811 (4.95%)	23,798 (4.54%)	23,838 (2.61%)	31,671 (2.13%)	33,650 (1.45%)	57,737 (1.71%)	70,934 (1.52%)	151,019* (2.51%)
State highway	-	-	56,765 (6.20%)	94,359 (6.35%)	127,311 (5.47%)	132,100 (3.92%)	163,898 (3.50%)	186,528 (3.00%)
District roads	173,723 (43.44%)	257,125 (49.02%)	276,833 (30.26%)	421,895 (28.40%)	509,435 (21.89%)	736,001 (21.82%)	998,895 (21.36%)	632,154 (10.17%)
Rural roads	206,408 (51.61%)	197,194 (37.60%)	354,530 (38.75%)	628,865 (42.34%)	1,260,430 (54.16%)	1,972,016 (58.46%)	2,749,804 (58.80%)	4,535,511 (72.97%)
Urban roads	-	46,361 (8.84%)	72,120 (7.88%)	123,120 (8.29%)	186,799 (8.03%)	252,001 (7.47%)	411,679 (8.80%)	544,683 (8.76%)
Project roads	-	-	130,893 (14.31%)	185,511 (12.49%)	209,737 (9.01%)	223,665 (6.63%)	281,628 (6.02%)	354,921 (5.71%)
Total	399,942	524,478	914,979	1,485,421	2,327,362	3,373,520	4,676,838	6,215,797

Figures in parenthesis indicate the percentage of total road length for that fiscal year.

*Includes National Highways and Express ways.

Source: Compiled by author from Annual Reports of Ministry of Road Transport and Highways in India.

Since independence, not only growth of road routes, but so too have the number of commercial heavy vehicles, especially buses and trucks, expanded dramatically. A significant increase in traffic on the roads has made it extremely difficult to manage. There has also been a consistent rise in the quantity of traffic accidents. Air pollution has increased along with the amount of traffic on the roads.

Classification of Roadways:

The Nagpur Plan classifies roadways into four types on the functional basis as the following:

(i) National Highways,

(ii) State Highways,

(iii) District Roads and

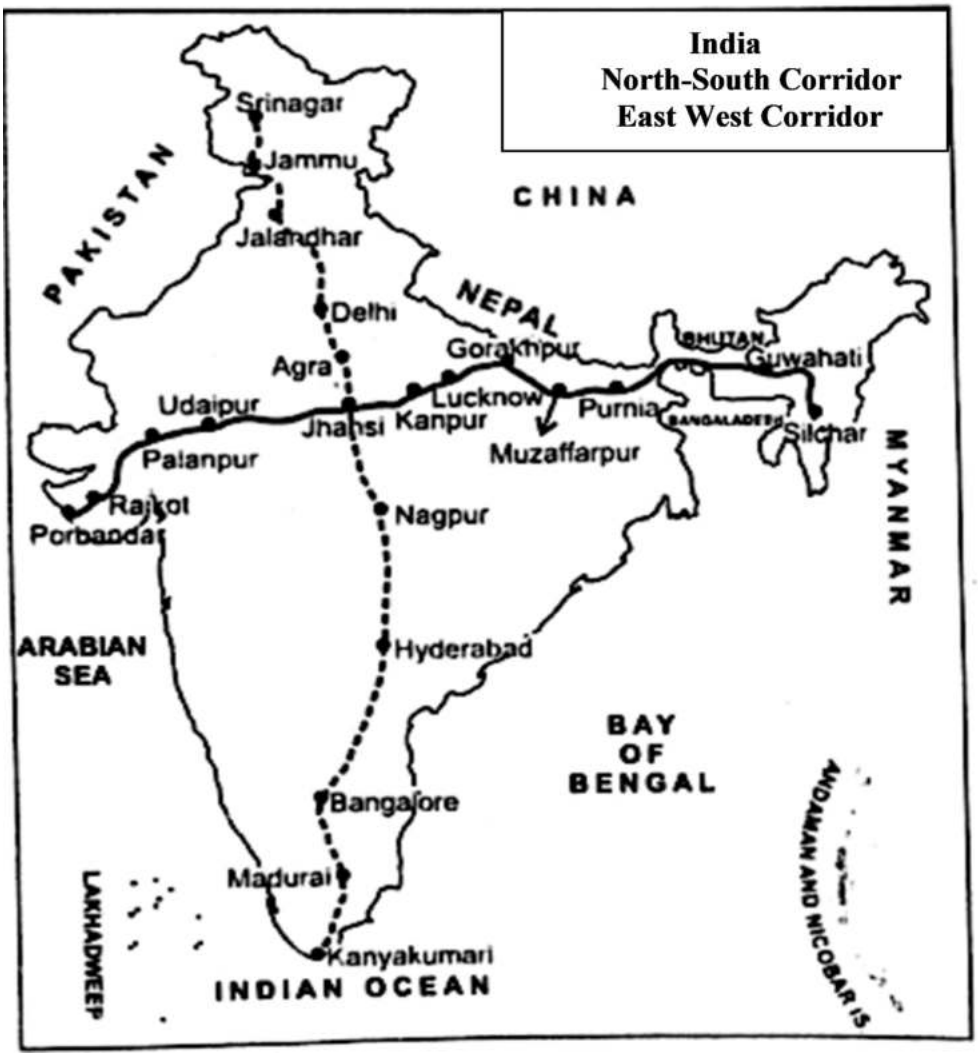
(iv) Village roads.

(i) National Highways: *National Highways are the trunk roads linking major cities of the country. They are built and maintained by the Central Government.* As of 2021, the total national highways and express highways network in India is 1,51,019 km (alone National highways 1,36,440 kms only). They account 2.13 % of total road network and 40 % of total road transport load in India. Through three organizations, the Ministry of Transportation oversees the creation and upkeep of the nation's highways. They are: National Highway Authority of India (NHAI), State Public Works Department (PWD) and Border Roads Organization (BRO). The length of National Highways expanded from 19,811 km in 1951 to 1,51,019 km in 2021. There are 599 National Highways in India. The longest national highway, NH44, with 3745 km length from Kanyakumari in Tamil Nadu to Srinagar in Jammu and Kashmir and the shortest National Highway, NH766EE, connects the Karnataka ports of Hettikeri and Belekeri with a distance of 4.27 km.

(ii) State Highways: they connect state capitals with district headquarters and other cities, towns in the country. These are built and maintained by state governments (P.W.Ds). In last five decades, the length these roads in the country grown three times from 56,765 km in 1971 to 186,528 km in 2021. The central government received proposals for declaration of state highways as national highways from various states and conversion has been started across Indian states.

(iii) District Roads: The district headquarters is primarily connected to these roadways by the major towns, cities, and significant villages. The majority of these roads used to be devoid of culverts and bridges. These roads have grown by more than three and a half times, from 1,73,723 km in 1951 to 6,32,154 km in 2021.

(iv) Village Roads: They are mainly constructed connecting village panchayats to increase accessibility of villages with nearby towns and cities. These roads length has increased from 2,06,408 km in 1951 to 45,35,511 km in 2021.



Source: Geography of India Through Maps by Anil Keshri.

Boarder Road Organization: It was established on 7th May 1960 for accelerating economic development and to strengthen defence preparedness by rapid and coordinated improvement of roads in the north and north-eastern borders of India. As of 2022, about 55,000 km length of road network was constructed by BRO. The world's highest roadway connecting from Chandigar-Manali-Leh centres with an altitude of 4270 metres from MSL was constructed by BRO. This organization has brought under the control of Ministry of Defence since 2015.

National Highway Development Project (NHDP): The National Highways Development Program (NHDP) was established in 1998 *to boost economic development in the country*. The programme is being implemented in the seven phases listed below;

Phase I: Gloden Quadrilateral (GQ) comprising National Highway connecting four metro cities viz, Delhi, Mumbai, Chennai and Kolkata. Total length of the Golden Quadrilateral is 5846 km. The construction has almost been completed.

Out of the total 5846 km, four lining of about 4856 km, length has already been completed by 31st May, 2005. Phase I also entails enhancing port connectivity.

Phase II: It consists of 7300 km of the NS and EW corridors. The NS corridor (*Srinagar to Kanyakumari*) and EW corridor (Silchar to Pobundur). The project also includes the construction of 1000 km of express highways and port connectivity. Already 75% of the NS-EW works and 99% of the GQ works have been completed.

Phase III: This phase involves widening 12,109 km of high-density national highways.

Phase IV: this includes 20,000 km of single-lane roads upgradation.

Phase V: involves widening 6,500 km of four-lane highways to six lanes.

Phase VI encompasses building a 1,000 km road system to link important commercial and industrial centres.

Phase VII consists of building 700 km of ring roads, by-passes, underpasses, flyovers, and other types of highways.

Geographical Distribution of Roads

The average length of roads per 1000 square kilometres is called as 'road density'. When compared to developed nations, India still has a relatively low road density. The Northern Plains have a dense population, fertile soil, and level terrain, which contribute to a large concentration of roads. The average Road density in India has increased from 1422.63 per 1000 Sq. Km in 2011- 12 to 1926.02 per 1000 Sq. Km in 2018- 19.

Check Your Progress

(i) Mention the different modes of transport in India?

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(ii) Classify the roadways in India?

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24.4 Railways

The Indian railway network is the fourth largest in the world next only to USA, China, and Russia. It's made people from the most remote parts of India, a big country, more kinship-oriented. For long-distance freight and passenger transportation, railroads are perfect. Of the departments under the Central Government, it employs the most people.

Development of Railways: The first train steamed off for public transport in the country on April 16, 1853, when the first train travelled 34 kilometres from Bhori Bandar (near Mumbai) to Thane. Indian railways have expanded into a massive network after independence. The following table may give you an idea about the growth of the railway system during the post-independence era.

Table: Growth of Railway network in India from 1950-51 to 2020-21

Year	Electrified Routes (in '000 kms)	Non-electrified Routes (in '000 kms)	Total Routes (in '000 kms)
1950-51	0.4	53.2	53.6
1960-61	0.8	55.4	56.2
1970-71	3.7	56.1	59.8
1980-81	5.4	55.8	61.2
1990-91	10.0	52.4	62.4
2000-01	14.0	48.1	63.0
2010-11	19.6	44.8	64.4
2020-21	44.8	23.3	68.1

Source: https://indianrailways.gov.in

From the table above, it reveals us an idea of quantitative progress made by the railways over 50 years. In the first place the total route length has increased very slightly. As of March 31, 2021, India had 68,103 km length of its rail network. Out of total network, broad gauge accounts about 64,403 km (94.57%) and metre gauge is 2,112 km (3.10%), and narrow gauge is roughly 1,588 km (2.33%). *As seen earlier, the new railway lines have been added only marginally.* India's rail network expanded from 53.6 thousand kilometres in 1950–1951 to 68.1 thousand kilometres in 2020–21. Electrified routes comprise of 44.8 thousand km of the network, while the non-electrified routes encompass about 23.3 thousand km.

Indian Railways operates a number of quick trains by fortifying the railway rails along the main route. In the past, there were just two types of trains: express or mail trains and passenger trains. At present, the fastest express the Shatabdi, runs between crowded terminals, as do the Rajdhani and Super-fast expresses. *Now metro rail is a new concept which provide faster transport facility in metro cities.* The first metro system in Kolkatta was started in 1984. Metro train services have been started in India's largest cities including Delhi (2002), Bangalore (2011), Gurgaon (2013), Mumbai (2014) and Hyderabad (29^{th} November, 2017).

Vande Bharath: Vande Bharath, also known as Train 18, is India's first semi-high speed train to be planned and constructed domestically. As part of the Made in India campaign, Integral Coach Factory in Chennai designed and manufactured this train. This is the first attempt in India to operate a train using distributed traction power technology, which does not require a locomotive. On February 15, 2019, the first Vande Bharat train was inaugurated, beginning its trip between Delhi and Varanasi. There are 16 passenger cars on this train, with room for 1128 people to sit.

Railway zones: For administrative purpose, the Ministry of Railways, the Government of India, divided railway network into various zones. Presently, Indian railways network has been divided into 18 zones (see table).

Table: Railway zones in India (as of 31.03.2021)

S.No	Railway Zones /Headquarters	Year of Establishment	Route Kms.
1	Central Railway, Mumbai, Maharashtra	1951	4,152
2	Eastern Railway, Kolkata, West Bengal	1952	2,820
3	East Central Railway, Hajipur, Bihar	2002	4,215
4	East Coast Railway, Bhubaneshwar, Odisha	2003	2,801
5	Northern Railway, Baroda house, New Delhi	1952	7,323
6	North Central Railway, Allahabad, Uttara Pradesh	2003	3,522
7	North Eastern Railway, Gorakhpur, Uttar Pradesh	1952	3,471
8	Northeast Frontier Railway, Maligaon, (Guwahati), Assam	1958	3496
9	South coast Railway, Vishakapatnam, Andhra Pradesh	Feb-28, 2019	4,239
10	North Western Railway, Jaipur, Rajasthan	2002	5,651
11	Southern Railway, Chennai, Tamilnadu	1951	5,087
12	South Central Railway, Secundrabad, Telangana	1966	6,425
13	South Eastern Railway, Garden Reach, Kolkata, West Bengal	1955	2,753
14	South East Central Railway, Bilaspur, Chhattisgarh	2003	2,440
15	South Western Railway, Hubli, Karnataka	2003	3,606
16	Western Railway, Mumbai, Maharashtra	1951	6,542
17	West Central Railway, Jabalpur, Madhya Pradesh	2003	3,025
18	Metro Railway, Kolkata, West Bengal	2010	31

The Northern Railway Zone, which was founded in Chennai on April 14, 1951, is the first railway zone in India. South Coast Railway Zone, which split off from South Central Railway Zone in 2019, is the newest and most recent railway zone in India. With 7323 km of lanes, Northern Railway is the largest railway zone in the nation. At present, in India, Uttar Pradesh has the longest railway lines, measuring 8566 km. Sikkim is the only state in India without any railway infrastructure.

Source: NCERT

Indian Railways has implemented various strategies aimed at enhancing its effectiveness and public utility. They are as the following:

- Considerable growth in railway running track.
- Growth in electrification of busy trunk routes.
- Upgradation of metre gauge railway lines into broad gauge.
- Introducing several types of fast and superfast passenger trains

- Provide fast goods and special foodgrain train services.
- Afford better facilities for reservation and other customer care services, introducing online reservation system.

Distribution of Railway network

Let's take a quick look at the areas with dense, moderate, and sparse railway networks.

(i) The Regions of Dense Network: There is a dense railway network in the eastern coastal regions and northern plains. The causes for this extensive railway network are the level terrain, rich soils, dense population, and dispersion of businesses. The other regions are the Chhotanagpur Plateau, Central Tamil Nadu, and the plains of Gujarat and Saurashtra. The industries in these areas are highly developed.

(ii) The Regions of Moderate Railway Network: With the exception of Tamil Nadu and Chhotanagpur region, the whole peninsula plateau has moderate railway network. The terrain's hills and plateaus make it difficult to build railway lines. The major industrial centres and ports are connected by extensive trunk roads. The railway tracks either go through the tunnels or the wide spaces between hills.

(iii) The Regions of Sparse Railway Network:

The Himalayan Mountain region, comprising Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh have hardly a line here and there. The hilly terrain, rugged topography are the main reasons responsible for the very sparse network. The North eastern part of India has also sparse railway network. Only Brahmaputra valley in Assam has main railway line. All hilly states in this region are almost without a railway line. In western Rajasthan, the desert region, has also sparse network of railways. There are some metre gauge railway lines which link the big cities. However, most of these metre gauge railway lines have been converted into broad gauge lines.

Check Your Progress

(iii) Write a note on Vande Bharath train?

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(iv) How many railway zones are there in India?

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24.5 Water Ways

Waterways are the most traditional and affordable form of transportation. They served as the main mode of transportation prior to the introduction of railroads. The Indian mainland and its island groupings have more than 6100 kilometres of coastline. There are Thirteen large ports along this lengthy stretch of coastline that are under central management. The state governments also manage more than 200 smaller ports that are in operation. Ninety percent of the nation's international waterborne trade is handled by the 13 major ports.

There are two kinds of water ways in India. They are (1) Inland Water ways (National water ways) and (2) Maritime water ways (International water ways).

(1) Inland waterways: They are also known as National Waterways (NWs). They encompass rivers, canals, backwaters, creeks etc. But their share is about 1% in the transportation of the country. These are in a very bad situation in India. For the development, protection and regulation of shipping and navigation in India *'The Inland Waterways Authority of India'* has been formed in 1986. It has declared 106 new inland waterways as national waterways in India. Together with already existing 5 waterways, the number of national waterways in the country increased to 111, which cover about 20,375 kms waterways in 24 states. We are actually utilizing 14,500 kms of waterways.

Important National waterways in India:

(i) NW – 1: *Ganga river between Allahabad and Haldia covering a distance of about 1620 km.* This is the longest National waterway in India.

(ii) NW – 2: *Brahmaputra River is navigable* from Sadiya to Dhubri in Assam state *a distance of 1384 km. Out of which only 891 km lies in India, the rest being in Bangladesh.* The Bramhaputra River is navigable from Sadiya to Dhubri in Assam state with a length of 891 km. It was declared as NW-2 on 1st September, 1988.

(iii) NW – 3: *The Kollam and Kotapuram stretch of west coast cannal along with Champakara and udyogmandal canals in Kerala which stretches for about 205km.* It is the first national water way in India useful for 24 hours navigation.

NW – 4: This NW includes Godavari and Krishna rivers and Kakinada to Puducherry Canal. it was declared in 2008. It has a length of 1095 km and the second longest NW in India. This NW includes Godavari and Krishna rivers and Kakinada to Puducherry Canal. The Kakinada and Puducherry Canal includes Kakinada Canal, Eluru Canal, Commamur Canal, North Buckingham Canal and South Buckingham Canal from north to south respectively.

Source: NCERT

(i) NW – 5: This includes the Brahmani River and Mahanadi River system along the east coast. It has a length of 623 km and was declared as NW-5 in 2008.

(ii) NW-6: It was declared as NW in 2013. This NW is proposed between Lakhipur to Bhanga on Barak River (Aai) a tributary of Brahmaputra River.

The factors that influence national water ways in India are as the following:

(i) Diversion of water of rivers for irrigation.

(ii) Silting of river beds reduces the depth of river water.

(iii) Seasonal fluctuations in the water level of the rivers.

(iv) Presence of bridges, waterfalls and cataracts in the course of rivers.

(v) An unequal competition with railways and road ways.

Inland water ways in India have not been developed as they cannot compete with the railways and roads.

(2) Maritime waterways: They are also known as "International Waterways". The water ways authority of India has divided the ports of the country into three types. They are: Major ports, Intermediate ports and minor ports. At present, in India, there are 13 major ports and more than 200 minor and intermediate ports.

The major sea ports along the western Sea coast (Arabian sea) include Kandla, Mumbai, Jawahar Lal Nehru Port (at Nava Seva), Marmugao, New Mangalore and Kochi. The remaining five ports are Tuticorin, Ennore, Chennai, Visakhapatnam, Paradeep (Paradwip), Kolkata and Haldia. Thus, all the states on the western coast and eastern coas have at least one major port. The Jawahar Lal Nehru port of Navi Mumbai is the most modern port.

Check Your Progress

(v) What are the different types of waterways in India?

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24.6 Air ways

The swiftest and most practical form of transportation is airways, although being more expensive than other options. An aeroplane can travel from Delhi to Bangalore in approximately two and a half hours, whereas a railway express train will take approximately 42 hours to go same distance.

In areas where land transportation is hard to build, airways become extremely crucial. These areas might have tall mountains, marshlands, hills, and lush woods. India is favourably situated on a busy international air route, connecting North America, Europe and South-west Asia on the one hand and East and South-east Asia together with Australia on the other.

The first air transport in India began on 18 February, 1911 between Allahabad to Nainital with a 10 km air mail services. In 1953, The Air India International and Indian Airlines two corporations were formed to start International and domestic services respectively. In the public sector, there are Air India Indian Airlines, Air India Charters Limited and Alliance Air. In the private sector, there are several scheduled airlines (passenger), namely, Jet Airways, Sahara Airlines, Deccan Aviation, Spice Jet, Go Airways, Kingfisher Airlines, Paramount Airways and Indigo. There is also one cargo private scheduled airline, i.e., Blue Dart Aviation.

(i) **Air India:** It provides international air services. By handling the international airports and connecting India with other countries across the world. It handles the foreign traffic which includes both cargo and passenger services. Presently, air India providing services to 170 countries.

(ii) **Indian Air Lines:** This handles the domestic air services. There are regular flights among the state capitals and major cities of the country. This also provides services to the places of tourist interest. It provides services to neighbouring countries such as Sri Lanka, Nepal, Bangladesh, Pakistan, Malaysia, Singapore, Male and Middle East. At present, it is providing air services to 19 nations.

Pawan Hans Helicopter Limited: It a public sector company, is engaged in providing helicopters services to ONGC and OIL. It's also used by various State Government.

Vayuduth: It services were began on 20th January, 1981. The vayuduth provides services in accessible and remote areas which do not covered by Indian airlines.

Air India and Indian Airlines were merged and emerged as Air India Limited on 27th February, 2011. As of 2022, there are about 137 operational airports in India. The table discloses about the important airports in the country.

Table: The list of the Important Airports in India (as of 2021)

S. No.	Name of the Airport	City/ State
1.	Rajiv Gandhi International Airport	Hyderabad, Telangana
2.	Sri Guru Ram Dass Jee International Airport	Amritsar, Punjab
3.	Lokpriya Gopinath Bordoloi International Airport	Guwahati, Assam
4.	Biju Patnaik International Airport	Bhubaneswar, Odisha
5.	Gaya Airport	Gaya, Bihar
6.	Indira Gandhi International Airport	New Delhi, Delhi
7.	Veer Savarkar International Airport	Port Blair, Andaman and Nicobar Islands
8.	Sardar Vallabhbhai Patel International Airport	Ahmedabad, Gujarat
9.	Kempegowda International Airport	Bengaluru, Karnataka
10.	Mangalore International Airport	Mangalore, Karnataka
11.	Cochin International Airport	Kochi, Kerala
12.	Calicut International Airport	Kozhikode, Kerala
13.	Trivandrum International Airport	Thiruvananthapuram, Kerala
14.	Chhatrapati Shivaji Maharaj International Airport	Mumbai, Maharashtra
15.	Dr. Babasaheb Ambedkar International Airport	Nagpur, Maharashtra
16.	Jaipur International Airport	Jaipur, Rajasthan
17.	Chennai International Airport	Chennai, Tamil Nadu
18.	Tiruchirappalli International Airport	Tiruchirappalli, Tamil Nadu
19.	Chaudhary Charan Singh International Airport	Lucknow, Uttar Pradesh
20.	Lal Bahadur Shastri International Airport	Varanasi, Uttar Pradesh
21.	Netaji Subhas Chandra Bose International Airport	Kolkata, West Bengal
22.	Kannur International Airport	Kannur, Kerala
23.	Surat Airport	Surat, Gujarat
24.	Devi Ahilya Bai Holkar Airport	Indore, Madhya Pradesh
25.	Dabolim Airport	Dabolim, Goa
26.	Coimbatore International Airport	Coimbatore, Tamil Nadu
27.	Sheikh ul-Aalam International Airport	Srinagar, Jammu and Kashmir
28.	Imphal International Airport	Imphal, Manipur
29.	Madurai Airport	Madurai, Tamil Nadu
30.	Bagdogra International Airport	Siliguri, West Bengal
31.	Mangalore International Airport	Mangalore, Karnataka
32.	Chandigarh International Airport	Chandigarh
33.	Nashik Airport	Nashik, Maharashtra
34.	Vadodara Airport	Vadodara, Gujarat
35	Kushinagar Airport	Kushinagar, Uttar Pradesh

Source: Compiled by author from Khullars' India a Comprehensive Geography.

Check Your Progress

(vi) Write about Air India and Indian Airlines?

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24.6 Trade

Trade refers to the services that include the purchasing and selling of things. Similar to banking, transportation, and other tertiary services, it is crucial infrastructure for the growth of the nation's industry and agriculture as well as the economy. Trade can occur on a local, regional, national, or worldwide scale.

Trade expansion is reliant on the availability of a sophisticated market and sophisticated communication infrastructure.

Types of Trade: On basis of geographical locations, trade can be divided into three types; i) Local trade; ii) regional trade iii) International or Foreign Trade.

(i) **Local Trade:** It takes place in towns, cities, and villages. Local markets are the places where things are exchanged and locally needed items are produced. The primary means of transport to organize local trade are roads, railroads, etc.

(ii) **Regional trade**: This type of trade takes place between two regions, states, or nations that differ in terms of boundaries, religion, climate, and other factors.

(iii) **International or Foreign trade**: this includes export and imports. Export refers to the transfer of goods or commodities from one nation to another. Imports are the exchange and bringing of goods into a nation from another. International trade is the exchange of goods between two or more nations.

International Trade

It involves selling and buying various commodities at the international level. International trade may be multilateral or bi-lateral; depending upon the number of parties involved. India's international trade has grown very rapidly after Independence. India's total international trade has increased from US$2.5 billion in 1950-51 to US$758 billion in 2014-15. However, over the past several years, India's imports and exports have both sharply decreased, mostly as a result of a drop in the price of commodities and a collapse in worldwide demand. Over the past 25 years, India's exports have expanded more than 17 times, from US$ 18.1 billion in 1990–1991 to US$ 309 billion in 2014–15, and its imports have increased 19 times, from US$ 23.5 billion in 1990–1991 to US$ 447 billion in 2014–15.

Exports

During the colonial era, the main goods we exported were either food products like wheat, tea, coffee, and spices, etc., or raw materials like cotton, jute, leather, spices, and minerals. Britain served as the intermediary for all trade. Due to the nation's quick industrial development after independence, the export goods have undergone substantial modifications. India exports around 7,500 items these days. Over the past 25 years, there has been a appreciable growth in exports from US$ 18.1 billion in 1990–1991 to US$ 309 billion in 2014–15. The exports from India have expanded more than 17 times. After independence, there has been a significant change in the export products. The largest value of exports is now obtained manufactured products.

Imports

Since its Independence, there has been a sharp increase in the value of imports in India. Currently, we import roughly 6000 commodities. Prior to independence, the primary imports were products such as textiles, machinery, manufactured goods, chemicals, and medications. Due to the country's split, India's imports throughout the early decades of its independence were mostly made up of food grains. In last two and half decades, the imports value in India has surged 19 times, from US$ 23.5 billion in 1990–1991 to US$ 447 billion in 2014–15. The other main imports include artificial resins, machinery, project goods, pharmaceutical and medical items, coal, coke and briquettes, artificial resins, pearls, and precious and semi-precious stones.

The Recent Trends in Foreign trade in India

When India gained its independence, it had virtually little international trade. India was the major importer of machinery and manufactured goods and exporter of primary commodities. Following independence, both industry and agriculture have advanced quickly. The global market has grown as well. Over the past few decades, there has been a significant shift in the import and export of commodities. To promote its exports, India has established economic ties with nations in Asia, Africa, and Oceania. Export promotion has benefited from incentives like lower interest export credits and the removal of export limitations and controls. The export of commodities with value addition is prioritised.

India's exports during the post-liberalization era have changed significantly, with a growing share of developing nations and a declining share of advanced and established economies. Between 1990–1991 and 2014–2015, Asia's share increased from 34 to 49 percent, while Africa's share increased from 3 to 11 percent. Nonetheless, Europe's share of the total has dropped over this period, from 41% to 19%. POL (petroleum) has continuously been the most important import into India's trade, both before and after the reform. It made up 27% of all imports in 1991–1992, while now it makes up about 33% of all imports. Gold is the second most important import after crude oil.

In recent years, India's trade has greatly expanded its market diversity. The percentage of India's exports to the US and the EU declined from 23,6% and 20,1% in 2004–05 to 18,6% and 17,2% in 2013–2014, appropriately. Between 2004 and 2013, India's imports and exports to the US, Singapore, the EU, and Africa increased, while those from Asia and Africa decreased.

Balance of Trade

The balance of trade is defined as the difference between the value of imports and exports. A country's foreign trade is balanced when the value of its imports and exports is equal. If exports exceed the imports, it is favourable; and on the other hand, when imports are more than exports, it is unfavourable trade.

Our foreign commerce was beneficial at the time of independence, but in the first 20 years of post-independence, India's imports rose significantly as a result of the imports of food grains. The nation currently imports more goods than it exports. As a result, our overseas commerce is no longer beneficial.

Recent Trends in Balance of trade in India:

- India trade balance for 2022 was $-151.46B, a 82.18% increase from 2021.
- India trade balance for 2021 was $-83.13B, a 690.53% increase from 2020.
- India trade balance for 2020 was $-10.52B, a 85.61% decline from 2019.
- India trade balance for 2019 was $-73.07B, a 28.13% decline from 2018.

Check Your Progress

(vii) Mention the types of trade?

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24.7 Summary

Trade and transportation are crucial economic infrastructure resources for any country. They support industrial and agricultural development specifically as well as the growth of the economy as a whole. The modes of transportation are air, sea, road, and railway. They have a significant role in fortifying national solidarity. Additionally, they are the nation's main engine of social and economic prosperity. The development and expansion of various transport were focused in this lesson.

The trade relations of India have grown very rapidly after Independence. India has bilateral trade with many developed and developing countries. There has been a significant change in the commodities of export and import after independence. India has now adopted the policy of liberalisation of trade removing restrictions on imports. Despite phenomenal growth in foreign trade India's share in world trade is very low - not even one per cent.

24.8 Check Your Progress – Model Answers

(i) There are four modes of transport: Road ways, Railways, Airways and Water Transport.

(ii) The Nagpur Plan classifies roadways into four types on the functional basis as the following: National Highways, State Highways, District Roads and Village roads.

(iii) Vande Bharath, also known as Train 18, is India's first semi-high speed train to be planned and constructed domestically.

(iv) Presently, Indian railways network has been divided into 18 zones.

(v) There are two kinds of water ways in India. They are (1) Inland Water ways (National water ways) and (2) Maritime water ways (International water ways).

(vi) Air India: It provides international air services. By handling the international airports and connecting India with other countries across the world. Indian Air Lines: This handles the domestic air services. There are regular flights among the state capitals and major cities of the country.

(vii) On basis of geographical locations, trade can be divided into three types; i) Local trade; ii) regional trade iii) International or Foreign Trade.

24.9 Terminal Questions

Essay Questions

1. Describe the growth of roadways in India?
2. Explain about the important National water ways in India?

Short Questions

3. National highways
4. Distribution of railway network in India

5. Major exports and imports of India trade

Very short question

6. What is the largest National Highway in India?

7. What is the first railway zone in India?

8. How many major sea ports are there in India?

9. Which is the longest National waterway in India?

10. Mention the total railway network in India as of 2021?

24.10 Further Readings

- INDIA A Comprehensive Geography, 2022, by DR Khullar, Kalyani Publisher, New Delhi, India.
- Senior Secondary Course of Geography, NIOS, Noida, India.
- Intermediate Geography, Second Year, Telugu Academy, Hyderabad.
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Chapter - 25

POPULATION GROWTH, DISTRIBUTION AND DENSITY

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25.0 Introduction

We have looked into natural resources and various human activities of India, in the previous lesson. They consist of resources related to land, soil, water, forests, minerals, and wildlife. Along with the above-mentioned resources' distribution, we have also recorded the direction and rate of their extraction and utilisation for development. Studying each of these facets in light of the population in India is necessary. People include both the aggregate number of consumers and the individuals who generate or manage natural resources. In order to do this, we consider their health, education, and social and occupational abilities as well as, most importantly, their goals and value system, which includes their work habits and "work ethics."

In this situation, you would understand that people are not just consumers but also a nation's most valuable resource. This lesson will look at India's population in relation to other countries. We'll look at population distribution, density, and the several factors that affect them. Finally, we will examine population growth trends, including their causes and effects.

25.1 Objectives

After completing this lesson, you will be able to understand:

- Describe the size of the Indian population in relation to the rest of the world.
- Learn the patterns in population increase since 1901
- Examine the causes of the unequal distribution of the population; and
- Explain the problems and difficulties brought on by population growth.

25.2 Population Size and Growth

Size: India is the world's second most populous country, after China. According to 2011 Census, the total population of India accounts 1,210,854,977 (about 1210 million or 1.21 billion). This represented 16.7% of the global population. Put another way, there is an Indian for every sixth person on the planet. India comprises only 2.42% of the world's total geographical area.

India is ranked seventh in the world by area, behind the US, Australia, Brazil, China, Russia, and Canada. With the exception of China, the combined population of these five sizable nations is far lower than that of India. It is also evident from the fact that India has a larger population than all of North America, South America, and Australia combined. Furthermore, the population is growing by more than 17 million every year. It exceeds Australia's whole population. In actuality, China's annual net population growth is lower than growth of India (see figre 25.1).

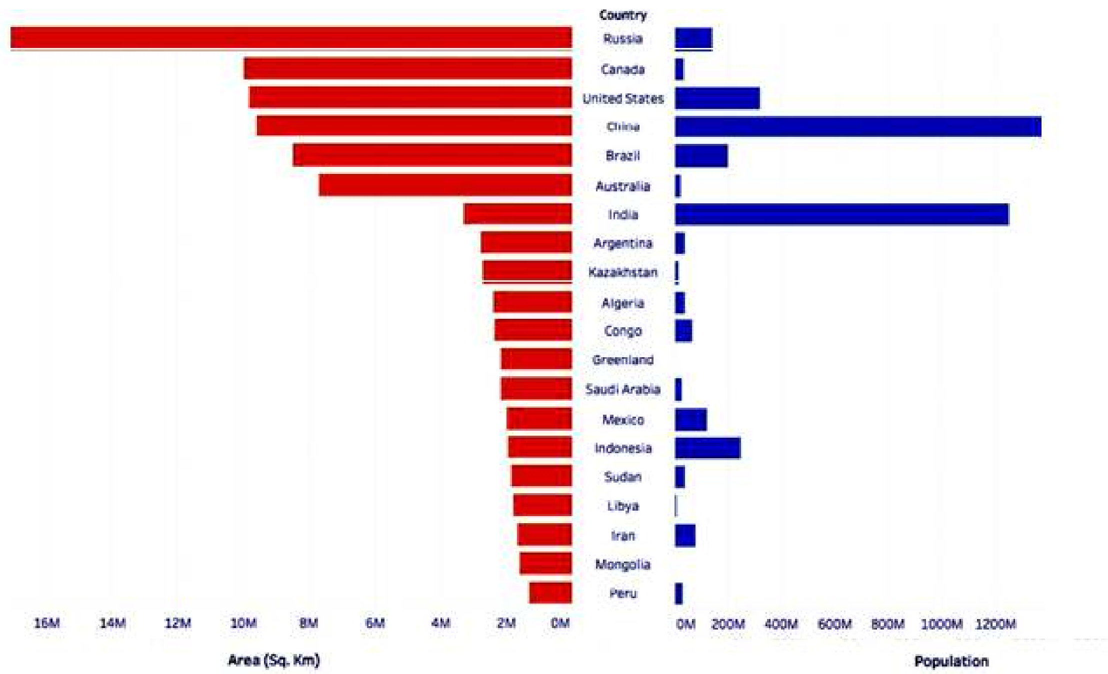

Figure: 25.1

Based on interpolation of the latest United Nations data, the estimated population of India is 1,393,409,038 (also known as 1.39 billion, 1393.4 million, or 139 crore) as of July 1, 2021. In 2020, the estimated total population of India will be 1,380,004,385 (or 1.38 billion, or 1380.04 million, or 138 crore people). After China, India has the second-highest population in the world. Based on current estimates, India is expected to surpass China as the world's most populated nation by 2027, with 1.47 billion people. And India will surpass the 1.5 billion mark by 2030. India's population is expected to peak in 2059 at 1.65 billion, and then decline to 1.45 billion by 2100.

Population Growth: The growth of population in a region depends upon fertility, mortality and migration. The total number of live births per thousand people annually is used to calculate fertility, also known as the 'birth rate'. Numerous social, economic, and demographic factors generally have an impact on the fertility rate. A death rate, often known as mortality, is expressed as the total number of deaths per thousand people in a given year. The term "natural growth rate" refers to the difference between these two rates, or fertility and death. The movement of people across national borders or between different areas is referred to as migration. The number of people residing in a region changes depending on the rate of migration, which impacts the region's population growth.

There are two possible population growth rates: positive and negative. A region's population is said to be growing when its growth rate is positive; on the other hand, a declining population is indicated by a declining growth rate. When there are more births and in-migration than out-migration and deaths, there is a positive growth rate; in contrast, a negative growth rate is the exact opposite of a positive growth rate.

Table 25.1: India: Decadal Growth of Population 1901-2011

Census Year	Total Population (in millions)	Absolute Growth	Growth (In %)	Annual Growth rate (in %)
1901	238.40	———-	———	——-
1911	252.09	+ 13.70	5.75	0.56
1921	251.32	-0.77	-0.31	-0.03
1931	278.98	+11.00	11.00	1.04
1941	318.66	+39.68	14.22	1.33
1951	361.09	+42.43	13.31	1.25
1961	439.23	+78.15	21.64	1.96
1971	548.16	+108.92	24.80	2.22
1981	683.33	+135.17	24.66	2.22
1991	843.39	+163.06	23.86	2.14
2001	1027.02	+180.63	21.34	1.93
2011	1210.19	+181.58	17.64	1..62

Source: Census of India

Table 25.1 shows that there were 238 million (in 1901) people living in our nation as a whole. It increased to the astounding number of 1027 million by 2011. There have been an additional 972 million people in the past century. Since 1901, the rise has increased by around 4.3 times.

The population growth during the past 100 years can be categorized into the following four ways:

(i) Period of stagnant growth rate (before 1921): The population was growing slowly, irregularly, and sporadically prior to 1921. The high birth and death rates were the main cause of this. As thus, the natural growth was negligible. A little decrease in the absolute increase occurs in 1911–21 as a result of famines, diseases, etc. The population has been growing since 1921. Therefore, in the population studies of India, 1921 is referred to as the demographic division.

(ii) **Period of steady growth rate (1921-1951):** The population grew steadily between 1921 and 1951. This is a result of the death rates' consistent reduction. The improvement of medical facilities and cleanliness was the primary cause of the fall. Additional contributing elements included the construction of new roads, which made it easier to meet the demands of the food scarcity, and a notable expansion of the agricultural industry. As a result, the population expansion that occurred during this time was referred to as mortality-induced growth.

(iii) **Period of rapid growth rate (1951-1981):** In terms of India's population growth, this is a very important time. Over the course of these three decades, the population nearly doubled. The birth rate declined little during this time, whereas the death rate declined rapidly. As you can see from the table, during this time the birth rate decreased from 41.7 to 37.2 while the mortality rate decreased from 22.8 to 15.0. As a result, there was a significant disparity between the birth and mortality rates, which kept the natural growth rate high. This resulted from the acceleration of developmental efforts, additional advancements in healthcare facilities, better living conditions for the populace, etc. We refer to this development phase as fertility-induced growth.

(iv) **Period of declining growth rate (1981-2011):** Over the course of the last three decades, specifically from 1981 to 1991, 1991 to 2001, and 2001 to 2011, the rate of growth has gradually decreased. It marks the start of a new chapter in India's demographic history. The birth rate decreased dramatically during this time, from 37.2 in 1971–1981 to 24.8 in 1991–2001, while the mortality rate continued to reduce at a slower pace. Over this time, the death rate has decreased from 15.0 to 8.9. This downward tendency is a good thing, and it can be linked to the government's successful promotion of family welfare initiatives and public awareness.

Spatial Variations in Population Growth:

All regions of India are not experiencing the same pace of population growth. In certain areas, the rate is higher than in others. The nation experienced an average decadal increase of 17.64% between 2001 and 2011. According to Census 2011, in terms of inter-state disparities, Kerala has been shown to have the lowest growth rate, at 9.4%, while Meghalaya has registered the highest decadal growth rate during 2001-11 i.e. 27.80%. There is an obvious north-south divide, as shown by the general state-level pattern that develops. While every state in the north and northeast has seen rapid expansion, every state in the south has seen slow growth. This is mainly due to differences in the level of socio-economic development which include high literacy rates, better primary health care facilities, more urban population, more development economy etc.

Check Your Progress

(i) What is the size of population in India as of 2011?

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(ii) What is the annual growth rate of population in India from 2001 to 2011?

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25.3 Distribution of Population

The population of any nation or the world is not dispersed uniformly. The same holds true for India as well. There are poorly populated areas, moderately populated areas, and highly populated areas throughout the nation (figure 25.2). For instance, the plains and lush areas around the Ganga River are thickly populated, yet the steep and forested regions of the Himalaya are sparsely populated. Know why that is the case? These variances are caused by a number of causes. These elements can be roughly divided into two groups: socioeconomic and physical.

Factors responsible for distribution of population:

As we have already in above paragraphs, India's population is not distributed uniformly over its geographical area. There are significant regional differences. Let's examine the different elements that contribute to these differences. These variables that influence population distribution can be divided into two main categories. They are (A) physical factors and (B) socio-economic factors.

A. Physical Factors: The density and distribution of the population are significantly influenced by physical factors. Soil, climate, and landform are examples of physical elements. Despite significant advancements in technology, the global population distribution patterns persist in reflecting the impact of diverse physical elements.

B. **Socio-Economic Factors:** Socio-economic factors are just as significant in determining population distribution as physical elements are. However, there may not be a perfect agreement upon the relative importance of these two determinants. In certain places physical factors play a vital role whereas in some places socio-economic factors have a greater impact. Various socio-economic factors which have impact upon the population distribution are (i) socio-cultural and political factors; (ii) availability of natural resources.

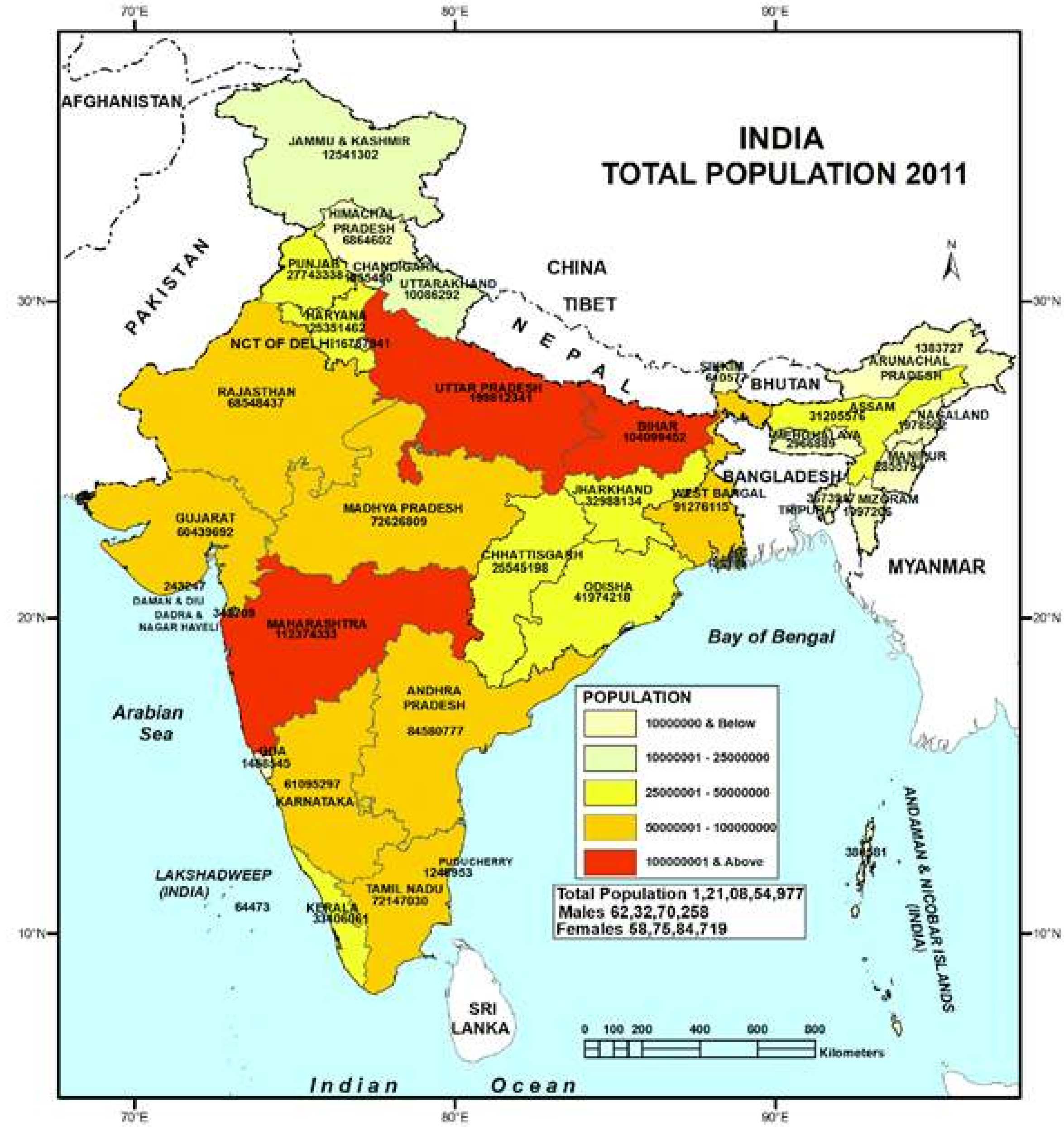

Fig. 25.2: India: Distribution of Population (2011)

25.4 Density of Population

There are numerous ways to compare the population sizes of different regions. Comparing the population's absolute size is one approach. In general, the populations of different nations are compared in terms of population density. This is a technique for comparing various locations' ratios of people to land. In order to compute the number of persons per sq.km, it is assumed that a region's population is dispersed equally throughout. This is known as population density, or simply arithmetic density of population. Therefore, the population density of a country or region is determined by dividing its entire population by its total area.

According to 2011 census, the density of population in India is 382 persons per Sq.km. The density has increased over five times in the last 110 years (1901 to 2011). It has grown from 77 in 1901 to 382 in 2011. The statement that India has a population density of 382 people per sq.km does not imply that there are 382 people in every sq.km. In fact, India has a very unequal population distribution. According to 2011 census, the fact that the average population density in Arunachal Pradesh is only 17 people per sq.km, while in Delhi it is 11,320 people per sq.km demonstrates the unequal distribution of population density in India. Among the states, northern Indian States, Bihar (1106), West Bengal (1028) and Uttar Pradesh (829) have higher densities, while Kerala (860) and Tamil Nadu (555) have higher densities among the southern Indian states. States like Assam, Gujarat, Andhra Pradesh, Haryana, Jharkhand, and Odisha have moderate densities. The hill states of the Himalayan area and the northeastern states of India have comparatively low population densities, with the exception of Assam and Tripura, but the Union Territories apart from the Andaman and Nicobar Islands have extremely high populations.

The population density of India can be broadly categorised into three zones based on state-level data availability: the areas of high density, the areas of moderate density and the areas of low density.

(i) The Areas of High Density: The regions in the above map that have a population density of more than 400 people per sq.km fall under this category. Because of their rich soil and copious amounts of precipitation, West Bengal, Bihar, and Kerala have high densities (figure 25.3). From the map provided above, which more states fit under this category? Because there is more fertile land available in these areas, more people can be fed per unit of area. This is because there is more land available for production of food. However, in the case of Union Territories such as Pondicherry, Chandigarh, and Delhi, the situation is completely different. These heavily urbanised areas provide employment in the service and industrial industries. Therefore, we can conclude that dense population is found in places with fertile land and high employment prospects. Determine which additional states have a high population density.

(ii) The Areas of Moderate Density: States and Union Territories are classified as areas of moderate density of population if there are between 100 and 400 people per square kilometre. They are the following: Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tripura, Chhattisgarh, Uttarakhand, Himachal Pradesh, Nagaland, Manipur, Meghalaya, and Andhra Pradesh. By area, this region encompasses the majority of the nation. In general, regions with a moderate population density are those where agriculture is hampered by rough terrain, little precipitation, and a lack of water for irrigation. If the necessary facilities are made available, there is a lot of room for the development of elementary and secondary activities. For example, at the time of independence

Chhotanagpur region was a sparsely populated area but development in the field of mining and industries in this part of the country has been mainly responsible for moderate density of population in this region.

(iii) The Areas of Low Density: This category includes all of the remaining regions of India where there are fewer than 100 people per sq.km. This category comprises the States and Union Territories - the Andaman and Nicobar Islands, Mizoram, Sikkim, and Arunachal Pradesh. Rough terrain, little rainfall, or an unhealthful climate is characteristics of locations with low population densities. The aforementioned factors make it unlikely for people to make a living in these places. Too much dryness or coldness prevents the development of agriculture. The rate of urbanisation and industrialization is constrained by uneven topography and inadequate agricultural resources. As a result, in these areas, the number of people who can be supported per unit area is minimal. There are challenges with transport and communication in hilly and mountainous locations, but there are also issues with the general levels of economic growth. This explains why there is a low population density in each of these places.

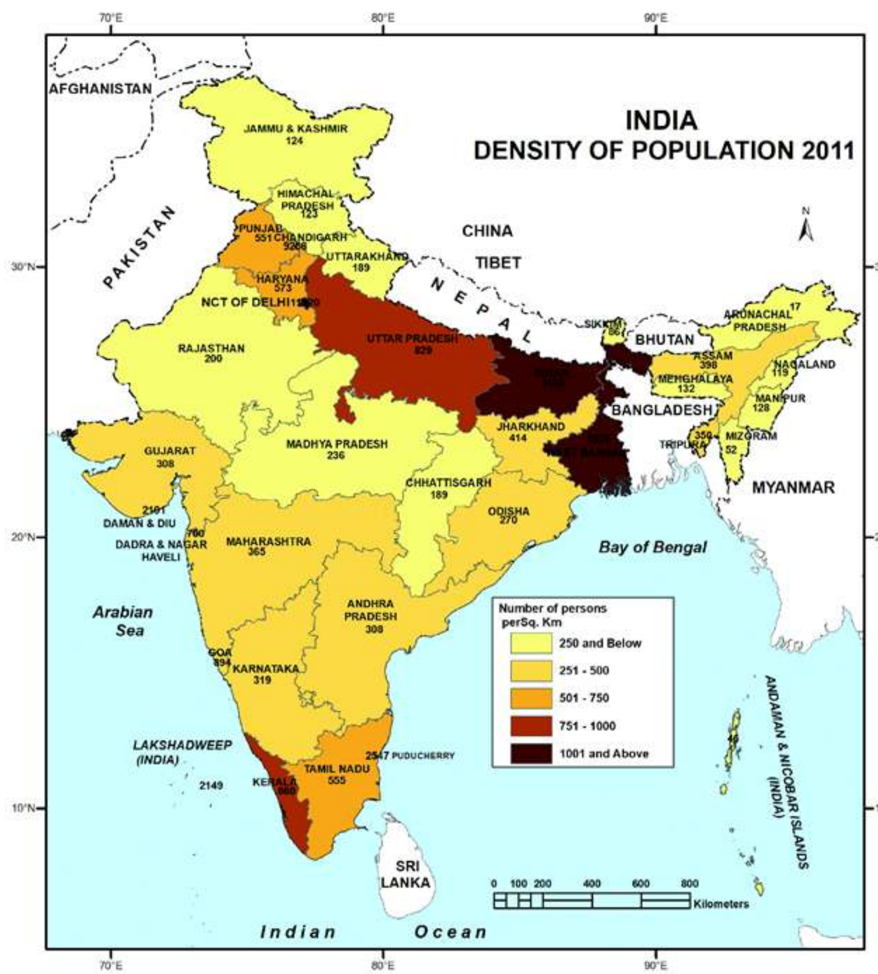

Fig. 25.3 India: Density of Population (2011)

Check Your Progress

(iii) What are the factors responsible for distribution of population in India?

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(iv) What do you mean by population density?

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25.5 Summary

The most valuable resource in a given location is its human resources. For a nation's economy to flourish, the quality of this resource matters more than its amount. After China, India has the second-highest population in the world. Usually, studies of population dispersion consider density. India's population density is not constant. India may be split into three main sections based on population density: high density areas, moderate density areas, and low density areas. Two categories can be used to classify the elements that influence density and distribution. There are two types of factors: socioeconomic and physical. There are two types of factors: socioeconomic and physical. Since 1921, India's population has grown at an incredibly fast rate. The area's migration, birth, and death rates all affect the population growth rate. Similar to density and distribution, there are regional variations in the growth rate across the nation. There have been differing opinions regarding the amount and growth of the people in the nation given its enormous size.

25.6 Check Your Progress – Model answers

(i) According to 2011 Census, the total population of India accounts 1,210,854,977 (about 1210 million or 1.21 billion).

(ii) Annual growth rate of population in India between 2001 to 2011 is 1.63%.

(i) The factors that influence population distribution can be roughly divided into two main categories. They are (A) physical factors and (B) socio-economic factors.

(ii) The population density of a country or region is determined by dividing its entire population by its total area.

25.7 Terminal Questions

Essay questions

1. Explain the growth trends of population in India?
2. Describe the density of population distribution in India?

Short questions

3. Write a note on 2021 population projections of India?
4. What are the areas of high density of population in India?
5. Mention the physical factors that influence distribution of population?

Very short questions

6. Death rate and birth rate
7. Density of population
8. Which state has lowest density of population in India as of 2011?

25.8 Further Readings

- *INDIA* A Comprehensive *Geography, 2022,* by DR Khullar, Kalyani Publisher, New Delhi, India.
- Senior Secondary Course of Geography, NIOS, Noida, India.
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Chapter - 26

POPULATION COMPOSITION OF INDIA

Contents

26.0 Introduction

26.1 Objectives

26.2 Sex Ratio

26.3 Age Composition

26.4 Linguistic Composition

26.5 Religious Composition

26.6 SC & ST Population Composition and Distribution

26.7 Literacy

26.8 Rural and Urban Population

26.9 Summary

26.10 Check Your Progress – Model Answers

26.11 Terminal Questions

26.12 Further Readings

26.0 Introduction

We have already covered the distribution, density, and population growth of India's population. We also studied the factors that influence population density and distribution, as well as their causes. For the last 110 years, we have been considering the reasons behind and effects of the rapid population growth. We will examine the demographic composition of Indians in this course along a few different axes. First, we would like to learn the size, location, and preferred reasons for habitation of various towns. This makes up the population's distribution between rural and urban areas. We shall next ascertain whether the number and, more crucially, the status of males and girls are equal. Our observation will also focus on the age composition of the Indian population and its implications. Then, we would move our focus from the demographic aspects of our population composition to the socio-cultural aspects. This will assist us in understanding the linguistic and religious structure of population community. Lastly, we take a quick look at the population of scheduled tribes and scheduled castes in terms of distribution, number, and location. The literacy rates in our nation are the last, but certainly not the least, significant focus of our investigation. All of these analytical facets would enable us to view our population as human resources in addition to just a collection of numbers.

26.1 Objectives

After learning this lesson, you will be able to understand:

- Understand sex ratio and age composition of population in India
- Explain the spatial and temporal variations of literacy levels in India
- Identify the concentrations of SCs & STs population, and analyse the religious and linguistic population composition in India
- Describe the rural and urban population distribution in India

26.2 Sex Ratio

The number of females per thousand males in an area is known as the "sex ratio." According to 2011 Indian Census, it is found that there are just 943 females per every 1,000 males. Therefore, India's sex composition is not favourable. It indicates that there is less number of women than men in the population. It is considered favourable when there are more females than males. The country's sex ratio has been steadily declining over the past century (1911–2011), with the exception of a few minor gains in 1951, 1981, 2001, and favourable good sex ratio (1058). It boasts the nation's highest sex ratio. Haryana has the lowest sex ratio (877) in our country. With 1,001 females for every 1,000 males, Pondicherry has the greatest sex ratio in the nation among

Union Territories; Daman and Diu has the lowest ratio, with 618 females for every 1,000 males. With a few minor rises in the 1951, 1981, 2001, and 2011 censuses, the country's sex ratio has been progressively dropping, which is a noteworthy trend (see table 26.1).

Table 26.1: Sex ratio in India between 1911 to 2011

Census Year	Sex Ratio
1911	964
1921	955
1931	950
1941	945
1951	946
1961	941
1971	930
1981	934
1991	927
2001	933
2011	943

Source: Census of India, 2011.

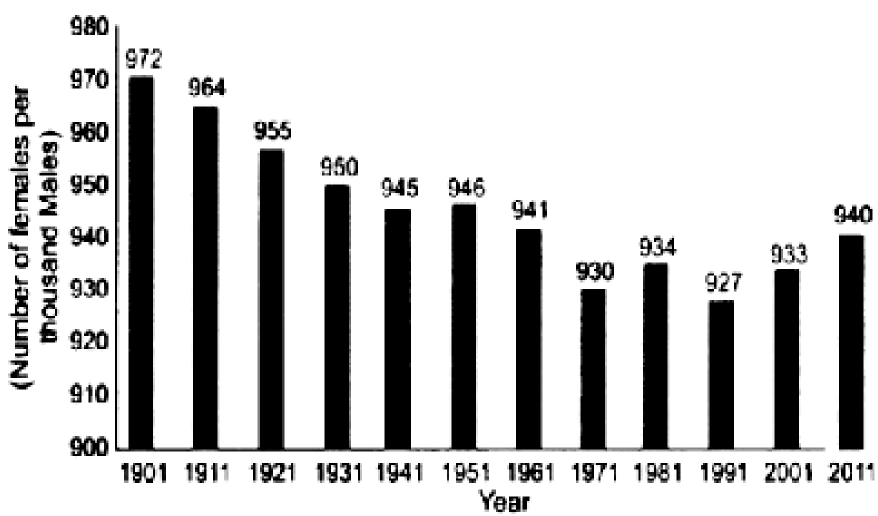


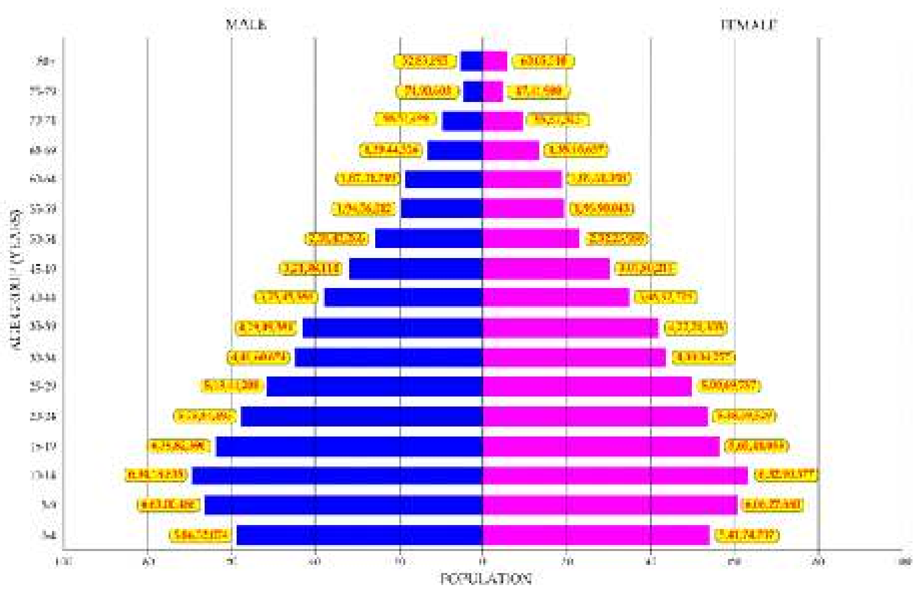
Fig. 26: Trends of Sex Ratio in India, 1901-2011

Reasons for Decline of Sex Ratio in India: The greater risk of maternal death and the high child mortality rate among female offspring are the main causes of India's declining sex ratio. The relatively lower status of women in our culture is connected to these two issues. Apart from this, the sex ratio is decreasing because of our socio-religious values and beliefs, such as male preference in our culture. With women's status improving and access to improved healthcare and education, especially for women, the female mortality rate is probably going to decline. The rate of child mortality and maternal deaths during childbirth has decreased gratitude to the upgraded Medicare facilities.

26.3 Age Composition

The term "age-sex pyramid" describes how the population is divided into two categories: age and sex. It provides information about the population's growth rate as well as its composition, including the proportion of working and non-working people. According to census of India 2011, the country's population under the age of 14 is 30.80% and the population under 15 to 59 years age group is 60.7%. The population above the age of 60 years is 8.4% to the total population of India. Over the past few decades, there have been some subtle alterations to the age structure.

The trends is that there is a decrease in the percentage of the younger population, or those in the 0–14 age group, and an increase in the percentage of people in the working age group, or those in the 15–59 age group, as well as the old age population, or those in the 60+ age group. However, the proportion of people in the 15–59 age group rose from 56.9% in the 2001 Census to 60.7% in the 2011 Census. Nonetheless, the percentage of the population in the senior age group rose from 7.4% in the 2001 census to 8.7% in the 2011 census. In the 2011 census, the percentage of people under 14 years old fell from 35.3% in the 2001 census to 30.80%



26.2: Age-Sex Pyramid Graph of India, 2011

26.4 Linguistic Composition

The linguistic diversity of India is as diverse as its natural environment. There are hundreds of languages spoken, together with their various dialects. A total of 1652 languages were identified as mother tongues in India in the 1961 census. Out these only 23 languages collectively made up 97% of the nation's overall population. Only 22 of these 23 numerically significant languages are recognised by the Indian Constitution, aside from English, and are listed in the Eighth Schedule. Assamese, Bengali, Hindi, Telugu, Tamil, Malayalam, Kannada, Marathi, Gujarati, Oriya, Punjabi, Kashmiri, Mauritian, Urdu, Bodo, Dogri, Maithili, and Santhali are among these languages. Sanskrit is the least spoken language of the 22 languages listed above, while Hindi is spoken by the majority of people. Fourteen of these languages were first included in Fourteen of these languages were first mentioned in the Constitution. The language of Sindhi was added in 1967. In 1992, three further languages were added, namely Konkani, Manipuri, and Nepali. Bodo, Dogri, Maithili, and Santali were subsequently added in 2004.

Language has a significant role in culture, and distinct varieties of different languages are spoken throughout India. It adds diversity and richness to Indian culture. Additionally, each of the nation's major languages has an almost entirely distinct regional character, and the distribution of these languages has been used as a foundation for state reorganisations following independence. India may be classified into twelve main language areas based on numerical strength. A linguistic region is thus one where the majority of people speak the same language. Kashmiri, Punjabi, Hindi/Urdu, Bengali, Assamese, Oriya, Gujarati, Marathi, Tamil, Telugu, Kannada, and Malayalam are among the languages that make up India's linguistic regions.

Though all the languages spoken in India seem to be different from each other, they can be grouped into four Linguistic families on the basis of their roots and genesis. The four linguistic families are: Austric Family (Nishada), Dravidian Family (Dravida); Sino-Tibetan Family (Kirata) and Indo-European Family (Arya).

(i) Austric Family: Tribal people of Meghalaya, the Andaman and Nicobar Islands, and some areas of the Central Indian tribal belt particularly in the districts of Santhal Praganas, Ranchi, and Mayurbhanj speak the Austric family's language.

(ii) Dravidian Family: The southern region of India has a higher concentration of speakers of Dravidian languages. The majority of people in the states of Tamil Nadu, Andhra Pradesh, Karnataka, and Kerala—Union Territory of Pondicherry—speak these languages. Many of the indigenous people that inhabit the Peninsular Plateau also speak this family's languages.

(iii) Sino-Tibetan Family: Tribal people in the country's northeast and northwest, as well as in the Sub-Himalayan region, speak languages and dialects belonging to the Sino-Tibetan family.

People, who live in the Union Territory of Ladakh, as well as in some areas of Himachal Pradesh and Sikkim, speak these languages.

(iv) Indo-European Family: The northern and central regions of the nation are home to a greater concentration of speakers of the Indo-Aryan language family. The speakers of this family live throughout the North Indian plain. There are also many speakers of these languages in the states of Maharashtra and Madhya Pradesh.

There are large variations in the percentage of the overall population that speaks languages belonging to different families. Speaking the languages of the Indo-Aryan family, over 70% of people speak them; on the other hand, just 0.85% of people speak Sino-Tibetan languages, and only 20% of people speak Dravidian languages.

26.5 Religious Composition

There are many different religious communities in India. However, there are basically seven major religions. One of these seven major religions is practised by the majority of people. These include Zoroastrianism, Jainism, Buddhism, Sikhism, Islam, Christianity, and Hinduism. The majority religious group in India is Hindu.

Table 26.2: Population by Religion in India- 2011

S. No.	Religion	Population inn Crores (%)
1	Hindu	96.63 (79.8%)
2	Islam	17.22 (14.2%)
3	Christian	2.78(2.3%)
4	Sikh	2.08 (1.7%)
5	Buddhism	0.84 (0.7%)
6	Jain	0.45 (0.4%)
7	Other Religions and Pursuations	0.79 (0.7%)
8.	Religion Not Stated	0.25 (0.2%)

As per the 2011 census, 79.8% of the population follows Hindu religion. This religion's adherents are primarily found in the northern plains and northern regions of the plateau. Nonetheless, they are widely distributed throughout the nation, with the exception of a few north-eastern states and Lakshadweep's union territory. However, there are only a few areas where the other religious communities are more concentrated, and their distribution is less uniform overall.

In India, Uttar Pradesh has the highest concentration of Muslims, followed by West Bengal and Bihar. However, a sizable majority of the people living in Jammu & Kashmir and the Union Territory of Lakshadweep are Muslims. Assam and Kerala are two other states where the Muslim population is significantly higher than the national average, in addition to the aforementioned states and the Union Territory. With the exception of Kerala and Jammu & Kashmir, the majority of these states are spread across the Northern Plains when we examine their spatial distribution.

In India, Kerala has the highest concentration of Christians, followed by Tamil Nadu and Andhra Pradesh. However, when compared to the whole population, it is concentrated in Mizoram, Meghalaya, and Nagaland, three northeastern states. Regarding Sikhs, Punjab alone is home to more than ¾ of the Sikh population. The Sikh population is concentrated in the bordering districts of Rajasthan and Haryana in addition to Punjab. In addition to these states, there are sizable Sikh populations in the National Capital Territory of Delhi and the Terrai region of Uttarakhand. Maharashtra has the highest concentration of followers of both Buddhism and Jainism among all the states.

In addition to Maharashtra, there are traditional Buddhist communities in the Union Territory of Ladakh, Dharamsala (Mcleodganj), and the nearby districts of Tripura, Himachal Pradesh, Sikkim, and Arunachal Pradesh. Similarly, Jains are well-represented in the states of Rajasthan, Gujarat, Madhya Pradesh, and Chhattisgarh in addition to Maharashtra.

Check Your Progress

(i) What is the sex ratio of India (2011)?

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(ii) Mention the linguistic families in India?

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26.6 SCs & STs Population Composition and Distribution

Indian Constitution has recognised many castes and tribal groups. Scheduled classes (SC) and Scheduled Tribes (ST) are the names given to certain classes and tribes, respectively. They make up the majority of India's population. Scheduled Tribes make up 8.6% and Scheduled Castes 16.6%, respectively, of the 2011 Indian census results. They are dispersed quite differently across the nation.

(1) Scheduled Castes

In terms of numbers, Uttar Pradesh has the highest concentration, followed by West Bengal and Bihar. There are the fewest SC people in Mizoram. There are no recognised SC Populations in the Union Territories of Lakshadweep, Andaman & Nicobar Islands, or the state of Nagaland. When it comes to the percentage of a state's total population that they represent, Punjab has the highest number, making up about 28.85% of the total, followed by Himachal Pradesh (24.7%) and West Bengal (23.3%). The majority of the Scheduled Castes are landless agricultural labourers, small-scale landholder cultivators, and artisans or makers of commodities. The country's alluvial and coastal plains are home to their largest populations because of their link with agricultural activity. Because of this, the states of Punjab, Uttar Pradesh, West Bengal, and Bihar have the highest concentrations. On the other hand, the Scheduled Castes are underrepresented in the hilly, forested areas and tribal belt of central and northeastern India. The following three zones are determined by the examination of the district level pattern.

(i) Area of High Concentration: The Scheduled Castes are concentrated in two main places. They are the eastern coastal plain and the Indo-Ganga plain. These plains are blessed with rich soil, a sufficient amount of water, and a climate that allows for the cultivation of a wide range of crops. These chances contribute to the development of intensive agriculture, which feeds a sizable population.

(ii) Area of Medium Concentration: As was previously said, the districts bordering the zone of high concentration are home to a moderate concentration of Scheduled Castes.

(iii) Area of Low Concentration: The hilly regions of the northeast, the coastal regions of Karnataka and Maharashtra, the western dry region of Rajasthan, the central Vindhyas, and the Chhotanagpur region are among the areas with a low concentration of Scheduled Castes.

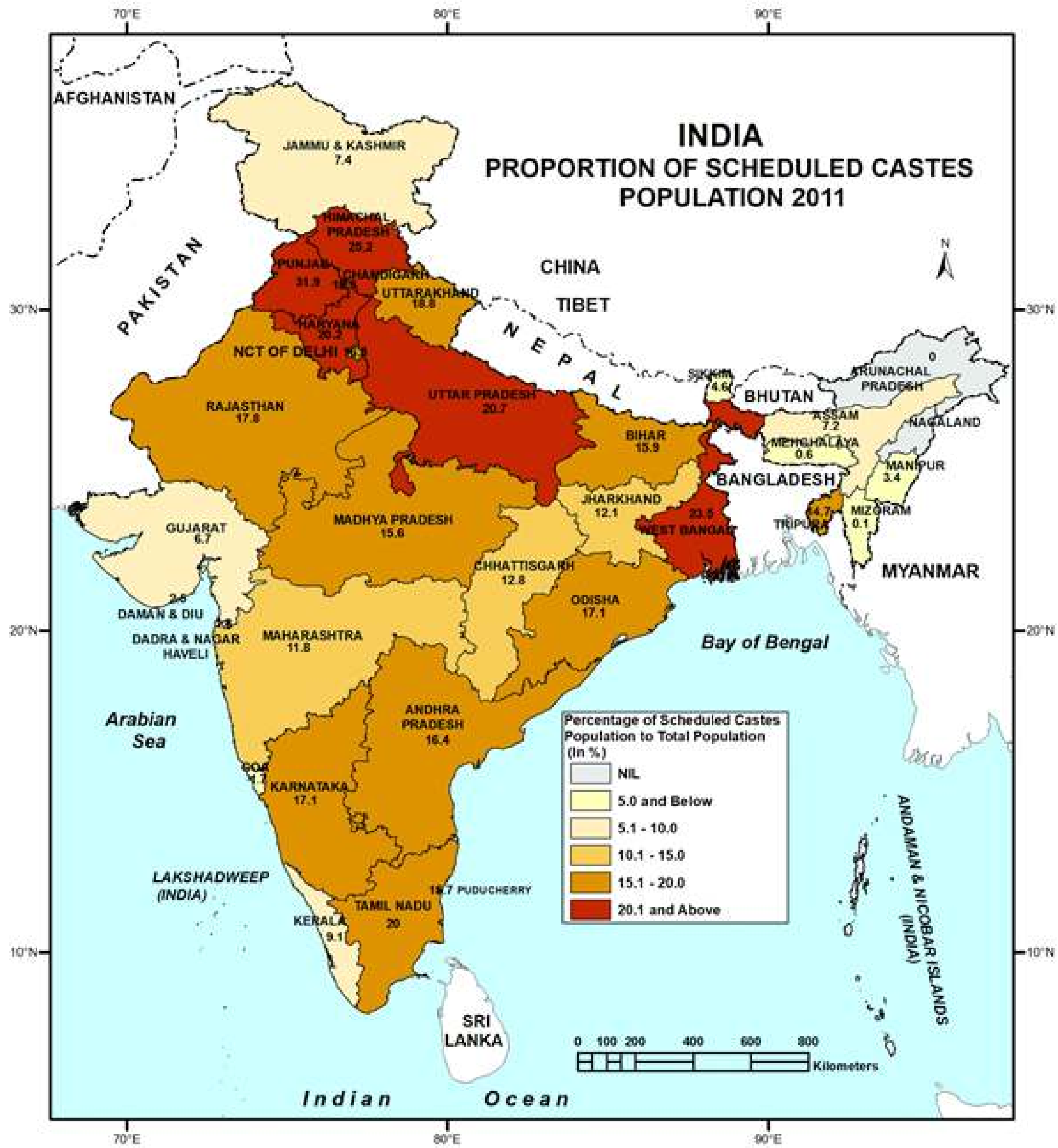

Fig 26.3: Scheduled Caste Population in India

(2) Scheduled Tribes

The tribal people are distinguished from the other people by a variety of unique traits. They generally practise very ancient religious beliefs and live in seclusion in hilly and forested areas. The majority of these groups lack written language in their native tongues and are illiterate. The majority of them think that supernatural entities and abilities exist. There is variation in the Scheduled Tribes' geographic distribution across the nation.

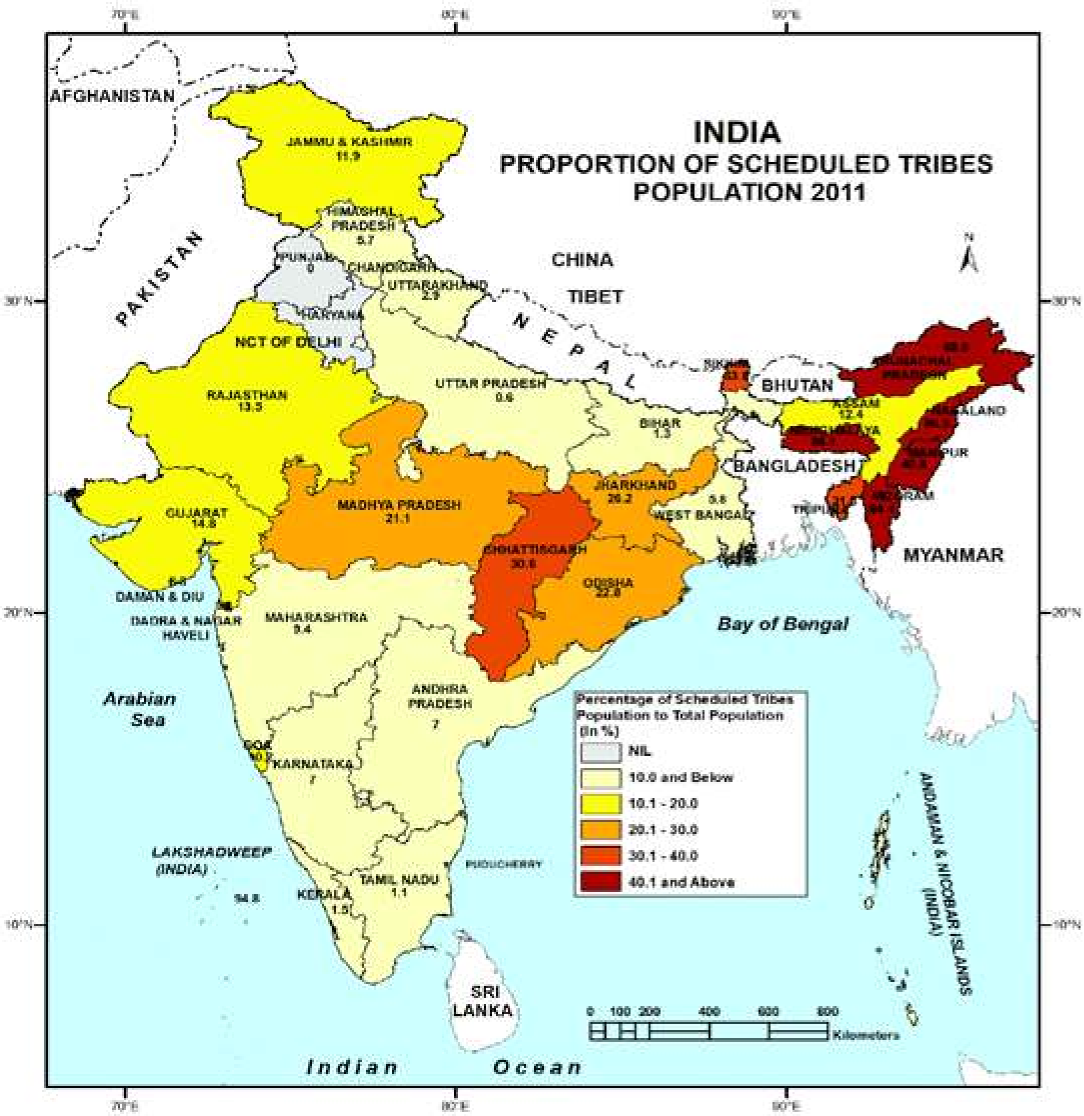

Fig 26.4: Scheduled Tribes Population in India

The majority of ST population concentrated in three primary regions. These areas are:

(i) The Central Indian belt: this region includes portions of West Bengal, Rajasthan, Gujarat, Madhya Pradesh, Chhatisgarh, Jharkhand, and Orissa;

(ii) The North-eastern belt: It comprises the mountainous states of Arunachal Pradesh, Nagaland, Tripura, Meghalaya, Manipur, Mizoram, and Assam

(iii) The Southern belt: this belt includes the hilly areas of Andhra Pradesh, Tamil Nadu, and the Andaman and Nicobar Islands.

The map (see fig 26.4) and the explanation above make it clear that India's tribal population is concentrated in a small number of distinct areas. A detailed examination of the map will also demonstrate that the majority of the tribal population resides in steep, forested areas with poorer agricultural production. The majority of these regions experience climatic and topographical challenges, and all of them have extremely low levels of economic development. The low levels of development are also a result of the limited development of communication and transportation infrastructure as well as the underutilization of natural resources.

26.7 Literacy

Literacy is generally defined as a person's ability to read, write and able to understand as well as to do some simple calculation. Despite this liberal definition, the rate of literacy in India is not very high. As per the 2011 Census of India, the average literacy rate of India consisting of 74.04 %. Those under the age of seven are not included in this percentage. There is a significant disparity in the literacy rate across the country. In terms of literacy percentage, Kerala stands first rank with highest percentage of literacy with 94.00 %, followed by Mizoram, Tripura and Goa, whereas Bihar state stands last place with a literacy rate of only 61.80 %. Among Union Territories, Lakshadweep has the highest literacy percentage of 91.85%, while Dadra & Nagar Haveli has the lowest percentage, at 76.24 %.

There is a gender difference in the literacy rate as well. In India, the average literacy rate for men is 82.14 %, greater than the average for women (65.46 %). Bihar has the lowest rates of literacy for both genders (71.20 and 51.50 %, respectively), while Kerala boasts the highest rates of literacy for both genders (96.11 and 92.07 %, respectively). India has a somewhat high literacy rate; however it is rising with every census. It was less than 6 % in 1911 and could only reach over 16.7 % in 1951. The greatest significant advancement in this area occurred following the 1951 census. The percentage of literate population has increased from roughly 24% in 1961 to 74.04% in 2011. The rate at which female literacy has increased the most notable trend in this regard. In 1911, only 1.1 percent of females were literate; by 2011, that percentage had increased to 65.46 percent. This is mostly a result of government initiatives that prioritise the universalization of elementary education. Expanded educational facilities in rural areas have made a significant contribution to the nation's increased literacy rate, particularly among women.

The percentage of the population that lacks literacy is rising, but so is the total number of illiterate people in every census that follows. The 2001 census shows a decrease in the number of illiterate people for the first time when compared to the 1991 census. They still have a fairly large number, though. The government has launched a number of initiatives to address this issue, including the New India Literacy Programme, Sarv Shiksha Abhiyan, and National Literacy Mission.

- A person who can read and write with an understanding in any one language is called literate.
- According to 2011 census the rate of literacy in India is 74.04%.
- The highest rate of literacy is in Kerala (94.00 %) and the lowest rate is in Bihar (61.80 %).

- The rate of literacy is higher among the males than among the females and in Urban areas than the rural areas.
- The rate of literacy is rising rapidly in India since independence.

26.8 Rural and Urban Population

Based on the size and occupation of settlements, the population is divided into rural and urban population. The people who live in rural areas are dispersed throughout tiny settlements. People who live in big settlements, such as towns and cities, are referred to as urban population. But the basis for this division occupational structure is far more significant. A rural area in India is one where at least three-fourths of the population works in primary industries like farming, animal husbandry, forestry, fishing, quarrying, etc. Conversely, an urban region is defined as one in which at least 75% of the population works in non-agricultural sectors like banking, manufacturing, trade, transportation, and social services like administration, health, and education.

Table 26.3: Rural and Urban Population in India (1901-2011)

	Percentage of total population	
Census Year	**Rural**	**Urban**
1901	89.2	10.8
1911	89.7	10.3
1921	88.8	11.2
1931	88.0	12.0
1941	86.1	13.9
1951	82.7	17.3
1961	82.0	18.0
1971	80.1	19.9
1981	76.7	23.3
1991	74.3	25.7
2001	72.2	27.8
2011	68.8	31.2

Source: Census of India

Rural Population: India's population is distributed throughout 6,40,867 villages and 7,935 towns. India is seen as a nation of villages. The rural population of India accounts 68.8% as of 2011 census. However, the percentage of people living in rural areas has been declining with every census since 1901 (See Table 26.3). The rural population of India in 1901 was 89.7% which decreased to 82.7 % by 1951. It has drastically decreased to 68.8 % by 2011. Since 1991, India's rural population has been growing less rapidly. Highest percentage of rural population is recorded in Himachal Pradesh (89.96%) followed by Bihar (88.7%), Assam (85.92%), and Odisha (83.32%).

Fig 26.5: Metropolitan Cities in India

Urban Population: as per 2011 census, about 37.71 crores of population living in urban centres. As a result of rural to urban migration, the percentage of people living in cities relative to the overall population has been gradually rising. By 2011, it had increased to 31.2% from a low of 10.8% in 1901. This is due to the fact that urban population growth is outpacing that of rural population increase. But the population is growing for other reasons than just natural increase. Actually, a large portion of the population increase in cities can be attributed to the high rate of migration from rural to urban areas. Municipal or city corporation boundaries are frequently expanded to include nearby sub-urbans or villages.

There is a large variation in the level of urbanization across India. Highest urbanized state is Goa with 62.17%, followed by Mizoram (51.51%), Tamilnadu (48.45%), and Keral (47.72%), Maharashtra (45.23%).

In India, half of urban population is existing in five states only. They include Maharashtra, Uttar Pradesh, Tamil Nadu, West Bengal, and Andhra Pradesh. The states of Gujarat, Karnataka, Madhya Pradesh, Bihar, Rajasthan, and the Union Territory of Delhi account for around 32% of the nation's urban population. The remaining states and Union Territories are home to the remaining 18% of the urban population.

According to 2011 census, there are 53 cities in India which have more than one million population. They are called the metropolitan or million plus cities. These 53 metropolitan cities alone account for 37.8% of the total population of India. This faster growth of metropolitan cities will brings several problems like supply of housing, electricity, water, school, dispensaries, ration shops etc. Let us now find out the distribution of these metropolitan cities in India.

The 53 major cities are grouped according to decreasing population levels. These are Mumbai, Delhi, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Jaipur, Kanpur, Lucknow, Nagpur, Ghaziabad, Indore, Coimbatore, Kochi, Patna, Kozhikode, Bhopal, Thrisur, Vadodara, Agra, Vishakhapatnam, Mallapuram, Thiruvananthapuram, Ludhiana, Kanur, Nasik, Vijaywada, Madurai, Varanasi, Meerut, Faridabad, Rajkot, Jamshedpur, Srinagar, Jabalpur, Asansol, Vasai-Virar, Dhanbad, Allahabad, Aurangabad, Amritsar, Jodhpur, Ranchi, Raipur, Kolam, Gwalior, Durg-Bhilainagar, Chandigarh, Tiruchirapalli, and Kota (see fig 26.5)

- About 31.20 % of the total population of India lives in urban areas.
- The proportion of urban population to the total has been increasing steadily at a faster pace.
- The rate of growth of urban population in the country is higher than the rate of growth of rural population.

- The cities which have a population of more than 1,000,000 each are called metropolitan cities or Million Plus Cities. According to 2011 census, there are 53 metropolitan cities in India.

Check Your Progress

(i) What is the literacy rate in India (2011)?

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(ii) Mention the rural and urban population percentage in India (2011)?

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26.9 Summary

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's sex composition is not favourable. According to the Census of India 2011, there are only 943 females per thousand males. It indicates that there is less number of women than men in the population. It is considered favourable when there are more females than males. The country's sex ratio has been steadily declining over the past century. e. The highest number of females per one thousand males in Karala (1058) whereas it is lowest in Haryana (877). The rate of literacy in India is not very high (74.04%). It is the highest in Kerala where the literacy rate is as high as 94% and on the other extreme is the state of Bihar where literacy is as low as 61.80 %.

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. The Schedule Castes are intermixture of various racial stocks. According to 2011 census, Scheduled Castes and Scheduled Tribes constitute 16.60 % and 8.60 % respectively of the total population. As of 2011, Urban population is 31.2% and rural population accounts 68.80%. There are 53 million plus cities in the country.

26.10 Check Your Progress – Model Answers

(i) According to 2011 Indian Census, sex ratio of India is 943 females per every 1,000 males.

(ii) The four linguistic families in India. They are: Austric Family (Nishada), Dravidian

Family (Dravida); Sino-Tibetan Family (Kirata) and Indo-European Family (Arya).

(iii) As per the 2011 Census of India, the average literacy rate of India consisting of 74.04%.

(iv) According to 2011 census, India comprises 68.8 % of rural population and 31.2 % of urban population.

26.11 Terminal Questions

Essay questions

1. Give a detailed account on ST & SC population in India?
2. Describe about age composition of population in India?
3. Write a note on growth of rural and urban population in India?

Short questions

4. What are the reasons for decline of sex ratio in India?
5. Mention the religious composition of population in India?
6. What are the million plus cities in India?

Very short questions

7. Which has highest sex ratio in India?
8. ST population percentage in India?
9. What are the metropolitan cities in India?

26.12 Further Readings

- D. R. Khullar, 2022, India A Comprehensive Geography, Kalyani Publications, India.
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Chapter - 27

HUMAN SETTLEMENTS - RURAL AND URBAN

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27.1 Objectives

27.2 Understanding Human Settlements

27.3 Types of Rural Settlements

27.4 Types of Urban Settlements

27.5 Summary

27.6 Check Your Progress – Model Answers

27.7 Terminal Questions

27.8 Further Readings

27.0 Introduction

In the previous lesson, we have learnt about population composition; total population; rural-urban population; population growth, etc. In the present chapter, our focus will be on human settlements. Therefore, topic will revolve around the concept of settlements meaning and nature, evolution, and classification of rural and urban settlements in India.

27.1 LEARNING OBJECTIVES:

After learning this lesson, you will be able:

- To describe the meaning of settlement and identify different types of rural settlements;
- To define an urban area as stated by census of India;
- To analyze the distributional patterns of rural and urban settlements; and
- To explain functional classification of urban settlements as stated by census of India.

27.2 Understanding Human Settlements

The term settlement is used very often and it is very difficult to understand and define. It can be defined as "any form of human habitation which ranges from a single habitation to large city". The term human settlement has another connotation as well as this is a process of opening and settling of a previously uninhabited area by the people. In geography this process is also known as occupancy.

Human settlements are classified into two categories namely; (i) rural settlements and (ii) urban settlements. Before conversing the meaning and classification of rural and urban settlement in India, it important to identify the differentiate between rural and urban centres.

(i) The difference between rural and urban areas is their function. Rural areas have predominantly dominated by primary activities, whereas urban areas have domination of secondary and tertiary activities.

(ii) Generally, the rural areas have low density of population compared to the urban areas.

27.3 Types of Rural Settlements

The term settlement pattern is used to discourse the spatial arrangement or distribution of settlements within a given zone. It varies from form of settlement. Form of a Settlement express more to the spatial characteristics of individual settlement. However, sometimes forms and patterns are used interchangeably. Then an attempt is made here to explain the patterns only. As far as type of rural settlements is concerned, it implies the degree of dispersion of the dwellings. Several geographers and scholars have identified different schemes of classification.

Settlements found in India, can be broadly be categorized under four groups:

- Compact settlement
- Semi-compact
- Hemleted settlement
- Dispersed settlement.

(a) Compact Settlements: they also known as clustered or nucleated settlements. These settlements are closely built-up areas. In such settlements all the houses are concentrated in one central site and this inhabited area is distinct and separated from the farmlands and open pastures. Most of the settlements in India comes under this category. They are found over almost every part of the country. These settlements are spread over the entire northern Indo-Ganga plain (from Punjab in the north-west to West Bengal in the east), Orissa coast, basins of Mahanadi in Chhattisgarh, coastal areas of Andhra Pradesh, cauvery delta of Tamil Nadu, Maidaus of Karnataka, lower Assam, and Tripura, in the valleys of Siwaliks etc.Very often these settlements have a. definite pattern due to closely built area and intervening street patterns. As many as 11 patterns are identified. Five major patterns are: (i) Linear pattern (ii) Rectangular pattern (iii) Circular pattern (iv) Square pattern (v) Radial pattern

- **Linear Pattern:** The settlements of such pattern are found along main roads, railways, streams, etc. It may have a single row of houses arranged along the main line of transport. For example, rural settlements found along the sea coast, river valley, mountain ranges etc.

- **Rectangular Pattern:** This is a very common pattern which develops around the agricultural fields in rectangular shape. Accessibility to farms and fields and connectivity to other settlements lead to rectangular shape of settlements. The settlements of coastal Maharashtra and Andhra Pradesh and either side of Aravali hills are few examples.

- **Square Pattern:** This is one of the types of rectangular pattern. Such a pattern is found in rural areas lying at the crossing of cart tracks or roads and related to features restricting the extension of the village outside a square space.

- **Circular Pattern:** In the upper Doab and Trans – Yamuna districts, Malwa region, Punjab and Gujarat, large villages are characterized by a very high degree of compactness. The outer walls of houses adjoining each other and present a continuous front so that when viewed from outside, the villages look like a walled and fortified enclosure.

- **Radial Pattern:** In this pattern, several streets converge on one centre which may be a source of water (pond, well), a temple or mosque, a centre of business activity or simply an open space. Thus, the streets seem to be radiating from a common centre. Examples are settlements near Gurushikar, Mount Abu in Rajasthan, Vindhyachal in Uttar Pradesh, etc.

(b) Semi- Compact Settlement: The houses are not very close, are called as semi-clustered or semi-nucleated settlements. Such settlements are characterized by a small but compact nucleus around which hamlets are dispersed. It covers more area than the compact settlements. These settlements are found both in plains and plateaus. Such settlements are situated along streams in Manipur Mandla and Balaghat districts of Madhya Pradesh, and Rajgarh district of Chhattisgarh. Like, compact settlements, semi-compact settlements may also have different patterns. Some of the patterns are (i) checker board pattern (ii) Elongated pattern (iii) Fan shaped pattern.

- **Checker Board Pattern:** This is a type of settlement is found generally at the junction of two roads. The village streets meet each other at an angle or are parallel to each other. This is because of the tendency to align the dwellings along cardinal axes. This pattern is common in the northern plains.
- **Elongated Pattern:** Such settlement occurs because of elongation of the rectangular pattern due to influence of site features. For example, in the Ganga plains, in areas liable to inundation, the rectangular pattern becomes unusually elongated along the high ground. Even otherwise the advantage offered by riverside location forces such a pattern.
- **Fan Shaped Pattern:** This is seen where some focal points or line is situated at one end of the village. A focal object may be a tank a riverside, a road, an orchard, a well or even a place of worship. Such patterns are common in the delta region as in the case of Mahanadi, Godavari, Krishna, Cauvery, etc.

(c) Hamleted Settlements: These types of settlements, are divided into several small units. The main settlement does not have much influence on the other units. Very often the original site is not easily distinguishable and these hamlets are often spread over the area with intervening fields. This segregation is often influenced by social and ethnic factors. The hamlets are locally named as faliya, para, dhana, dhani, nanglay etc. These settlements are generally found in West Bengal in India.

(d) **Dispersed Settlements:** This is also known as isolated settlements. The settlement is characterized by units of small size which may consist of a single house to a small group of houses. Such type of settlements are found in tribal areas of central part of India covering Chhota Nagpur plateau, Madhya Pradesh, Rajasthan, etc. Such patterns are also common in the hills of north Bengal, Jammu & Kashmir, Tamil Nadu and Kerala states.

27.3.1 Factors Responsible for the Type of Rural Settlements

There are three factors that influence the type of settlements in India. These factors are (i) Physical (ii) Ethnic or cultural and (iii) Historical or defense.

- **(i) Physical Factors:** These factors include relief, altitude, soil capability, climate, drainage, ground water level, etc. They influence the type and spacing of dwelling or instance, in dry regions of Rajasthan, water is a crucial factor and, therefore, houses are situated along a pond or well which guides the compactness of the settlement.
- **(ii) Ethnic and Cultural Factors:** These include aspects like caste, community, ethnicity, and religion. In India it is commonly found that the main land-owning caste resides at the center of the village and the other service providing castes on the periphery. This leads to social segregation and fragmentation of a settlement into several units.
- **(iii) Historical or Defense Factors:** In the past, mostly border areas of north- western plains were conquered or attacked frequently by outsiders. For a long time, apart from attack from outsiders, there had been continuous fight between princely states and kingdom within the country therefore, security concerns favored the evolution of nucleated settlements.

Check Your Progress

(i) Define a settlement?

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(ii) What are the factors responsible for type rural settlements?

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27.4 Urban Settlements

The term urban is not a new one and it is always referred to in rural terms. The growth and possible of urban settlements is yet not fully comprehended, otherwise it could have been controlled and its after eect could have analysed. Urban settlements could be studied a s a referral code of urban growth.

According to the census of India urban areas are those which satisfy the conditions given below.

(a) All places with a municipality corporation, cantonment board or notified town area committee etc.

(b) All other places which satisfy the following criteria:

- a minimum population of 5000;
- at least 75 percent of male working population engaged in non- agricultural sector; and
- a density of population of at least 4,00 persons per square kilometer.

Therefore, there are two broad groups of town or urban settlement, namely Statutory towns and census towns. Statutory towns are the places which satisfy the conditions mentioned in (a) category and the census town are centres which fulfil the conditions mentioned in (b) category in above paragraph.

Urban agglomeration may consist of anyone of the three combinations given below:

- a town and its adjoining urban outgrowth;
- two or more contiguous towns with or without their outgrowths; and
- a city and one or more adjoining towns with their outgrowths together forming contiguous stretch.

The extend of cantonment area, port area- seaport and airport, railway colonies, etc. are examples of urban outgrowth.

27.4.1 Types of Urban Settlements

Geographers and scientists have identified several parameters for classification of urban settlements. Nevertheless, the most commonly used classification of urban settlements is based on size and function.

Classification based on Population Size

According to population size, census of India classifies urban centres into six classes as the following:

Table 27.1 Classification of urban settlement

Category	Population Size
Class I	> 1,00,000
Class II	50,000 – 99,999
Class III	20,000 – 49,999
Class IV	10,000 – 19,999
Class V	5,000 – 9,999
Class VI	< 5,000

The urban settlements can be classified into the following four types. They are:

(a) Town: the places which comprises population less than one lakh.

(b) City: It is an urban centre which encompassed population between 1,00,000 and one million.

(c) Metropolitan City: the cities which comprise population between one million and five millions. Examples, Surath, Vijayawada, Nizamabad and Warangal etc.

(d) Mega City: the cities that comprises more than 50,00,000 lakhs of population. For example, Hyderabad, Banglore, Chennai etc.

Functional Classification

The most popular and widely accepted classification of urban places in India as well as in other parts of the world is functional classification. In India, several scientists have attempted to classify urban settlements on the basis of function they perform. But the most popular and widely accepted functional classification was given by Ashok Mitra a noted demographer and the then Registrar General of India. They are as the following:

1. Administrative Towns: they include capital cities, centres of states and district headquarters. These are well organized towns. For example, Delhi, Lucknow, Mumbai, Bangalore, and Hyderabad etc.

2. Commercial Towns: in some towns, retailing and trading is the biggest function. They are called commercial towns. They encompass financial offices, business buildings, banks and oer commercial services. For example, Kanpur, Kanchi, Surath, Agra, Bhopal, and New York etc.

3. Market Towns: these are the urban centres where the collection and distribution of various goods as main function and perform exchange activities. Generally, these urban centres have mandis, wide range of shops, stores, go downs, and warehouses, which are supported by a good network of transport facilities.

4. Mining Towns: The main functions of these turban centres are exploitation of minerals from mining areas. Their location is governed by the availability of mineral resources. For example, Singarani, Raniganj, Jharia, and Bokaro etc.

5. Industrial Towns: these include the urban centres which primarily perform secondary activities of altering raw materials into finished goods or end products. These towns offer facilities of power, labour, market, efficient network of communication and transport. For example, Bangalore (watches), Vishakapatnam (steel), and Ahmadabad (Textiles) etc.

6. Cultural Towns: these urban centres include - educational towns – Patna, Allahabad, Bangalore, Cambridge, Oxford etc., Entertainment towns – Mumbai, Hollywood etc., Religious towns– Varanasi, Rishikesh, Jerusalem, Ayodhya, Mecca etc, Coastal Resorts – Puri, Mumbai, Goa, Kochi etc, Hill Stations – Shimla, Mussorie, and Nainital etc.

7. Defensive Towns: the urban centres which comprise naval docks, air bases and are characterized by barracks, cantonment special air fields, training centres for army, and fortified hospitals. For example, Ambala, Dehradun, Cochi, and Chennai etc.

8. Residential Towns: the towns which are mainly new and planned towns located far from the congested cities. They provide residential facilities for urban population. These are well planned and comprises of healthy environment. For example, Chandigarh and Bangalore etc.

Check Your Progress

(i) What are the two types of towns according to census of India?

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(ii) Define mega-cities?

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27.5 Summary

Any type of human habitation, from a single home to a big city, is referred to as a settlement. The two main categories of settlements are rural and urban. Function is the primary distinction between rural and urban areas. Rural settlements in India can be broadly classified into four groups. They are scattered, hamleted, compact, and semi-compact. In compact towns, homes are gathered in one central location and the area is densely populated. This group includes the majority of our nation's settlements, which are dispersed practically everywhere in the country. India's rural settlement patterns are influenced by a number of significant elements, including physical ethnicity, culture, history, and defence.

Topography, climate, the availability of building materials, and other factors all affect the variations. Urban settlements are categorised using several criteria, much as rural settlements. Classifications based on function and size are more prevalent, though. Urban settlements can be classified as towns, cities, metropolitan areas, or megacities based on their population size. Cities can be categorised into administrative, industrial, transportation, commercial, mining, cantonment, educational, religious, and tourism categories based on their purposes.

27.6 Check Your Progress- Model Answers

(i) Any form of human habitation which ranges from a single habitation to large city.

(ii) There are three factors that influence the type of rural settlements in India. they are: Physical, Ethnic or cultural and Historical or defense factors.

(iii) There are two broad groups of towns or urban settlements, namely Statutory towns and census towns.

(iv) The cities that comprises more than 50,00,000 lakhs of population. For example, Hyderabad, Banglore, Chennai etc.

27.7 Terminal Questions

Essay questions

1. Explain various types of rural settlement in India.
2. Describe various factors influencing settlement types in India.
3. Explain the classification of towns on the basis of function?

Short Questions

4. Compacted Settlements

5. Classification of towns on the basis of size

6. What are Industrial towns?

Very Short Questions

7. Define Settlements?

8. What are Statutory towns?

9. Define Metropolitan cities?

10. What are the examples of commercial towns?

27.8 Further Readings

- D. R. Khullar, 2022, India A Comprehensive Geography, Kalyani Publications, India.
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REGIONAL GEOGRAPHY OF TELANGANA

Chapter - 28

ADMINISTRATIVE DIVISIONS, PHYSIOGRAPHY AND DRAINAGE, CLAIMATE, SOILS AND NATURAL VEGETATION

Contents

28.0 Introduction

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28.2 Administrative divisions

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28.4 Drainage

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28.8 Summary

28.9 Check Your Progress

28.10 Terminal Questions

28.11 Further Readings

28.0 Introduction:

Telangana state was formed on the 2nd of June, 2014. It is a land-locked state located in the southern Indian peninsula on the Deccan Plateau, with Hyderabad as its capital. The region lies between 15°50’10" N and 19°55’4" N latitudes and 77°14’8" E and 81°19’16" E longitudes. It is bordered by Maharashtra on the North and North-West, Chhattisgarh on the East and North-East, Karnataka on the West, and Andhra Pradesh on the South and South-East.

Telangana is ranked 12th in the country in terms of population (350.04 Lakh as per the 2011 Census) and ranked 11th in terms of area (1,12,077 Sq. Km). The region is majorly drained by the Godavari and Krishna rivers with 79% and 69% catchment areas respectively. The official languages of the state are Telugu and Urdu. The state re-organised 10 districts into 33 districts, 459 mandals into 612 mandals, and 8,368 Gram Panchayats into 12,769 Gram Panchayats

Fig 28.1 Telangana Map (Source : Telangana State Portal)

28.1 Objectives:

After learning this Chapter, you will be able to:

- Understand administrative features of Telangana state.
- Understand the physiographic features of Telangana, including its topography and hills
- Explain the significance of the Godavari and Krishna rivers in shaping the region's agricultural practices and water resources.
- Understand Climatic conditions like rainfall , temperature and seasons in the state of Telangana.
- Identify the various soil types in Telangana and their suitability for different crops
- Discuss the distribution and types of forests in Telangana, along with their ecological importance and contribution to biodiversity.

28.2 Administrative Divisions

On 2nd June 2014, Telangana came into existence as the 29th state of India. The total area of the state was 1,12,077 sq km. The number of districts in Telangana state at the time of formation was 10 districts, namely Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Rangareddy, Khammam, Nalgonda, Mahbubnagar, and Hyderabad, with 464 mandals.

As per the AP Re-organisation Act 2014, Telangana state lost seven mandals, namely: Kukunoor, Velairpadu, Chintoor, Kunavaram, Vara Ramachandrapuram, Bhurgampadu, and Bhadrachalam from Khammam district to Andhra Pradesh to facilitate the Polavaram Irrigation Project. Among these seven mandals, five mandals were completely merged, and the other two mandals, i.e., Bhadrachalam and Bhurgampadu, lost most of their area. Finally, there were 459 mandals in Telangana State. For administrative convenience and the effective delivery of welfare and developmental programs to the people, 21 new districts were formed from existing 10 districts on 11th October 2016, the auspicious day of Vijaya Dasami, increasing the total number of districts to 31. Furthermore, on 17th February 2019, Mulugu and Narayanpet districts were created, bringing the total number of districts in Telangana state to 33.

SL No.	District	Revenue Divisions	Total Mandals	Urban Mandals	Revenue Villages	MCs	Municipalities	GPs	MPPs	ZPPs
1	Adilabad	2	18	1	509	-	1	468	17	1
2	Kumuram Bheem	2	15	-	434	-	1	335	15	1
3	Mancherial	2	18	2	385	-	7	310	16	1
4	Nirmal	2	19	1	430	-	3	396	18	1
5	Nizamabad	3	33	2	450	1	3	530	27	1
6	Jagtial	3	20	-	293	-	5	383	18	1
7	Peddapalli	2	14	1	212	1	3	263	13	1
8	Jayashankar	1	11	-	223	-	1	241	11	1
9	Bhadradri Kothagudem	2	23	2	377	-	4	481	22	1
10	Mahabubabad	2	18	-	288	-	4	461	16	1
11	Warangal	3	13	-	191	-	3	323	13	1
12	Hanumakonda	1	14	4	163	1	-	208	10	1
13	Karimnagar	2	16	1	210	1	4	313	15	1
14	Rajanna Sircilla	2	13	1	171	-	2	255	12	1
15	Kamareddy	3	24	-	473	-	3	526	22	1
16	Sangareddy	4	28	1	601	-	8	648	25	1
17	Medak	3	21	-	380	-	4	468	20	1
18	Siddipet	3	26	-	383	-	5	499	23	1
19	Jangaon	2	12	-	176	-	1	281	12	1
20	Yadadri Bhuvanagiri	2	17	-	321	-	6	421	17	1
21	Medchal-Malkajgiri	2	15	10	162	4	9	61	5	1
22	Hyderabad	2	16	16	66	1	-	-	-	-
23	Rangareddy	5	27	6	599	3	13	558	21	1
24	Vikarabad	2	20	-	510	-	4	568	18	1
25	Mahabubnagar	1	17	1	307	-	3	441	14	1
26	Jogulamba Gadwal	1	12	-	203	-	4	255	12	1
27	Wanaparthy	1	14	-	223	-	5	255	14	1
28	Nagarkurnool	4	20	-	358	-	4	461	20	1
29	Nalgonda	3	32	-	566	-	8	844	31	1
30	Suryapet	3	23	-	279	-	5	475	23	1
31	Khammam	2	21	1	380	1	3	589	20	1
32	Mulugu	1	9	-	336	-	-	174	9	1
33	Narayanpet	1	13	-	250	-	3	278	11	1
	Total	74	612	50	10,909	13	129	12,769	540	32

Fig.28.2 List of 33 Districts in Telangana

Source : Telangana State Statistical Abstract - 2022

Check your progress

(i) What are the two new districts created on 17th February 2019, in the state of Telangana?

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(ii) As per the Andhra Pradesh Reorganization Act, how many mandals from Telangana were ceded to Andhra Pradesh?

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28.2.1 Administrative Profile

Telangana comprises of 33 districts, each with its unique identity and administrative responsibilities. The state is further organized into 74 revenue divisions, encompassing 612 revenue mandals and 10,909 revenue villages. In terms of local governance, Telangana boasts 12,769 Gram Panchayats, providing essential services at the grassroots level. Additionally, there are 129 municipalities and 13 municipal corporations that oversee urban areas, contributing to the state's development. From a legislative perspective, Telangana is represented by 119 assembly constituencies and 17 parliamentary constituencies, ensuring the voice of its people is heard at both the state and national levels

28.2.2 New Zonal System

As per the zonal system introduced in 2021, the state is divided into 7 zones - Basara, Bhadradri, Kaleshwaram, Rajanna, Charminar, Jogulamba, and Yadadri.The zones Basara, Bhadradri, Kaleshwaram and Rajanna together form Multi-Zone 1 while Charminar, Jogulamba, and Yadadri together form Multi-Zone 2.

Telangana Fact File

	Item	Unit	Telangana	All India
1	Revenue Divisions*	Nos.	74	NA
2	Mandals/ Tahsils **	Nos.	612	7,243
3	Revenue Villages (CCLA)***	Nos.	10,909	6,63,424
4	Revenue Villages (Census)	Nos.	10,434	6,40,932
	a. Inhabited Villages	Nos.	9,834	NA
	b. Un-Inhabited Villages	Nos.	600	NA
5	Census Towns	Nos.	116	3,892
6	Zilla Praja Parishads / District Panchayats	Nos.	32	662
7	Mandal Praja Parishads/ Intermediate Panchayats	Nos.	540	6,683
8	Urban Local Bodies	Nos.	142	4,776
	a. Municipal Corporations	Nos.	13	247
	b. Municipalities	Nos.	129	4,529#
9	Gram Panchayats	Nos.	12,769	2,55,296
10	Cantonment Boards	Nos.	1	59
11	Population	Lakhs	350.04	12,108.55
	a. Males	Lakhs	176.12	6,232.70
	b. Females	Lakhs	173.92	5,875.85
12	Decadal Growth Rate	Rate	13.58	17.7

	Item	Unit	Telangana	All India
13	Density of Population	Per Sq. Km.	312	382
14	Sex Ratio	Ratio	988	943
15	Rural Population	Lakhs	213.95	8,337.49
	a. Males	Lakhs	107.05	4,277.81
	b. Females	Lakhs	106.9	4,059.68
	c. Sex Ratio	Ratio	999	949
16	Urban Population	Lakhs	136.09	3,771.06
	a. Males	Lakhs	69.07	1,954.89
	b. Females	Lakhs	67.02	1,816.17
	c. Sex Ratio	Ratio	970	929
17	Child Population (0-6 Years)	Lakhs	38.99	1645.15
18	Literacy Rate (%)	%	66.54	72.98
19	Households	Lakhs	83.04	2,495.02
	a. Rural	Lakhs	51.69	1,686.13
	b. Urban	Lakhs	31.35	808.89
	c. Average Household Size	No.	4	5

Fig.28.3 Telangana Fact File

Source : Telangana State Statistical Abstract - 2022

Check your progress

(iii) As per the Zonal system introduced in 2021, how many zones were formed in Telangana State?

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(iv) How many revenue divisions are there in present Telangana state?

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28.3 Physiography of Telangana

An appraisal of geographical background is essential in assessing the regional development in Telangana. This region is quite distinct in Physiography, geology, drainage, vegetation etc. These are important determinants of the present distribution and pattern, and form of urban development in the region.

28.3.1 On the basis of the physiographical background, the Telangana State can be divided into three regions viz. 1) Godavari depression, 2) Telangana plateau and 3) Krishna piedmont.

1) Godavari depression: It covers Adilabad, Asifabad, Nirmal, Mancherial, Nizamabad, Kamareddy, Jagitial, Rajanna, Karimnagar, Peddapalli,Jayashankar, Mulugu, Warangal R, Warangal U, Mahabubabad.,Jangaon, Khammam, and Bhadradri districts.

The hills of the erstwhile Adilabad districts are called Nirmal hills. The Nirmal hills spread over 150 kms length and 55-65 kms width. These hills have the different names in the parts of the districts. They are Rakiguttalu in erstwhile Karimnagar district; Konga gutalu in erstwhile Warangal districts; Raju Guttalu and Yellandlapahad in Khammanm; Sirnapaly Pankutalu in erstwhile Nizamabad district.

2) Telangana Plateau comprising the north-eastern part of the Deccan plateau, has an area of about 57,3 70 square miles (148,000 square km), a north-south length of about 480 miles (770 km) and an east-west width of about 320 miles (515 km). Telangana is situated largely in an upland region of the Deccan (peninsular India). Much of its surface area is occupied by the Telangana Plateau in the north and the Golconda Plateau in the south and is composed of Archean gneissic rock (gneiss being a foliated rock formed within Earth's interior under conditions of heat and pressure) and sheets of Granite rocks which effectively traps rain water. Under the thin surface layer of soil is the impervious grey granite bed rock. The Telangana region consists of peneplains developed on the Achaeans Gneisses. Peneplains are a land having highly eroded, flat hillocks scattered all over the surface.

The average elevation of the plateau area is about 1,600 feet (500 metres), higher in the west and southwest and sloping downward toward the east and northeast, where it meets the discontinuous line of the Eastern Ghats ranges.

The Telangana plateau is slightly tilting towards east side and it is dotted with some mountains and hills. In this plateau, tors and boulders are formed due to the weathering of granitic rocks. It covers mainly Medak, Sangareddy, and part of the Siddipet district: It also covers Vikarabad, Rangareddy, Medchal districts; Hyderabad; Mahbubnagar. Narayanpet. Jogulamba, Wanaparthy, Nagarkurnool, Nalgonda, Suryapet, and Yadadri districts. Hyderabad city is also located in the middle of the Telangana plateau which is having about 600 meter elevation. Doli Gutta from Venkatapuram mandal is the highest mountain peak (965 metres) in the northern part of the Deccan Plateau. It is located at the border of Mulugu district in Telangana and Bijapur district in Chhattisgarh.

Drainage is dominated by the basins of the Godavari River in the north and the Krishna River in the south. As a result of erosion, the topography of the plateau region consists of graded valleys with red sandy soil and isolated hills. Black soil is also found in certain parts of the area.

3) Krishna piedmont: The Krishna piedmont is made up of a deeply dissected plateau of Archaean Gneisses and Granites. In the piedmont, we can see the paneplain composed of basaltic lava between Sangareddy and Mahbubnagar in Telangana State at height of 600-900 m. The Krishna piedmont covers Vikarabad, Rangareddy, Mahbubnagar, Narayanpet, Jogulamba, Wanaparthy, Nagarkurnool, Nalgonda, Suryapet, Yadadri districts.

Altitude: Based on the Altitude, Telangana plateau is divided into three categories. They are l) More than 600 meters (MSL); 2) 300-600meters (MSL); 3) 150-300 meters (MSL)

Godavari river is passing through below 150 metres altitude which is covered partly in the districts of Nirmal, Nizamabad districts. While, fully covered districts are Jagital, Jayashankar, Mulugu, and Bhadradri districts. The most general level lines are between 480 to 800 metres altitude in this portion.

On the south, the Krishna and Tungabhadra valley lies at an altitude of 300 to 450 metres below the rugged break of slope down from the Mysore plateau. To the north west, the watershed between the River Bhima and Godavari is a great swelling upland reaching an altitude of 720 metres in central places. The Gondwana appear in the Godavari basin while northern and western are covered by the trappean lava. The Telangana is a long belt of peneplains mainly developed over the gneissic rocks. It has an average altitude between 300 m and 600 m with general slope towards the east. Its northern and north-eastern margin is occupied by the Godavari valley which is distinct due to its faulted structure. The Hyderabad plateau around the metropolis is conspicuous by its imposing position and Laterite and lava deposits.

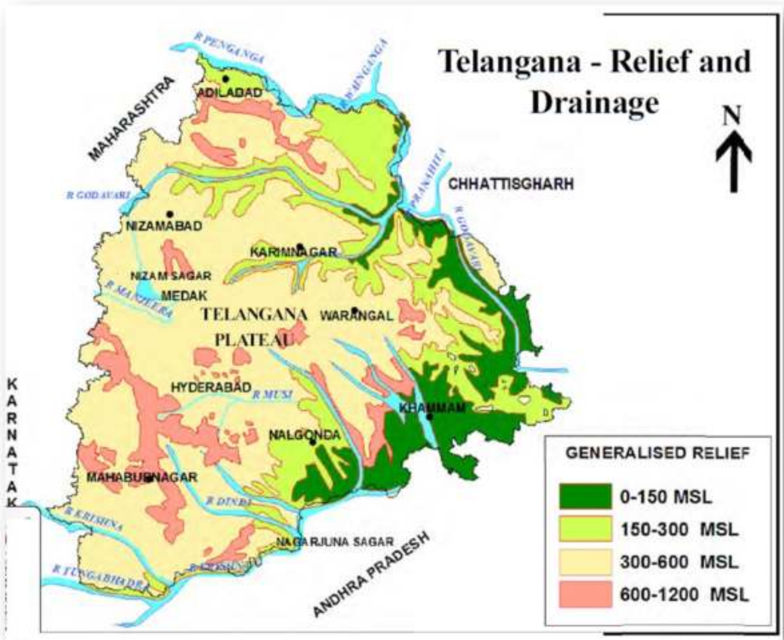

Fig.28.4 Telangana Relief & Drainage Map

Upper Telangana Plateau: Upper Telangana Plateau spread over the west side of the Telangana State and fully covered districts are Nizamabad, Rajanna Sircilla, Kamareddy, Siddipet, Medak, Sangareddy, Vikarabad, Rangareddy, Medchal, Mahbubnagar districts and partially covered in Narayanpet,Jogulamba,Nagar Kurnool, Wanaparthy, Nalgonda, Yadadri, Jangaon, Warangal U, Karimnagar, Jagitial, Nirmal, Adilabad, KomaramBheem, Mancherial districts. While, rest of the districts are fall under lower Telangana Plateau region.

Check your progress

(v) Geographically Telangana State is Part of which Physiographic division of India?

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(vi) What is the Average elevation of Hyderabad City Area?

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28.4 Drainage

The drainage system, also known as the River system is formed by the rivers or streams in a catchment area or River basin. The landlocked Telangana State is a hub of several rivers which are depending on monsoons. If monsoons fail the rivers dry up, generally southwest monsoons (June to September) brings heavy rain due to which the Western Ghats receive high rainfall when compared to the Eastern Ghats. Because of this geographical phenomenon, major rivers origin in the Western Ghats that flow towards the Bay of Bengal as the land surface is high in the North West side and slope towards South East.

In Telangana, there are 4 major rivers i.e. Godavari, Krishna, Manjeera, and Musi. Godavari and Krishna are perennial rivers that are the largest and broadest in South India flowing from North West side to the South East side and empty at the Bay of Bengal. Every year, thousands of TMC water from Godavari River is going towards the Bay of Bengal due to improper planning of storage. In Telangana and the Andhra Pradesh State, Governments have recently built dams across the rivers for the storage of rainwater for both agriculture and domestic purposes (Ex: Kaleshwaram Irigation- Telangana State, Polavaram Andhra Pradesh Projects).

28.4.1 Godavari River

The Godavari river is India's second-longest River after the Ganga. It also has one of the largest River basins (3,12,812 sq.km) in the Indian subcontinent, after Ganga and Indus River drainage basin. In terms of length, catchment area and discharge, Godavari is the largest in peninsular India and had been called as the Vridha Ganga.

Source - Location	Brahmagiri mountain, Tryambakeshwar,Nasik, Maharashtra
Source - Elevation	920m (3,018 ft)
Mouth - location	Antarvedi into the Bay of Bengal,East Godavari, Andhra Pradesh
Length	1,465 km (910 miles)
Basin	312,812 km (120,777 sq mi)
Tributaries - left	Purna, Kadam, Pranahita, Indravathi, Taliperu, Sabari
Tributaries - right	Nasardi, Darna, Pravara, Sindphana, Manjira, Manair, Kinnerasani
Cities	Basara,Ramagudem,Bhadrachalam

The Godavari originates in the Western Ghats near Thiryambakeshwar , Nasik which is 1067 meters elevation in Maharashtra, 80 km from the Arabian Sea. It flows first eastwards across the Deccan Plateau then turns southeast, entering in Renjal Mandal, Nizamabad district. From its Source the Godavari River flows east for 1,465 km (910 mi), draining the states of Maharashtra, Telangana, Andhra Pradesh and emptied into the Bay of Bengal through its wide network of tributaries. Godavari River flows about 570 km in Telangana i.e., one-third of the length of its course. The catchment area of the River is more than half of the Telangana area (22,880 sq. miles).

The Godavari enters into Telangana in Nizamabad district at Kandakurthy village in Renjal Mandal where Manjira, Haridra Rivers joins the Godavari and forms Triveni Sangamam. The River flows along the border between Nimal and Mancherial districts in the north and Nizamabad, Jagityal, Peddapalli districts to its south side. About 12 km after entering Telangana it merges with the backwaters of the Sriram Sagar Dam. The Godavari River also has a small but an important tributary, Kadam River. The Pranahita river merges with Godavari on the left side. This place is also known as Thriveni Sagamam, then emerges at its eastern side to act as state border with Maharashtra. Later enters Jayshankar Bhupalpalli, Mulugu and Bhadradri districts. In Bhadradri district the River flows through an important Hindu pilgrimage town - Bhadrachalam. The River further swells after receiving a minor tributary Kinnerasani and Sabari River and enters into Andhra Pradesh state.

Godavari River has an area of 312,812 sq. km (120,777 sq mi) which is nearly one-tenth of the area of the Country. The River basin is considered to be divided into 12 sub-basins namely: 1) Upper Godavari 2) Pravara 3) Purna, 4) Manjira, 5) Middle Godavari 6) Manair 7) Penganga 8) Wardha 9) Pranahita 10) Lower Godavari l1) Indravathi l2) Sabari basins. These put together account for 24.20% of the total basin area. The water allocations from the River among the covered states are governed by the Godavari Water Disputes Tribunal.

Tributaries: The Godavari receives several important tributaries which can be classified as the left bank and right bank tributaries. Left bank tributaries are Penganaga Wain Ganga, Kadva, Shivana, Purna (Maharashtra), Kadam, Pranahita, Indravati and Kinnerasani (Telangana State), Talipru, Sabari (Andhra Pradesh and Odisha). Among these tributaries, the Purna, Pranahita, Indravati, and Sabari covers nearly 59.7% of the total catchment area of the basin. Right bank tributaries are Pravara (Maharashtra); Manjira and Manair (Telangana State) together contributing l6% of the basin.

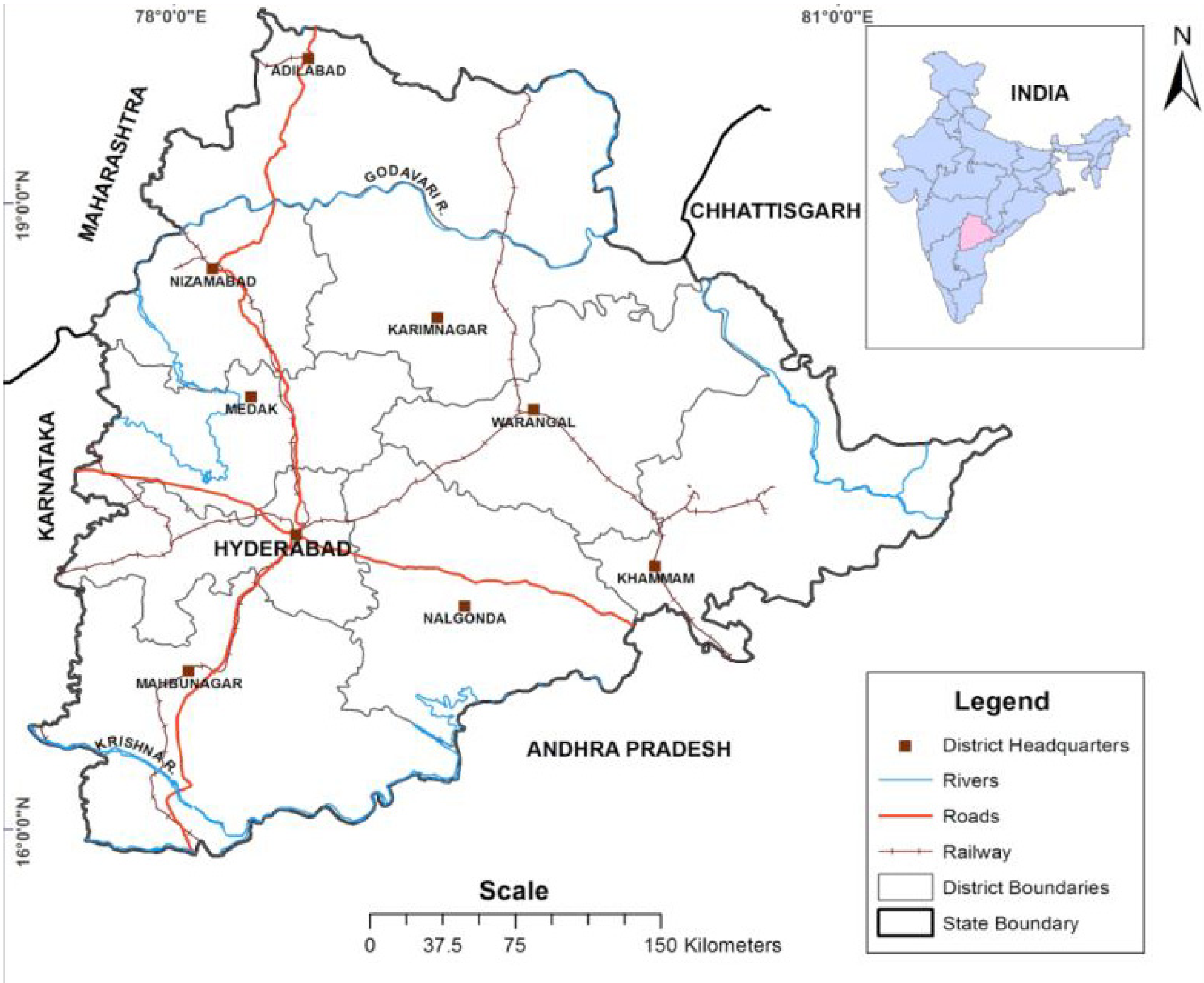

Fig 28.6 Rivers Map of Telangana

Source : Irrigation & CAD Department Government Of Telangana

28.4.2 Krishna River

The Krishna River is the fourth-biggest river in terms of water inflows and River basin area in India, after the Ganga, Godavari, and Brahmaputra. It is the second- largest river in the state and also called Krishnaveni. The Krishna perennial River is the geographical divider of Telangana and Andhra Pradesh states. The water allocations from the River among the covered states are governed by the Bachawath Tribunal.

Origin : Krishna River originates near Jor village of Wai Taluka, Satara District of Maharashtra (Amarkantak in Mahabaleswar) in the Western Ghats at an altitude of about 1,327 meters and empties into the Bay of Bengal at Hamasaladeevi (near Koduru) in Andhra Pradesh.

Krishna River is about 1400 km long, of which 460 km is in Telangana. It flows through Maharashtra and Karnataka and enters into Telangana in Tangadi village, Makthal Mandal of Jogulamba Gadwal district and enters into Andhra Pradesh State.

Source - location	Jor village of Wai Taluka, Satara District, near Mahabaleswar, Maharashtra
Source - elevation	1327 meter
Mouth- location	Hamasaladeevi (near Koduru) into Bay of Bengal, Andhra Pradesh
length	1,460 km
Basin	258,948 km2 (99,980 sq mi)
Tributaries - left	Bhima (Karnataka); Dindi, Haliya, Musi (Telangana State); Paleru, Munneru, Polavaram right bank canal, Budameru diversion channel (Andhra Pradesh)
Tributaries - right	Koyna Panchganga (Maharashtra), Ghataprabha, Malaprabha (Karnataka); Tungabhadra Kondaveeti vagu (Telangana State)
States	Maharashtra, Karnataka, Telangana, Andhra Pradesh
Cities	Vijayawada

Fig 28.7 Details of the Krishna River

Source : Irrigation & CAD Department Government Of Telangana

The districts, which come under the catchment area of this river, are erstwhile districts of Mahbubnagar,Vikarabad, Suryapet, Nalgonda and the southwest parts of Warangal and Khammam districts in Telangana State. This River serves as the greater part of the southern boundary of Telangana.It flows through the state of Karnataka before entering Telangana State and merging into the Bay of Bengal at Andhra Pradesh.

The Krishna river basin lies in the states of Karnataka (113,271 sq.km), Telangana, Andhra Pradesh (76,252 sq.km) and Maharashtra (69,425 sq.km). It covers 8% of the total geographical area of the country and delta of this river is one of the most fertile regions in India. The Krishna basin has been divided into 12 sub-basins by the Krishna Godavari Commission namely; 1) Upper, Krishna Ghat Area, 2) Middle Krishna, 3) Ghatprabha Ghat area, 4) Malaprahbha Ghat area, 5) Upper Bhima Ghat Area, 6) Lower Bhima, 7) Lower Krishna Western Part Eastern Ghats Delta, 8) Tungabhadra Ghat area, 9) Vedavathi, 10) Musi, 11) Palleru and 12) Munneru. The sub-basins range between elevations of 4500 ft. to 100 ft. in all basins. The districts of erstwhile Mahbubnagar, Nalgonda, and Hyderabad comes under Krishna River basin areas.

Tributaries

The important left-bank tributaries are Bhima (Kamataka), Dindi, Haliya, Musi, Paleru. Murnneru (Telangana State): and right bank Rivers are Koyna, Panchganga (Maharashtra): Ghataprabha, Malaprabha (Karnataka): Tungabhadra, Kondaveeti vagu (Telangana State). Among these, tributaries namely: Bhima, Dindi, Peddavagu, Hallia, Musi and Munneru join from Northern part.

Manjira: Manjira is the longest tributary of the River Godavari and holds the Nizam Sagar reservoir. It passes through the states of Maharashtra, Karnataka, and Telangana. It originates in the Balaghat range of hills near Ahmednagar district at an altitude of 823 meters and empties into the Godavari river. The total length of the River is 644 km and has a total catchment area of 30,844 sq. km. It flows towards the southeast direction and enters into Medak district and merges with the Godavari at Kandukurthy village Nizamabad district. Nizamsagar project was constructed on the Manjira River in Nizamabad district.

Musi: Musi river is a major tributary of the Krishna River. It originates Shivareddyguda in Anantagiri Hills which is very near to Vikarabad town in Vikarabad district. It has a total of 256 km length and has 2219 sq. km drainage area. It passes through Hyderabad City and joins Krishna River at Vadapally in Nalgonda district. The districts of erstwhile Mahabubnagar, Nalgonda, Rangareddy and Hyderabad comes under Krishna River Basin.

Check your progress

(vii) Why does rivers in Telangana State flow from west to east?

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(viii) Name the river which originates from Anantagiri hills of Telangana ?

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28.5 Climate

Climate plays an important role in various spheres of human and economic activities such as, agriculture, commerce, industry, transportation, etc. Climate of any place or a region is influenced by a number of interplaying parameters like location, amount of insolation, pressure, wind, humidity, physiography, etc. The climate of Telangana in general lies between tropical semi-arid (Steppes) to tropical savanna dry and wet (Aw) type of Koppen Climatic Classification. Telangana state lies between tropic of Cancer and Equator. It is spread over the Deccan plateau region and there is no influence of the sea winds, because of these reasons the state gets very hot in summer and very cold in winter season.

Most of the South Asian countries have the same seasons. There are three Meteorological seasons over India as well as in Telangana State. They are summer, rainy season and winter season.

28.5.1 Seasons in Telangana

SI. No	Season	Period
1.	Winter Season	December-February
2.	Summer season	March-May
3.	Southwest Monsoon Season	June-September
4.	Northeast Monsoon Season	October-December

Summer-Season : Summers are extremely hot and dry, with temperatures often crossing 42-43°C. The season starting from March to June is fairly hot with average high temperatures in the 42°C range. During the summer, temperature can cross 40°C especially in May, although the average temperature is normally 25°C. Ramagundam (Peddapalli district) has highest average temperature (34°C - 48°C) in entire State and Bhadrachalam town also has 48-50 °C while, Hyderabad is the coolest place in the state because the city is located above 600m mean sea level (MSL).

Winter Season : A dry, mild winter starts in late November and lasts until early February, with little humidity and average temperatures in the 22-23 °C range. Hyderabad and Nizamabad experience very cold temperatures compared to the other districts. In the state, lowest temperatures are recorded in the month of December. The average minimum temperatures in Hyderabad reach about 15°C in January and February, while in the elevated areas it falls between 10 and 12 °C in the winter. The North eastern winds are very active in this season due to this, the lowest temperatures decreases.

Southwest Monsoon Season / Rainy Season: After summer, from June to October the monsoon season starts. Monsoon in Telangana is marked by plenty of rainfall, with a high level of humidity accompanying it, more than 75% of the rainfall that the state receives during this season. July is usually the month where there are more rainy days but in September rainfall situation is peak. Detailed information are given in rainfall topic.

28.5.2 Distribution of Temperature

Telangana is a semi-arid area and has a predominantly hot and dry climate. In summer, high temperatures are between 29°C to 32°C range while, lowest temperature lies between 20°C to 25°C. The highest temperatures are recorded in the month of May and reach up to 45°C. The highest temperatures (up to 48°C) are recorded in Ramagundam (Peddapalli district), Kothagudem and Bhadrachalam (Bhadradri district) towns. Hyderabad, Medchal, Vikarabad, Sangareddy, Medak,Rangareddy and Mahbubnagar districts get low temperatures during the summer as these are located above 600m mean sea level (MSL). In rainy season, the monsoon arrives in June and lasts until September with about 755 mm of precipitation. A dry, mild winter starts in late November with little humidity and average temperatures in the 22- 23 °C range. The high temperature is 29°C and lowest is up to 12°C. During winter season, the north Telangana districts get very low (up to 4°C) temperatures especially in Adilabad district. During the December month, the temperatures increase from western icianeana towards Eastern Telangana State. The western Telangana districts namely; Jogulamba Gadwal. wanaparthy, Mahbubnagar. Nagarkurnool, Rangareddy, Hyderabad, Medchal, Medak, Kamareddy and Nizamabad get low temperature.

28.5.3 Distribution of Rainfall

The average or normal rainfall of the State is about 905.4 mm and about 80% of annual rainfall is received from the south-west monsoons alone during (June to September). The rainfall in the State is erratic and uncertain and distribution of the rainfall is uneven in various mandals thus, making agriculture a proverbial gamble with the monsoons. The region of Telangana, over the decades, has been subjected to drought permanently or year after year, particularly under the regime of United Andhra Pradesh. The data during 1997-2014 on rainfall across the district reveals that certain districts such as Mahbubnagar district has been experiencing lower rainfall compared to the state (905.4 mm) and another district viz. Rangareddy recorded second lowest rainfall.

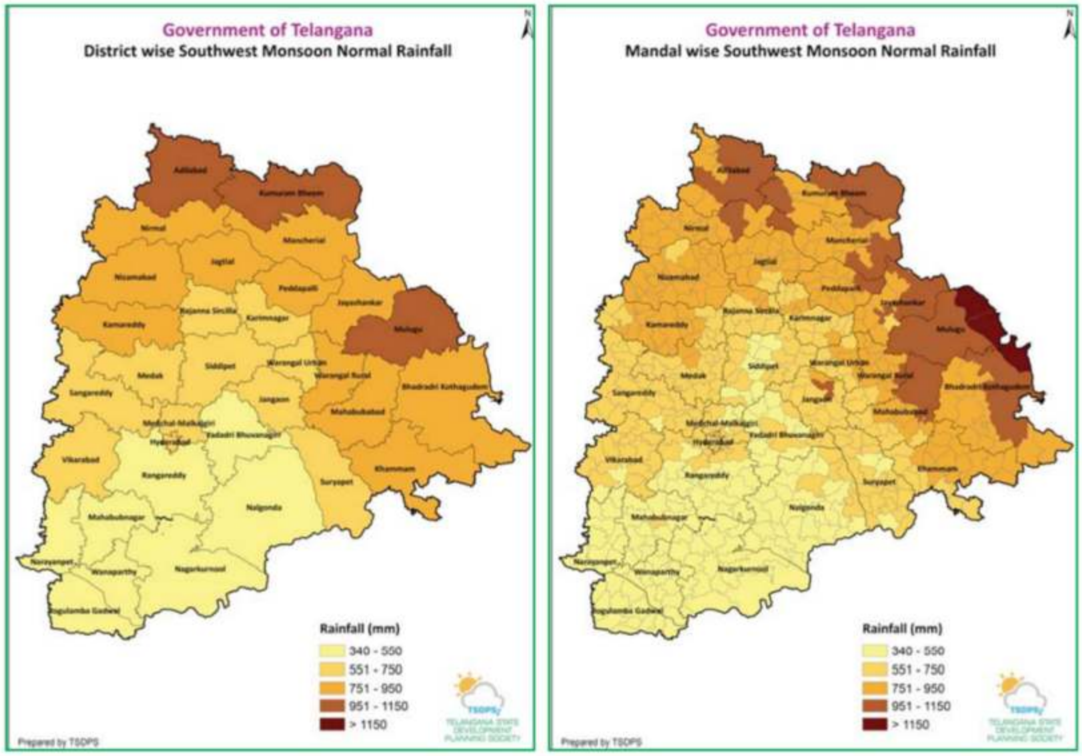

Fig 28.8 District wise Monsoon Rainfall

Source : Telangana State Development Planning Society

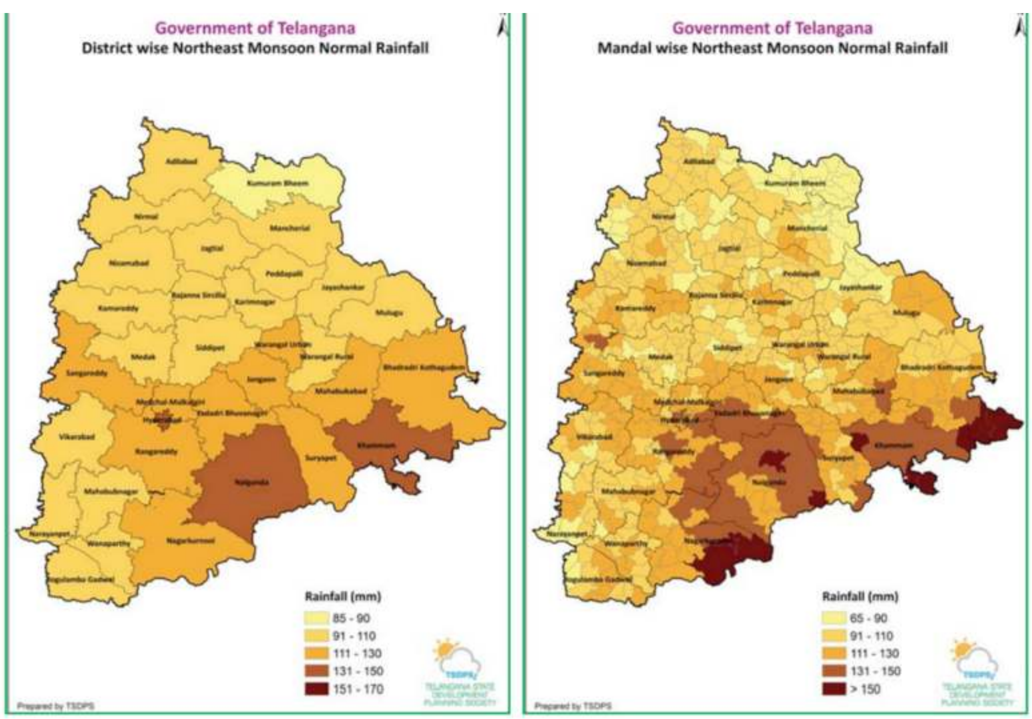

Fig 28.9 District wise Northeast Monsoon Rainfall

As per the 1MD reports-2019, the highest annual rainfall (1292mm) is recorded in Mulugu district followed by Adilabad (1198 mm), Komaram Bheem (1195mm). These three districts received more than 1190mm rainfall in the state. Other districts namely; Mancherial, Bhadradri, Nirmal have received 1125 to 1150 mm rainfall. Jayashankar, Peddapalli, Nizamabad, Warangal R, Khammam, Jagtial, Kamareddy, Mahabubabad also received more than 1000 mm annual rainfall Out of 33 district nearly 50% (16 districts) have recorded above state average (905.4innt) mini-all. The lowest rainfall districts in the state are Wanaparthy (579.8mm), Narayanpet (561.8mm) and Jogulamba (533mm). If we look into the geographical distribution of rainfall, the southern districts are receiving less rainfall than the northern districts of the state.

Southwest Monsoon: Southwest monsoon season starts from June- and ends in September. It contributes about 80% ofthe annual rainfall which means the state receives good rainfall in southwest monsoon period. But it varies from district to district. It increases from less than 800 mm in south-west part to more than 1200 mm in north and north-east part. The monsoon arrives in June and lasts until September with about 550 mm of precipitation. Telangana receives heavy rainfall during these months. In southwest monsoon period. Mulugu (1099mm), Komaram Bheem (1020mm) and Adilabad (1004mm) districts receives highest rainfall in the state while, the lowest rainfall is recorded in erstwhile Mahbubnagar districts namely Mahabubnagar (475mm), Nagarkurnool (461 mm), Wanaparthy (434mm). Narayanpet (424mm) and Jogulamba (385mm). The average rainfall of the season is 720mm rainfall only.

North East Monsoon: Northeast monsoon starts from October and ends in November. It contributes 13% rainfall of the state and the average rainfall is I 24.9min only. October and November sea low-pressure systems and tropical cyclones form in the Bay of Bengal which, along with the north-east monsoon, bring rains to the southern Telangana and some boarder districts with A. P. Coastal regions side of Telangana. North-East monsoon is least important in the state, because it gives very less rainfall than the South- West monsoon. Highest rainfall is Sileru at Adilabad district. During this season, the Hyderabad (152mm) district gets highest rainfall followed by the Khammam (150mm). Yadadri, Kamareddy, Nagarkurnool and Nalgonda districts receive some of the better rainfall (> 140mm) While lowest rainfall is observed in Mulugu,Wanaparthy, Peddapalli, Narayanpet, Mancherial and Jayashankar. These districts receive 100 min to 112mm rainfall only.

Rainfall is categorised into three sub categories. They are normal, below normal and above normal. Normal is when rainfall is within ± 10 %: below normal rainfall is < -10%; and Above Normal rainfall is > 10% of the Long Period Average. Daily rainfall measured at 8.30AM at all Rainguage stations and transmitted to Directorate of Economic and Statistics Department through online.

Check your Progress

(ix) What is the average or normal rainfall of Telangana State?

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(x) Which districts of the Telangana marks the highest temperatures in Summer?

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28.5.4 Soils

The upper surface of the Earth covered by small particles of inorganic minerals and organic matter supporting flora and fauna is called as "Soil" and process of formation of the soil from the parent rock is called "Paedogenesis". For an agricultural country like India soil forms the basic important resource. The prosperity of one's country depends on the richness of the soil. In general, soils are formed in two methods namely insitu and transported. lnsitu are those where the inorganic or mineral component of the soil is derived from the parent rock through weathering at source and no transportation is involved. Ex: Black soils, Red soils. On the other hand, the transported soils under the influence of exogenic forces like wind, water, glacier, etc, the finer soil particles are transported to long distances and deposited at various locations. Ex: Sand dunes in deserts, alluvial soils in delta regions, coastal sands, etc. In India, the Indian council of Agricultural Research (ICAR) has classified the soils into 8 Groups. They are 1)Alluvial Soils 2)Black Soils 3) Red and Yellow soils 4) Laterite soils 5) Mountain soils 6) Desert or Arid Soils 9) Saline Soils 10) Peaty or Organic soils.

Types of Soils: A total seven types of soils are spread over Telangana State (As per soils of AP-1976). They are 1) Red Loamy Sands (Dubba) 2) Red Sandy barns (Chalka) 3) Laterite Soils 4) Shallow to medium black soils 5) Deep black soils 6) Salt affected Soils and 7) Alluvial Soils. These soil types allow the planting of variety of fruits and vegetable crops such as mangoes, oranges, coconut, sugarcane, paddy, banana and flower crops.

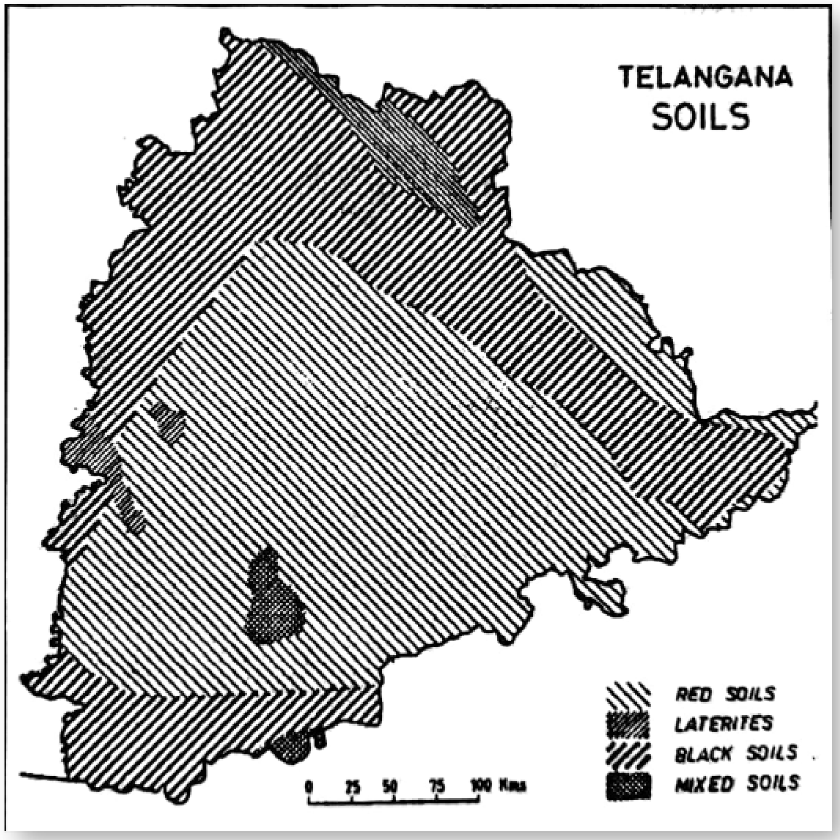

Fig 28.10 Soils of Telangana

1. **Red Soils:** In Telangana, basically two types of red soils are distributed. They are 1) Red sandy loamy (Chalka), 2) Red loamy sands (Dubba). Red soils are formed by decomposition of Granite (igneous) and Gneiss (metamorphic rocks). These soils are Reddish in color, due to presence of iron oxide in it. These soils lacks in Nitrogen, Phosphorous Acid and organic matter and are less fertile. These are generated from granite rocks and having less density, less weight with good water holding capacity. ln these soils, pulses like red gram, green gram, horse gram, etc, oil seeds like ground nut and castor are grown. Under assured irrigation, horticulture is favoured. In the recent times where sufficient water is available, crops like cotton, sugar cane, rice and other vegetables are preferred. Red soils are mainly used for cultivation of coarse grains, pulses and oilseeds. Red soils are spread in a substantially large geographical area in the state. A total 69% of the geographical area is covered by these red soils only. Out of33 districts, 32 districts (except Karimnagar district) are covered with red soils. Southern part of Nizamabad and northern part of Jogulamba Gadwal. Northern part of the Nizamabad and Jogulamba Gadwal districts are covered with very less red soils.

2. **Laterite Soils:** Laterite Soils are mainly found in those areas where rainfall occur more than 200 cm. It also formed in hot, humid and high rainfall regions. These soils are light in colour from whitish to red. These soils are so deep in nature with rounded pebble and alluvium at the bottom. Laterite soils are also divided into two types, they are 1) Associated with the steep slopes of hilly terrains and 2)Available near the shores but in low lying areas. Generally speaking soils with higher altitudes are more acidic than those of lower altitudes. More rainfall causes leaching away of laterite rocks because of which parts of silica and lime go down and compound or iron and aluminium are left in form of soils.These soils lack in nitrogen, potash, Humus, the paucity of lime makes these soils acidic. So they are suitable tor the cultivation of Tea. In Telangana State, the laterite soils are distributed in Zaheerabad,Nyalkal and Kohir mandals in Sangareddy district and some parts of the Vikarabad district

3. **Black soils:** The black soils are also known as Regur soils or Black cotton soils because these soils are famous for the cultivation of Cotton. It formed by solidification of lava spread over large area of Deccan plateau. Based on these differences, black soils are classified into four types. 1) Shallow black soils (with gypsum) 2) Shallow black soils (without gypsum) 3. Deep black soils (with gypsum and 4. Deep black soils (without gypsum).

These soils are generally clayey, deep and impermeable and having the capacity to retain moisture for the longer duration compare to other soils. When moisture and water evaporated then soils develop cracks. Black soils are very rich in mineral content because it is formed due to volcanic activities and contain high quantities of iron, Aluminium, Magnesium and lime. However, they are poor in organic matter, nitrogen and Phosphorous. This soil covers 30% of the geographical area of the country. In Telangana State, 27% of geographical area is covered by black soils. Deep Black soils are distributed is the lower part of Krishna and Godavari Basin. The black soils are distributed more in the northern part of the Telangana State than the southern part. The northern districts namely; Part of the Adilabad, Nirmal, Nizamabad, Komaram Bheem, Mancherial, Jagtial, Peddapalli, Karimnagar, Rajanna Sicilia, Warangal, Mahabubabad, Mulugu, Bhadradri and some part ofthe Siddipet, Khamman) black soils are distributed. Among these districts, Karimnagar district is covered by the black soils only. In southern part, part of Jogulamba, Wanaparthy and Nagarkurnool districts are covered with black soils.

Mixed Black and Red soils are found in the southern districts of the state namely, Jogulamba, Wanaparthy, Nagarkurnool (southern part) and northern districts namely; Adilabad, Nirmal, Komaram Bheem, Mancherial, Jagitial and Peddapalli districts. Adilabad district is having highest mixed black and red soils.

4. **Salt affected soils:** These types of soils are found in erstwhile Rangareddy, Nizamabad, and Medak districts.

5. **Alluvial Soils:** Alluvial soils are present in Medak district along the river course of Manjira,Haldia,Nakkavagu and Peddavagu. Alluvial soils are also found along river belt of Alair and Karga land that topography areas and along sides of river Krishna and its tributaries of Nalgonda and Suryapet districts. Drainage type soils are found in Krishna along with tributaries like Alair,Dindi,Halia,Peddavagu

Check your Progress

(xi) Name the two types of Red soils that are found in Telangana State ?

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(xii) Laterite soils are found in which two Districts of Telangana?

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28.5.5 Vegetation

Forests have been playing vital role in human development as well as a country or state development. Forest cover is critical for living environment, as it influences the quality and quantity of air and water and plays a major role in supporting livelihood activities of rural poor, contributing to the economy of the State, mitigating the threat of Global warming besides conserving the fertile soil and vulnerable Wildlife. Forest cover means all lands, one hectare and more in area, with a tree canopy destiny of 10% or more irrespective of ownership and legal status. Such lands may not necessary be a recorded forest area. It also includes orchards, bamboo and palm.

As per the India's National forest policy -1952, maintaining 33% country's geographical area under forest and tree cover was proposed, but many states have failed to maintain the 33% of the forest area including the Telangana State. Geographical area of the Telangana State is 1, 12,077 sq. kms, and the state is having a forest area of 27,292 sq. kms, which accounts for 24.3% of total geographical area, including social forestry. The core objective of forests is to enhance green cover by integrating it with livelihood of living beings.

In 2017, Forest Department, Govt. of India assessed the forest coverage area. The assessment has done based on Satellite data interpretation (October to December 2015) across the country. As per the report, Telangana has 20419 sq.km area which is 18.22% of the total geographical area. In terms of forest canopy density classes, the state has 1596 sq.km area under very dense forest, 8738sq.km moderate dense forest, 10085 sq. km area open forest and 3238 sq.km area of Scrub forest. If we look at altitude wise forest area coverage, A total 79.2% of forest area spread over 0-500 in altitude zone while rest of the (20.8%) of the distributed 500-1000m altitude zone. the report also reveals that, the 0-500m altitude having highest forest coverage classes i.e Very dense forest, Moderate and open forest than the 500- 1000m zone.

The assessment report -2017 also discloses that, a net increase of 565 sq.km area has been observed in the state compared to the previous assessment. The main reason behind this is the tree coverage area has increased in outside of the forest area. It is also analyzed that, the Forest area in Adilabad and Khammam districts has been decreased due to the rotational felling of commercial plantations.

28.5.5.1 Forests Types in Telangana

In India, forests are categorized by Champion (1936) with six types. They are I) Evergreen forest, 2) Moist Deciduous. 3) Dry Deciduous, 4) Hill forests 5) Tidal and 6) Thorny Scrub. Among these forest types. Telangana has only three types. They are l) Moist Deciduous 2) Dry Deciduous and 3) Thorny Scrub forest.

1. **Moist Deciduous Forests:** Moist deciduous are spread across those areas with 150 to 200 cm of mean annual rainfall. The trees that grow in lush quantities in these forests are Indian Kino,Indian Nettle tree, Saffron teak and Rose wood,Sal tree, Pyinkado, East Indian satin wood, Mvrobalan Nut, Button tree and Camel Foot Climber grow here and there within these forests. Plethoras of timber yielding plants also grow in this region and these forests form the main basis of timber in the region. This type of forest found in Mancherial, KumuramBheem, Bhadradri, Mulug, Adilabad, Nirmal, Nagarkurnool, and Khammam districts.

2. **Dry Deciduous Forests:** Dry Deciduous forests grow in such areas with 75 to 100 cm of mean annual rainfall usually recorded in Nirmal, Nizamabad, Warangal R, Peddapalli, Khammam, Sangareddy, Nagarkurnool and Rangareddydistricts.The important trees that grow in these forests are Indian nettle tree, Elephant Apple, Indian Kino, Indian Black wood, Oil Cake tree, Silk Cotton tree, Neem, Teak, Bamboo, White Siristree, Parrot tree, etc. A sufficient amount of timber and other forest products are available from these forests.

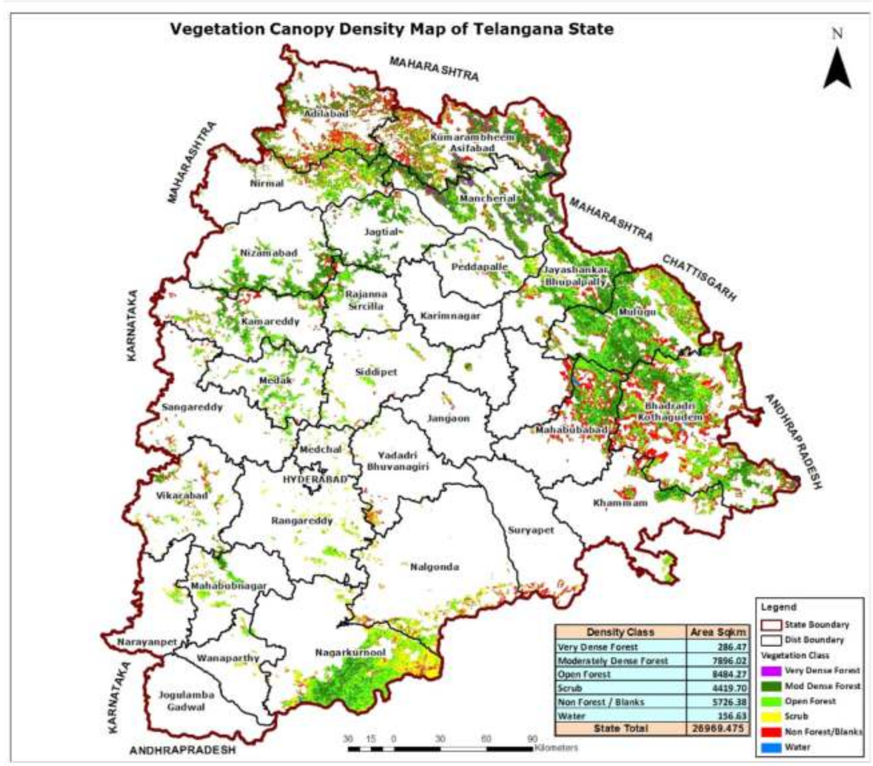

Fig 28.11 Vegetation Cover Map of Telangana

Source : Telangana Forest Department

3. **Thorny Scrub Forests:** Trees of moderate height that grow in drought conditions, with leaf modifications to thorns to reduce transpiration, are dominant in this type of forests. They are particularly found in erstwhile Rangareddy, Medak, and Nalgonda districts. Acacia, Bamboo, Zizypus, etc are the most Common plants found in these forests. Most of them are used as firewood and timber of a few is used in making agricultural implements.

Classification of Forest Area: In Telangana State, forest area is classified in to six categories based on Tree cover. They are 1) Very Dense forest, 2) Moderate Dense forest, 3) Open Forest, 4) Scrub Forest, 5) Non Forest and 6) Water Bodies. The highest dense forest is spread over in Mancherial, Kumuram Bheem, Bhadradri, Jayashankar, Adilabad, Nirmal, Nagarkurnool, and Khammam districts. The Highest Moderate dense forest is distributed in Jayashankar, Bhadradri, Mancherial, KumuramBheem and Adilabad districts while, lowest is noted in Warangal R, Warangal U and Yadadri Bhuvanagiri districts. Regarding openforest, highest open forest (1000sq.lm) is spread over in Jayashankar, Bhadradri and Nagarkurnool districts while, the lowest (10 sq.km) is observed in Warangal U, Jangaon, Suryapet, Karimnagar, and Hyderabad districts.

There is no open forest observed in Jogulamba Gadwal. The highest (>300 sq.km) scrub forest is observed in Nagarkurnool, Bhadradri, Jayashankar, KumuramBheem and Nalgonda districts while, the lowest (<10 sq.km) scrub is noted in Jogulamba, Jangaon, Warangal R, Warangal U, Hyderabad and Karimnagar districts. Water bodies are also one of the six categories. Out of the 33 districts only three districts namely; Nagarkurnool (59.6 sq.km), Bhadradri (20.2 sq.k m)and Jayashankar (10.6 sq.km) are covered more than 10 sq.km area of water bodies in the state while, lowest water bodies (<0.1 sq.km) area is noted Yadadri, Rangareddy, Jangaon and Wanaparthy districts. There is no water bodies' area in the district ofJogulamba, Warangal U, Hyderabad and Karimnagar districts. Highest non forest area is recorded in Bhadradri and Mahabubabad districts while, lowest is in Karirmagar and Hyderabad districts.

Distribution of forest: In Telangana State, Central Deccan Plateau region having dry deciduous forests and eco-region also covered. The eco- regions are observed in Hyderabad and Medchal districts. In Recent past, over 80% of the original forest has been cleared for agriculture, timber harvesting, or cattle grazing. However, the large forest blocks can be found in Nagarjuna Sagar-Srisailam Tiger Reserve in south east side. The northeast parts of the state have highlands and covered with moist deciduous forest spread over along and near the Godavari River. In One-fourth of land area in Telangana districts, the forests are both moist deciduous and dry savannah in nature with teak, rosewood, wild fruit trees and bamboos found in plenty. Generally, neem, banyan, mango and papal trees are quite common.

Social Forestry: The Telangana State Government has launched a massive people's movement called Haritha Haram involving general public and farmers in a big way to increase tree cover outside reserve forests to improve and protect the environment and also to provide gainful employment. The main components of social forestry are distribution of seedlings, raising plantations in community lands, institutions and road side avenues. Under this programme, free trees like Raavi, Marri, Neem, Kanuga, Badam, Neredu, Rela and others are distributing to public for planting in public lands.

Haritha Haram : The massive programme Haritha haram was started in 3rd July, 2015. The main aim is to rejuvenate degraded forests through planting trees across the state. This programme is yielding good results and it is also a solution to the drought in future. Forest department, GHMC, HMDA, NAREGA and other all government departments are involved in the planting trees programmes.

Forest Products: Telangana state forest is having different flora which is used for different ways. They sire like Tunilcaku, Roosa grass, Sandalwood, Bamboo, and Ippapuvvu. Tunikaku is used to make beedi which is available in the erstwhile districts of Adilabad, Nizamabad, Khammam and Karimnagar districts. Roosa grass is available in the forest of Nizamabad districts which are used for making of perfume oils. Roosa Grass is also available in erstwhile Adilabad district forests.

It is used for making of paper and Reyans. Sandalwood and teak is available from the forest of erstwhile Karimnagar, Mahbubnagar, Nizamabad, and Khammam districts. Highest Bamboo trees are available in erstwhile Adilabad district. The Bamboo is used for the paper and house constructions. Ippapuvvu is used for making of the Sara which is available in the forest of erstwhile Adilabad and Nizamabad districts. A recent study found that the Ippapuvvu is a very nutrition item in decreasing anaemia and improving the nutritional levels. So, many forest dwellers are making Ippapuwu laddus.

Check your Progress

(xiii) Which type of forest is found in Mulugu and Bhadradri Kothagudem?

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(xvi) What are the common plants found Thorny Scrub Forests of Telangana region?

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28.8 Summary

In this chapter, we explored the regional geography of Telangana, focusing on administrative divisions, physiography, drainage, climate, soils, and natural vegetation. Telangana, formed on June 2, 2014, is a landlocked state in southern India. It is bordered by Maharashtra, Chhattisgarh, Karnataka, and Andhra Pradesh. Telangana has 33 districts, 74 revenue divisions, 612 revenue mandals, and 12,769 Gram Panchayats, providing essential services at various levels of governance. The state's physiography can be divided into three regions: Godavari depression, Telangana plateau, and Krishna piedmont. The major rivers in Telangana include Godavari, Krishna, Manjeera, and Musi, each contributing to the state's drainage system. The chapter also covers the correlation between topography, climate, and vegetation, providing a comprehensive understanding of Telangana's geographical features.

The region experiences a tropical climate with distinct seasons - summer, monsoon, and winter. The state's climate is influenced by factors like latitude, insolation, pressure, wind patterns, and physiography. Telangana's soil types include red soils, black soils, laterite soils, and alluvial soils, each conducive to different types of crops and vegetation. The state's vegetation primarily consists of moist deciduous forests, dry deciduous forests, and thorny scrub forests. Telangana's forest cover plays a crucial role in supporting biodiversity, regulating climate, and providing resources for the local population.

28.9 Check Your Progress - Model Answers

(i) Mulugu and Narayanpet.

(ii) Seven mandals were ceded to Andhra Pradesh.

(iii) Seven zones were formed in Telangana State.

(iv) There are 74 revenue divisions in present Telangana state.

(v) Telangana State is part of the Deccan Plateau physiographic division of India.

(vi) The average elevation of Hyderabad City Area is about 500-600 meters.

(vii) Rivers in Telangana flow from west to east due to the higher land surface in the North West, which slopes towards the South East, leading the rivers in that direction.

(viii) Musi River originates from Anantagiri hills of Telangana.

(ix) The average or normal rainfall of Telangana State is about 905.4 mm annually.

(x) Ramagundam (Peddapalli district) has the highest average temperature (34°C - 48°C) in the entire state, and Bhadrachalam town also experiences high temperatures of 48-50°C in summer.

(xi) The two types of Red soils found in Telangana State are Red sandy loamy (Chalka) and Red loamy sands (Dubba).

(xii) Laterite soils are found in Zaheerabad, Nyalkal, and Kohir mandals in Sangareddy district and some parts of the Vikarabad district.

(xiii) Moist Deciduous Forests are found in Mulugu and Bhadradri Kothagudem.

(xvi) Common plants found in Thorny Scrub Forests include Acacia, Bamboo, and Zizypus.

28.10 Terminal Questions

1. Explain the administrative divisions of Telangana state.
2. Describe the physiographical regions of Telangana and their characteristics.
3. Discuss the major rivers in Telangana and their significance for the state's geography.
4. Explain the distribution of different soil types in Telangana and their agricultural significance.
5. Discuss the types of forests found in Telangana

REGIONAL GEOGRAPHY OF TELANGANA

Chapter - 29

ADMINISTRATIVE DIVISIONS, PHYSIOGRAPHY AND DRAINAGE, CLAIMATE, SOILS AND NATURAL VEGETATION

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29.0 Introduction

Irrigation is one of the most important backward linkages to Agriculture. Assured irrigation is critical for crop cultivation and farmer incomes, because it boosts productivity and protects farmers from poor monsoons. In addition, assured irrigation can improve water usage efficiency and help maintain groundwater levels. The Government of Telangana has adopted a comprehensive irrigation development strategy to provide irrigation facilities to about 125 lakh acres of land across the state.

Irrigation in Telangana is dependent on two major rivers, Godavari and Krishna having an allocation of 1266.94 TMC (967.94 TMC & 299 TMC in Godavari River and Krishna River respectively) of assured water besides 500 TMC of surplus waters in both the rivers.

29.1 Objectives

After learning this chapter, you will be able to:

- Understanding the Importance of Irrigation: To recognize the significance of irrigation in agricultural practices and its impact on crop cultivation, farmer incomes, and overall productivity.
- Exploring Major Irrigation Projects: To familiarize readers with key irrigation projects in Telangana, such as Nagarjuna Sagar, Sriram Sagar, and Kaleshwaram Lift Irrigation Project, and understand their role in ensuring water supply for farming.
- Analyzing Land Use Patterns: To study the land use pattern in Telangana, including forest area, barren land, agricultural land, and other non-agricultural uses, and comprehend their impact on agricultural activities.
- Examining Crop Cultivation: To examine the different crops grown in Telangana, including rice, cotton, maize, and millets, and understand their contribution to the state's agricultural sector.
- Assessing Cropping Intensity: To assess the cropping intensity in various districts of Telangana and understand its significance in evaluating agricultural efficiency.

These objectives aim to provide readers with a comprehensive understanding of irrigation practices, agricultural activities, and government interventions in the context of Telangana's agriculture sector.

29.2 Types of Irrigation in Telangana

There are three main common types of irrigation systems used in Telangana to provide water to crops. Telangana uses a combination of these three irrigation methods to cater to the diverse agricultural needs of the state. The government has implemented various projects to improve irrigation infrastructure, conserve water, and increase the irrigation potential of the state. Three main type of Irrigation are

1.Canal Irrigation: A canal is an artificial channel that is constructed to carry water to the fields to perform irrigation. The water is taken either from the river, tank or reservoirs. The canals can be constructed either by means of concrete, stone, brick or any sort of flexible membrane which solves the durability issues like seepage and erosion.

2.Tube well Irrigation: A well is a hole dug in the ground to obtain the subsoil water. An ordinary well is about 3-5 metres deep but deeper wells up to 15 metres are also dug. This method of irrigation has been used in India from time immemorial. A tube well is a deeper well (generally over 15 metres deep) from which water is lifted with the help of a pumping set operated by an electric motor or a diesel engine.

3.Tank Irrigation: A tank is a reservoir for irrigation, a small lake or pool made by damming the valley of a stream to retain the monsoon rain for later use. Tank irrigation is a traditional method of irrigation, where water is stored in tanks and used for irrigation purposes. Mission Kakatiya is a program implemented by the Telangana government to rejuvenate the traditional water bodies in the state.

Irrigated area in Telangana (2015-16)

In Telangana, a total of 20.27 lakh hectares of land is irrigated, which means it receives water to help crops grow. Among these, 18.05 lakh hectares, or 89%, are irrigated using wells, making it the most common method. Additionally, 1.21 lakh hectares, which is about 6%, use water from tanks. Canals are another water source, providing irrigation to 0.6 lakh hectares, or 3% of the total area. Apart from these, there are other sources contributing to irrigation for 0.4 lakh hectares, making up 2% of the irrigated land in the region.

Total irrigated Area	20.27 lakh hectares
Area under well irrigation	18.05 lakh hectares (89%)
Area Under tank irrigation	1.21 lakh hectares (5.96%)
Area under canals	0.6 lakh hectares (3%)
Area under other Sources	0.4 lakh hectares (2%)

Source : Agriculture Census 2015-16

Check your Progress

(i) What is the total irrigated area in Telangana, and what percentage of it is under well irrigation?

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(ii) How much area is irrigated through canals in Telangana?

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29.3 Major irrigation Projects in Telangana

S.No	Name of the Project	Irrigation Potential Contemplated Ayacut (Acres)		Irrigation Potential Created Ayacut (Acres)	
		New	Stab	New/Existing	Stab
	Completed				
1	Nagarjuna Sagar Left Canal	6,40,814	0	6,40,814	0
2	SRSP Stage-I	9,68,640	0	9,68,640	0
3	Nizamsagar Project	2,31,338	0	2,31,338	0
4	Ali Sagar LIS	0	53,792	0	53,792
5	A.R.R Guthpa LIS	0	38,792	0	38,792
6	Priyadarshini Jurala Project	1,04,741	0	1,04,741	0
7	Rajolibanda Diversion Scheme	87,500	0	87,500	0
8	Kaddam Narayan Reddy	68,150	0	68,150	0
9	Musi Project	31,428	0	31,428	0
	On-Going				
10	AMR SLBC Project	4,11,572	0	2,85,286	0
11	SRSP Stage-II	3,97,949	0	3,64,953	0
12	J Chokka Rao - Devadula LIS	5,58,722	0	3,68,000	0
13	Mahatma Gandhi Kalwakurthy LIS	4,24,816	0	3,07,000	0
14	Rajiv - Bhima LIS	2,03,000	0	1,58,000	0
15	Jawahar Nettempadu LIS	2,00,000	0	1,42,000	0
16	KomaramBheem	45,500	0	23,000	0
17	Koil Sagar	38,250	12,000	38,250	12,000
18	M. Baga Reddy Singur Project Canals	40,000	0	40,000	0
19	Sri Padasagar LIS	1,78,808	37,000	54,342	37,000
20	Indiramma Flood Flow Canal from SRSP	2,52,882	0	50,300	0
21	Sitarama LIS (Integrated as RDLIS, IDLIS)	3,87,859	6,44,031	0	0
22	Bhakta Ramadas LIS	0	58,958	0	58,958
23	Pranahitha Project	2,00,000	0	0	0
24	Kalleswaram LIS	45,280	0	0	0
25	Kalleshwaram Project (a, b & c)	18,25,700	18,82,000	1,16,885	13,20,000
26	Palamuru Rangareddy LIS	12,30,000	0	0	0
27	Dindi LIS Project	3,61,000	0	0	0
28	Lower Penganga	37,300	0	0	0
29	P.V Narasimha Rao Kanthanapally LIS	0	0	0	0
30	Chanakha-Korata	13,500	0	0	0
31	Ghattu LIS	28,000	5,000	0	0
32	Thummilla LIS	0	55,600	0	0
33	Lendi Project	22,000	0	0	0

Source : Telangana State Statistical Abstract - 2022

29.4 Important Projects of Telangana

1.Nagarjuna Sagar Project:

The Nagarjuna Sagar Project, also known as the Nandikonda Project, is a monumental feat situated on the Krishna River in Nandikgonda Village, Pedhapur Mandal, and Nalgonda District. Renowned as the world's largest masonry dam, constructed with stone, brick, and mortar, it stands as a joint endeavor between Telangana and Andhra Pradesh states. This colossal multipurpose project boasts a remarkable capacity of 408 TMC, making it the largest of its kind in South India. With an installed power generation capacity of 816 MW, Nagarjuna Sagar not only serves as a crucial water resource but also contributes significantly to power generation. Its vast irrigation network extends over 21 lakh acres, benefitting regions in Nalgonda, Khammam, Krishna, Guntur, and Prakasham Districts.

2. Sriram Sagar Project/Pochampadu

The Pochampad Project, a vital Multi-Purpose Project, spans across the Godavari River near Pochampad village in Nizamabad District, serving as the lifeline for Northern Telangana. This ambitious initiative plays a pivotal role in providing irrigation facilities to an extensive 9.69 lakh acres of Ayacut area, reaching across various districts, including Nizamabad, Kamareddy, Nirmal, Adilabad, Khammam, Mahabubabad, Suryapet, Jagtial, Karimnagar, Peddapalli, Warangal (Urban and Rural), and Jangoan.

3.Musi Project

The Musi Project, initiated in 1954 and officially launched in 1963, is a significant undertaking situated in Bopparam village, Kethepally Mandal, Nalgonda District. Spanning across the Musi River, a tributary of the Krishna, its primary objective is to irrigate a sprawling ayacut spanning 30,183 acres of agricultural land. Beyond its agricultural impact, the project plays a vital role in supplying drinking water to both the Suryapet Municipality and the broader district

4. Nizam Sagar Project

It strategically located across the Manjeera River in Achampet, Kamareddy District, was commissioned by Mir Osman Ali Khan between 1923 and 1931. Executed under the watchful supervision of Chief Engineer Nawar Ali Nawaz Jung Bahadur, this initiative aimed to irrigate an extensive 2.75 lakh acres of agricultural land in the Nizamabad and Kamareddy Districts.

5. Kaddam Narayan Reddy Project

It situated in Peddur village in Kaddam Mandal of Nirmal District, underwent construction from 1949 to 1958, with completion marking a storage capacity of 13 TMC. Geared towards enhancing agricultural capabilities, the project effectively irrigates approximately 70 thousand acres of land. The positive impact extends to multiple mandals, including Kaddam, Jennaram, Dendepally, Lakesttipeta, and Mancherial, showcasing its widespread benefits across the region.

6.Rajolibanda Diversion Scheme Project

It stands as a collaborative effort between Karnataka, Telangana, and Andhra Pradesh, jointly addressing water management across the Tungabhadra River. Constructed during the Nizam's rule between 1946 and 1958, the project is located at Rajolibanda village in Manni taluk, Raichur District of Karnataka. With an impressive irrigation reach of 87,500 acres through a 143 km canal network, the project brings substantial benefits to regions such as Gadwal and Alampur-Mahabubnagar in Telangana, Kurnool in Andhra Pradesh, and Manni in Karnataka.

7. The Priyadarshini Jurala Project

It holds the distinction of being the first multi-purpose project on the river Krishna. Loacted at Revulapally village, Darur Mandal, Jogulamba Gadwal district, this masonry dam was successfully completed in 1995. Notably, it boasts the largest number of blocks among dams at 84. With a reservoir capacity that increased from 11.94 TMC to 17.84 TMC, the project plays a crucial role in water storage and management in erstwhile Mahaboobnagar District.

8.The Singur Project

It is alternatively known as Mogiligundla Baga Reddy, is situated in Singur village near Sangareddy District. This project, constructed between 1978 and 1998, spans across the Manjira River and was specifically designed to provide water to the twin cities. Boasting a substantial storage capacity of 29 TMC

9. The Lower Manair Project

It is a pioneering initiative as the first project on the Manair River, is situated in Gambhiraopet Mandal, Karimnagar District. Spanning the years from 1974 to 1985, the project is strategically located in the Godavari Basin, specifically in the Manair Sub-Basin. Noteworthy for its 27-meter-high dam, the Lower Manair Project not only serves practical purposes such as water management but also offers residents of Karimnagar the scenic experience akin to visiting the Tank Bund.

10. Kaleshwaram Lift Irrigation Project

The Kaleshwaram Lift Irrigation Scheme of Telangana is a multi-purpose irrigation project on the Godavari River in Kaleshwaram, Bhupalpally, Telangana.The project starts at the confluence point of Pranahita River and Godavari River. Claimed to be an engineering marvel, the project comprises 1,832 km water supply route, 1,531 km gravity canal, 203km tunnel routes, 20 lifts, 19 pump houses and 20 reservoirs with a storage capacity of 240 TMC.

The Kaleshwaram Lift Irrigation Project is divided into 7 links and 28 packages spanning through 20 districts and utilizing a canal network of more than 1,800 km (1,100 mi). The project aims to produce a total of 240 TMC (195 from Medigadda Barrage, 20 from Sripada Yellampalli project and 25 from groundwater), of which 169 has been allocated for irrigation, 30 for Hyderabad municipal water, 16 for miscellaneous industrial uses and 10 for drinking water in nearby villages, with the remainder being estimated evaporation loss. The project aims at increasing total culturable command area (the sustainable area which can be irrigated after accounting for both upstream and downstream factors) by 1,825,000 acres across all 20 districts in addition to stabilizing the existing CCA.

Check your Progress

(iii) Which River is the Nagarjuna Sagar Project built on, and how much land does it irrigate in Telangana?

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(iv) What are the components of the Kaleshwaram Lift Irrigation Project, and how many districts does it span across?

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29.5 Introduction to Agriculture in Telangana

The agriculture sector is the backbone of the rural economy in Telangana. 4 key sub-sectors constitute the ‘Agriculture & Allied Sectors’ — Crops, Livestock, Forestry and Logging, and Fishing and Aquaculture. The sector is a principal source of employment for around 55% of the population in the state. Since state formation, the contribution of the ‘Agriculture and Allied Sectors’ to Telangana’s Gross State Value Added at current prices has consistently improved from 16.3% in 2014-15 to 18.7% in 2021-22(PE). There was a 155.7% increase in the Gross Value Added by the sector between 2014-15 and 2021-22.

Telangana is predominantly characterized by red soil including chalkas and dubbas, shallow to very deep black soil, alluvial soil, laterite and lateritic soils. Based on the rainfall, temperature, nature of soils, etc., Telangana is divided into 3 Agro-climatic zones. The soil classification for the different zones is given below:

1.Northern Telangana Zone (NTZ): This Zone includes erstwhile districts of Adilabad,Nizamabad & Karimnagar. There are 16 types of soils in NTZ. The predominant soil is shallow black soils (18.4%) followed by deep calcareous soils (16.6%) and red clayey soils (15.2%). Annual rainfall ranges between 867 and 1189 mm, Max. temperatures ranges from 31 to 39°C and Min. temperatures ranges from 14 to 25°C

2.Central Telangana Zone (CTZ): This Zone includes erstwhile districts of Medak,Warangal & Khammam .There are 19 types of soils in CTZ. Red type of soils cover 54% of this zone, followed by calcareous soils (13%), colluvial soils (8%) and black soils (6%). Annual rainfall ranges between 779 and 1213 mm, Max. temperatures ranges from 29 to 39°C and Min. temperatures ranges from 16 to 25°C.

3.Southern Telangana Zone (STZ): This Zone includes erstwhile districts of Rangareddy,Hyderabad,Mahaboonagar & Nalgonda.There are 19 types of soils in this zone. As a whole, the zone is dominated by different textured red soils with varied depths to an extent of 54.8%, followed by alluvial soils and calcareous soils (11.2%). Annual rainfall ranges between 606 and 853 mm, Max. temperatures ranges from 28 to 38°C and Min. temperatures ranges from 16 to 25°C

29.6 Trends in Telangana Agriculture

In Telangana, agriculture plays a crucial role, with 49.1% of the total geographical area designated as Net Area Sown, including fish ponds (DES, 2019-20). According to the Census of Landholdings (2015-16), there are 59.47 lakh landholdings covering a total area of 147.57 lakh acres. The majority of landholdings are by marginal farmers (<2.47 acres), constituting 64.6% of landholdings but accounting for 28.6% of the operated area. Small farmers (2.48 -4.94 acres) and semi-medium farmers (4.95-9.88 acres) hold 23.7% and 9.5% of landholdings, contributing to 33.1% and 24.6% of the operated area, respectively. Medium and large farmers hold 2.1% and 0.2% of landholdings, with corresponding contributions to the operated area.

Regarding social groups, Scheduled Tribes (STs) own 12% of landholdings, covering 12.4% of the operated area, while Scheduled Castes (SCs) own 11.8% of landholdings, covering 8.9% of the operated area. The majority of landholdings (76.2%) belong to the ‘Others’ category, covering 78.60% of the operated area.

In terms of crop production, Telangana saw a rice production of 134.79 lakh tonnes in 2021-22, with Nalgonda and Suryapet districts as the top contributors. Millet production reached 31.31 lakh tonnes, with Kamareddy and Nirmal districts leading the way. The production of pulses was 5.77 lakh tonnes, with Adilabad and Kamareddy as the top contributing districts. The overall foodgrain production, including cereals, millets, and pulses, was 172.02 lakh tonnes, with Nizamabad and Nalgonda districts as the major contributors.

Spice production in Telangana includes 6.51 lakh tonnes of chillies, a quarter of which comes from Khammam district, and 2.24 lakh tonnes of turmeric, with Nizamabad and Jagtial as significant contributors. Cotton remains a dominant fiber crop, with 25.08 lakh tonnes of cotton kapas and 48.08 lakh bales of cotton lint produced in 2021-22. Tobacco production in the state reached 7101 tonnes, with Jogulamba district contributing 33.2% and Nizamabad district contributing 23.3% to the total production. These trends reflect the diverse and significant agricultural landscape in Telangana.

29.7 Land use pattern in Telangana

S.No.	Land utilization	Area (acres)	Area (ha)	% of Total Geographical Area
1	Forest	66,67,005	26,98,045	24.1%
2	Barren & unculturable	15,01,055	6,07,457	5.4%
3	Non-Agricultural uses	20,65,780	8,35,993	7.5%
4	Culturable waste land	4,01,320	1,62,408	1.5%
5	Permanent pastures	6,95,636	2,81,480	2.5%
6	Miscellaneous Tree crops	2,76,926	1,12,069	1.0%
7	Current fallow land	10,99,112	4,44,232	4.0%
8	Other fallow land	13,98,111	5,65,733	5.1%
9	Net Area SownTotal	1,35,89,842	55,00,283	49.1%
	Geographical Area	2,76,94,787	1,12,07,700	

Source : Telangana State Statistical Abstract - 2022

The area brought under cultivation after the formation of the State has been tremendously increased. Gross Sown Area (GSA) has been increased from 131 lakh acres in 2014-15 to 198 lakh acres in 2021-22 (an increase of 51%). This increase in area is mainly due to the planned investments in new irrigation projects, revitalisation of existing irrigation systems and systematic procurement mechanisms implemented by the Government. Paddy cultivation in both seasons has made the State the rice bowl of India in a very short span. Paddy, Cotton, Maize, Red Gram and Soybean are the major crops grown in the State.

The area under these five major crops constitutes 85% of the total area in the State during 2021-22. Further, of these five major crops, paddy(50%) and Cotton(24%) constitute about 74% of the area. In 2014-15, the area cultivated under Paddy was about 35 lakh acres and increased by 180% to 98 lakh acres in 2021-22. Similarly, the area under the Cotton crop also increased by 12% from 42 lakh acres to 47 lakh acres in 2021-22.

Check your Progress

(v) What percentage of Telangana's geographical area is covered by forest according to the land use pattern data?

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(vi) What is the total net area sown in Telangana, and how much does it contribute to the state's geographical area?

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29.8 Cropping Intensity

The ratio of gross cropped area to net cropped area, is an indicator useful for assessing efficiency of the agriculture sector. Cropping intensity refers to the raising of a number of crops from the same field during one agricultural year. Thus, higher cropping intensity means that a higher proportion of the net sown area is cropped more than once during one agricultural year. Mulugu and Wanaparthy district has scored highest in cropping intensity Index for the year (2020-21)

Agriculture is a vital sector in the economies of developing countries and a key issue in sustainable development. The cluster of issues around 'sustainable agriculture, food security, and nutrition' has emerged as an important focus area. Due to the spread of harmful chemical agriculture, there is also a need for a transition to ecologically sound farming in many areas, otherwise, it can lead to a crisis. Lack of proper systems related to access to credit, and insurance systems can lead to many economic crises, as well. Considering all these issues, the Government of Telangana focuses on several flagship programs that are aimed at not only improving farmers' income but also the overall well-being of the farming community in the State

29.9 Summary

In this chapter, we learn about how irrigation, which means supplying water to crops, is crucial for farming in Telangana. The government of Telangana has worked on various projects to provide water to around 125 lakh acres of land. The state depends on two major rivers, Godavari and Krishna, for its water needs. Some significant irrigation projects like Nagarjuna Sagar, Sriram Sagar, and Kaleshwaram Lift Irrigation Project play a vital role in ensuring water supply for farming.

Additionally, the chapter talks about agriculture in Telangana. Agriculture is very important for the people living in rural areas. Telangana has different types of soil and is divided into three zones based on climate. Farmers here grow crops like rice, cotton, maize, and pulses. The chapter also discusses how the government is supporting farmers through various programs. This chapter gives us a clear picture of how irrigation and agriculture are essential for the people and economy of Telangana.

29.10 Check Your Progress - Answers

(i) The total irrigated area in Telangana is 20.27 lakh hectares, with 89% of it under well irrigation.

(ii) The area under canals in Telangana is 0.6 lakh hectares, which constitutes 3% of the total irrigated area.

(iii) The Nagarjuna Sagar Project is built on the Krishna River and irrigates more than 8,95,281 hectares or 21 lakh acres in Telangana.

(iv) The Kaleshwaram Lift Irrigation Project comprises 1,832 km water supply route, 1,531 km gravity canal, 203 km tunnel routes, 20 lifts, 19 pump houses, and 20 reservoirs. It spans through 20 districts in Telangana.

(v) Forest covers 24.1% of Telangana's geographical area according to the land use pattern data.

(vi) The total net area sown in Telangana is 55,00,283 hectares, contributing to 49.1% of the state's geographical area.

29.11 Terminal Questions

1. Explain the major crops grown in Telangana and their contributions to the state's economy.

2. What is cropping intensity, and why is it essential for assessing agricultural efficiency? Provide examples of districts with high cropping intensity in Telangana.

3. Discuss the impact of irrigation projects, such as the Kaleshwaram Lift Irrigation Project, on enhancing agricultural productivity in Telangana. Provide examples of districts that have benefitted significantly from these projects.

4. Describe the Agro-climatic zones in Telangana and their influence on crop cultivation.

29.12 Further Readings

1. ”Telangana Socio-Economic Outlook” - This official publication, often released by the government of Telangana, provides in-depth analysis On Agriculture and Irrigation Projects in Telangana state.

2. Telangana Irrigation and Agriculture Department Website (https://irrigation.telangana.gov.in/) - The official website of the Telangana Irrigation and Agriculture Department offers valuable information on irrigation projects, agricultural practices, policies, and initiatives within the state.

REGIONAL GEOGRAPHY OF TELANGANA

Chapter - 30

POPULATION OF TELANGANA

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30.0 Introduction

Demography refers to the statistical study of human populations – their size, composition and distribution across space – and the process through which populations change. Knowledge on the demographic patterns of the state provides insights to the Government to develop effective programs and policies.

After bifurcation of the erstwhile Andhra Pradesh, 327 revenue villages from bordering districts of Telangana State transferred to the State of Andhra Pradesh (Residual) as per the Andhra Pradesh Reorganization (Amendment) Act, 2014. As a result, geographical area of the Telangana State is 1,12,077 sq. kms., with a population of 3,50,03,674 comprising 83,03,612 households with 1,76,11,633 males and 1,73,92,041 females.

The sex ratio (number of females for 1000 males) of the state is 988. In the state, 61.1% of the population are living in rural areas and the rest of the population (38.8%) is living in urban areas. The density (living population in sq.km area) of the population is 312. Regarding literacy, it stands below national average of with 66.3% literacy rate.

In terms of the literacy by gender it is 75.04% of males against 57.9% females. However, the literacy rate of the urban population more than rural population. Urban population has 81% of literacy rate and rural population is restricted to 57.3% only. Of the total population in the State, Scheduled Castes (SC's) constitute 15.4% and the Scheduled Tribes (ST's) Constitute 9.08 %

30.1 Objectives

After learning this chapter, you will be able to:

- **Understand Demographic Patterns:** Gain insights into the demographic composition, size, and distribution of the population in Telangana, including urban and rural areas, and the representation of Scheduled Castes and Scheduled Tribes.
- **Explore Population Density:** Learn the concept of population density and analyze the population density variations across districts in Telangana based on the 2011 census data.
- **Examine Gender Disparities:** Investigate gender-wise population distribution, explore the differences in literacy rates between males and females, and understand the concept of child sex ratio in Telangana.
- **Identify Regional Disparities:** Recognize the disparities in various demographic indicators across districts, including literacy rates, sex ratios, and rural-urban divides, to comprehend the social fabric of Telangana comprehensively

30.2 Total Population

As of the 2011 census, Telangana was home to 3,50,03,674 people, constituting approximately 2.89% of India's total population. Projections by the National Commission on Population estimate that by 2021, the population would reach 3,77,25,000 and further increase to 3,92,07,000 by 2031. Despite this growth, Telangana's share in the national population is anticipated to decrease slightly, reflecting a changing demographic landscape.

Highest Populated Districts	Lowest Populated Districts
1.Hyderabad (39,43,323)	1.Mulugu (2,94,671)
2.Medchal (24,60,095)	2.Bhupalapally (4,16,763)
3.Rangareddy (24,26,243)	3.Asifabad (5,15,812)
4.Nalgonda (16,18,41)	4.Jangaon (5,34,991)
6)5.Nizambad (15,71,022)	5.Sircilla (5,52,037)

Source : Telangana State Statistical Abstract – 2022

30.3 Growth of Population

The increase in the number of people who inhabit a territory or state is called as Population Growth. The overall growth of total population during the decade 2001 to 2011 is 13.58 percent as against the national growth of 17.7 percent. The growth of the population in urban areas has been witnessing a significant increase, resulting in Telangana becoming one of the fastest urbanizing States in the country.

Urban population in the State grew by 38.12% during the decade 2001 to 2011, as compared with 25.13% in the preceding decade. In sharp contrast, rural population in the State grew by a modest 2.13% as per the 2011 census. Around 30% of total urban population in the State is residing in the capital city of Hyderabad alone.

30.4 Population Density

Population Density refers to average number of people living per square kilo meter. Density of population in a country is measured by dividing its total population by total land area. According to census 2011, density of population in Telangana was 312 per sq. km. Hyderabad District is the highly densely populated District in Telangana

Highest Density Districts	Lowest Density Districts
1.Hyderabad (18,161)	1.Mulugu(71)
2.Medchal(2,321)	2.Asifabad(115)
3.Warangal Urban(642)	3.NagarKurnool(135)

Source : Telangana State Statistical Abstract – 2022

Check Your Progress

(I) What was Telangana's population according to the 2011 census?

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(ii) Which District in Telangana has least Population density?

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30.5 Gender-wise Population

Telangana's population in 2011 was evenly distributed between males (50.3%) and females (49.7%). The state's sex ratio, calculated as the number of females per thousand males, stood at 988. However, this ratio varied across districts, ranging from 950 to 1046. Notably, Suryapet, Mahabubabad, and Hanumakonda recorded a balanced sex ratio at 996, while Rangareddy had the lowest at 950, and Nirmal had the highest at 1046.

Bottom Districts in Sex ratio	Top Districts in Sex ratio
1.Rangareddy (950)	1.Nirmal(1046)
2.Hyderabad (954)	2.Nizambad(1044)
3.Medchal (957)	3.Jagityal(1036)
4.Wanaparthy (960)	4.Kamareddy(1033)
5.Sangareddy (965)	5.Medak (1027)

Source : Telangana State Statistical Abstract - 2022

30.6. Urban and Rural Population

Telangana's urban and rural populations stood at 1,36,08,665 and 2,13,95,009, respectively, indicating a relatively balanced distribution with 38.9% residing in urban areas and 61.1% in rural regions. Hyderabad and Medchal Malkajgiri emerged as the most urbanized districts with 100% and 91.5% of their populations residing in urban areas. In contrast, Mulugu exhibited the highest rural population share at 96.1%.

Districts with Highest Rural Population

1.Nalgonda (12,50,113)

2.Nizamabad (11,06,272)

3.Khammam (10,84,811)

4.Rang Reddy (10,26,113)

Highest Urban Population

1.Hyderabad (39,43,323)

2.Medchal (22,50,267)

3.Rangareddy (14,20,152)

Lowest Urban Population

1.Mulugu (11,493)

2.Naryanapeta (41,752)

Source : Telangana State Statistical Abstract - 2022

Check Your Progress

(iii) What is the percentage of Telangana's population residing in urban areas according to the given data?

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(iv) Which district in Telangana has the highest rural population share?

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30.7 Social Groups

Scheduled Castes (SC) and Scheduled Tribes (ST) comprised 15.5% and 9.08% of Telangana's population, respectively, with Mancherial and Jayashankar Bhupalpally having the highest SC representation at 24.7% and 22.1%, respectively. Conversely, Hyderabad and Medchal-Malkajgiri exhibited lower SC representation at 6.3% and 9.4%, respectively. Rangareddy housed the maximum number of SC residents, while Mulugu had the fewest.

Highest Scheduled Castes percentage Districts

1.Mancherial (24.7%)

2.Bhupalapally (22.1%)

3.Nagarkurnool (21.3%)

Highest Scheduled Castes Population

1.Ranga Reddy (3,34,337)

2.Nalgonda (2,92,951)

3.Khammam (2,79,319)

Highest Scheduled Tribes Population Districts

1.Bhadradri (3,92,034)

2.Mahabubabad (2,92,778)

3.Adilabad (2,24,262)

Highest Scheduled Tribe Percentage Districts

1.Mahabubad (37.8%)

2.Badradri (36.7%)

3.Adilabad (31.7%)

Source : Telangana State Statistical Abstract - 2022

30.8 Literacy

Among individuals above six years old, 2,06,96,778 in Telangana were literate, with a state-wide literacy rate of 66.5%. This rate varied significantly across genders and regions, with females exhibiting a lower literacy rate of 58.0% compared to males at 75.0%. Urban areas boasted a higher literacy rate at 81.1% compared to the rural areas, where the rate was 57.3%.

Highest Literacy rate Districts

1.Hyderabad (83.25%)

2.Medchal (82.48%)

3.Warangal Urban (76.2%)

4.Rangareddy (72.0%)

Lowest Literacy rate Districts

1.Jogulamba Gadwal (49.9%)

2.Naryanpeta (49.9%)

3.Nagar Kurnool (54.4%)

4.Wanaparthy (55.7%)

Source : Telangana State Statistical Abstract - 2022

30.9 Child Sex Ratio

Telangana's child population (0-6 years) numbered 38,99,166, with a child sex ratio of 932 females per 1000 males. The district-wise analysis revealed disparities, with Wanaparthy and Mahbubabad recording the lowest child sex ratio at 903, and Mulugu showcasing the highest at 971.

Top Districts in Child Sex ratio

1.Mulugu (971)

2.Bhadradri (964)

3.Sangareddy (955)

4.Nizambad (953)

Bottom Districts in Child Sex ratio :

1.Wanaparthy (903)

2.Mahabubabad (903)

3.Nagarkurnool (909)

Source : Telangana State Statistical Abstract – 2022

Check Your Progress

(v) What is the literacy rate for females in Telangana according to the given data?

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(vi) Which district in Telangana has the highest child Sex ratio?

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(viii) What is the literacy rate in Jogulamba Gadwal District?

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30.10 Summary

The chapter on the population of Telangana delves into the state's demographic intricacies, providing valuable insights for policymakers. Telangana, with a population of 3,50,03,674 as of the 2011 census, constitutes approximately 2.89% of India's total population. The state's geographic area is 1,12,077 sq. kms., with 61.1% of the population residing in rural areas and 38.8% in urban areas. The sex ratio of Telangana stands at 988, indicating a relatively balanced gender distribution. The chapter highlights variations in population density, literacy rates, and child sex ratios across districts, offering a comprehensive overview of the social fabric of Telangana

30.11 Check Your Progress – Model answers

i. As of the 2011 census, Telangana was home to 3,50,03,674 people, constituting approximately 2.89% of India's total population

ii. Mulugu (71)

iii. Telangana's urban and rural populations stood at 1,36,08,665 and 2,13,95,009, respectively, indicating a relatively balanced distribution with 38.9% residing in urban areas and 61.1% in rural regions.

iv. Nalgonda (12,50,113)

v. The state-wide literacy rate of 66.5%. This rate varied significantly across genders and regions, with females exhibiting a lower literacy rate of 58.0% compared to males at 75.0%.

vi. Mulugu (971)

vii. Literacy rate in Gadwal is 49.9 % , making it the least literacy rate District in Telangana state

30.12 TERMINAL QUESTIONS

1. What is the demographic composition of Telangana's population according to the 2011 census data, including urban and rural distribution, and the representation of Scheduled Castes and Scheduled Tribes?

2. How is population density calculated, and what was the population density of Telangana according to the 2011 census data?

3. What is the difference in literacy rates between males and females in Telangana, as per the 2011 census?

4. How is sex ratio calculated, and provide the list of districts with the highest sex ratios in Telangana?

30.13 Further Readings

1. **”Telangana Socio-Economic Outlook”** - This official publication, often released by the government of Telangana, provides in-depth analysis and data on various social and economic indicators, including population, education, and social groups representation.

2. **Census of India Website (https://censusindia.gov.in/)** - The official website of the Census of India provides detailed data and reports on population demographics, literacy rates, urbanization, and more. You can find specific data related to Telangana on this website.

Chapter - 31

TYPES OF MAP SCALES AND METHOD OF REPRESENTATION OF RELIEF FEATURES

Contents

31.0. Objectives

31.1. Introduction

31.2. Map Elements

31.3 Map Scale and representation

31.4. Types of Maps Based on Function

31.5. Types of Maps Based on Scale

31.6. Relief features representation on Map

31.7. Summary

31.8 Model Answers to Check Your Progress

31.9 Model Examination Questions

31.10 Further Readings

31.0. Objectives

After studying this unit, you should be able to:

- Know the concept of map and map scale
- understand Physical maps , Cultural and thematic maps
- Know the representation of hills, valleys, etc on map

31.1. Introduction

A map, is a simplified depiction of whole or part of the earth on a piece of paper. In other words, it is a two-dimensional form of the three-dimensional earth. As it is impossible to represent all features of the earth's surface in their true size and form, a map is drawn at a reduced scale. A map is, therefore, defined as selective, symbolised and generalised representation of whole or apart of the earth's surface on a plane surface at a reduced scale. In the present chapter, we will study the essential requirements of maps, their types and the uses .

31.2. Map Elements

A map is a representation or drawing of the earth's surface or a part of its area drawn on a flat surface. A map is always made according to a scale. Cartography is the study and practice of making of maps of the whole or part of the earth. Cartography is the science and art of designing , constructing and producing maps. Maps are the primary tools by which spatial relationships are visualized. Maps therefore become importantdocuments. There are several key elements that should be included each time a map is created to aid the viewer inunderstanding the communications of that map and to document the source of the geographic information used. Common elements of a map are:

1. Title : Map title is an element in a Map layout that describes the theme or subject of a map. Map titles are often made up of three parts: the geographic name, the layer name, and the indicator name. The geographic name is the base area that the map is showing. The layer name is focusing on the overlying map layer. The indicator name is what information the map is trying to portray.

2. North Arrow : According to the rules, each map should have a north arrow. On a map it is used to indicatethe direction of north. (fig 1)

3. Scale : The scale of a map is the value of a single unit of distance on the map, representing distance in the real world. Thevalues are shown in map units (meters, feet or degrees) . The scale can be expressed in several ways, for example, inwords, as a ration or as a graphical scale bar. The indetialed about map scaled dissuced in the 31.3

4. Map Legend : A map is simplified representation of the real world and map symbols are used to represent real objects. Withoutsymbols, we would not understand maps. To ensure that a person can correctly read a map, a map legend is used toprovide a key to all the symbols used on the map. (fig 1)

5. Graticule(latitude & longitude) : A graticule is a network of lines of lattitude and longitudie on a map to make spatial orientation easier for the reader. The lines can be used as a reference.

6. Source / Acknowledgment : This include source of data , for which map preared . Can include the map source, the author, indication of the reliability of accuracy of the map, dates, or other explanatory material.

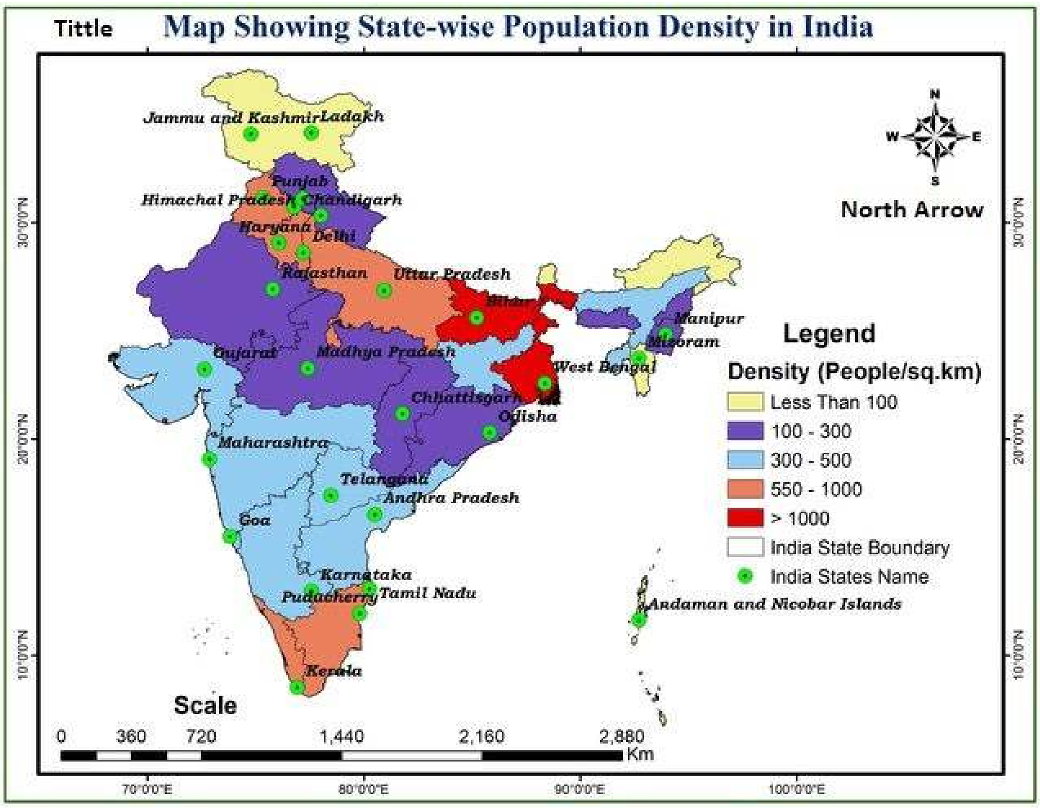

Fig 1: Map with map elements

Check your progress

(i) Define Map?

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(ii) What are the major map elemtns ?

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31.3. Map scale and representation

The scale is an essential element of all types of maps. It is so important that if a network of lines and polygons does not carry a scale, we call it a "sketch". map scale provides the relationship between the map and the whole or a part of the earth's surface shown on it. Map scale also express this relationship as a ratio of distances between two points on the map and the corresponding distance between the same two points on the ground

$$Maps\ Scale\ = map\ distance /\ ground\ distance$$

there are three ways in which this relationship can be expressed. These are: 1. Statement of Scale 2. Representative Fraction (R. F.) 3. Graphical Scale

1. Statement of Scale: The scale of a map may be indicated in the form of a written statement. For example, if on a map a written statement appears stating 1 cm represents 10 km, it means that on that map a distance of 1 cm is representing 10 km of the corresponding ground distance. It may also be expressed in any other system of measurement, i.e. 1 inch represents 10 miles. It is the simplest of the three methods. However, it may be noted that the people who are familiar with one system may not understand the statement of scale given in another system of measurement. Another limitation of this method is that if the map is reduced or enlarged, the scale will become redundant and a new scale is to be worked out.

2. Graphical or Bar Scale: The second type of scale shows map distances and the corresponding ground distances using a line bar with primary and secondary divisions marked on it. This is referred to as the graphical scale or bar scale (Fig.2). It may be noted that the scale readings as shown on the bar scale in Figure2 reads only in kilometres and metres. In yet another bar scale the readings may be shown in miles and furlongs. Hence, like the statement of scale method, this method also finds restricted use for only those who can understand it. However, unlike the statement of the scale method, the graphical scale stands valid even when the map is reduced or enlarged. This is the unique advantage of the graphical method of the map scale

Fig 2 : Graphical Scale

3. Representative Fraction (R. F.): The third type of scale is R. F. It shows the relationship between the map distance and the corresponding ground distance in units of length. The use of units to express the scale makes it the most versatile method. R. F. is generally shown in fraction because it shows how much the real world is reduced to fit on the map.

$$R.F = map\ distance/\ ground\ distance$$

For example, a fraction of 1 : 24,000 shows that one unit of length on the map represents 24,000 of the same units on the ground i.e. one mm, one cm or one inch on the map representing 24,000 mm, 24,000 cm and 24,000 inches, respectively of the ground. It may, however, be noted that while converting the fraction of units into Metric or English systems, units in centimetre or inch are normally used by convention.

Check your progress

(iii) Define Map Scale?

(iv) Explain the Graphical Scale?

31.4. Types of Maps Based on Function

The maps may also be classified on the basis of their functions. For example, a political map serves the function of providing administrative divisions of a continent or a country and a soil map shows the distribution of different types of soils. Broadly, maps based on their functions may be classified into physical maps and cultural maps.

(i) **Physical Maps**: Physical maps show natural features such as relief, geology, soils, drainage, elements of weather, climate and vegetation, etc. (a) Relief Maps: Relief maps show general topography of an area like mountains and valleys, plains, plateaus and drainage (b) Geological Maps: These maps are drawn to show geological structures, rock types, etc. (c) Climatic Maps : These maps depict climatic regions of an area. Besides, maps are also drawn to show the distribution of temperature, rainfall, cloudiness, relative humidity, direction and velocity of winds and other elements of weather (d) Soil Maps : Maps are also drawn to show the distribution of different types of soil(s) and their properties

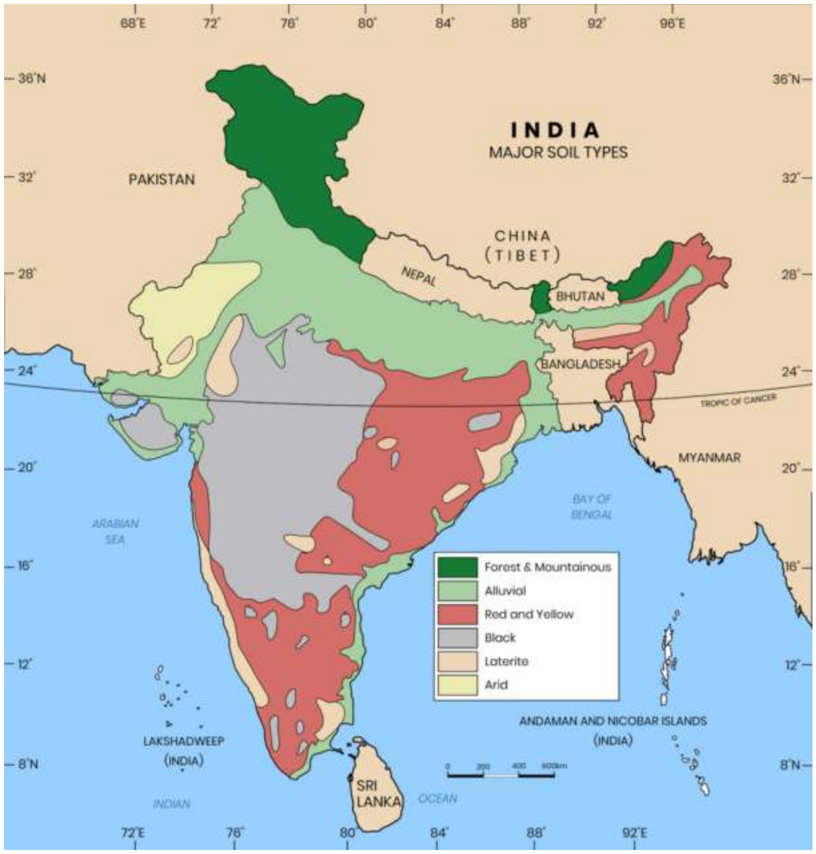

Fig 3 : Physical map – soil map of india

(ii) Cultural Maps: Cultural maps show man-made features. These include a variety of maps showing population distribution and growth, sex and age, social and religious composition, literacy, levels of educational attainment, occupational structure, location of settlements, facilities and services, transportation lines and production, distribution and flow of different commodities. (a) Political Maps : These maps show the administrative divisions of an area such as country, state or district. These maps facilitate the administrative machinery in planning and management of the concerned administrative unit. (b) Population Maps: The population maps are drawn to show the distribution, density and growth of population, age and sex composition, distribution of religious, linguistic and social groups, occupational structure of the population, etc. Population maps serve the most significant role in the planning and development of an area. (c) Economic Maps: Economic maps depict production and distribution of different types of crops and minerals, location of industries and markets, routes for trade and flow of commodities. **(**d) Transportation Maps: These maps show roads, railway lines and the location of railway stations and airports

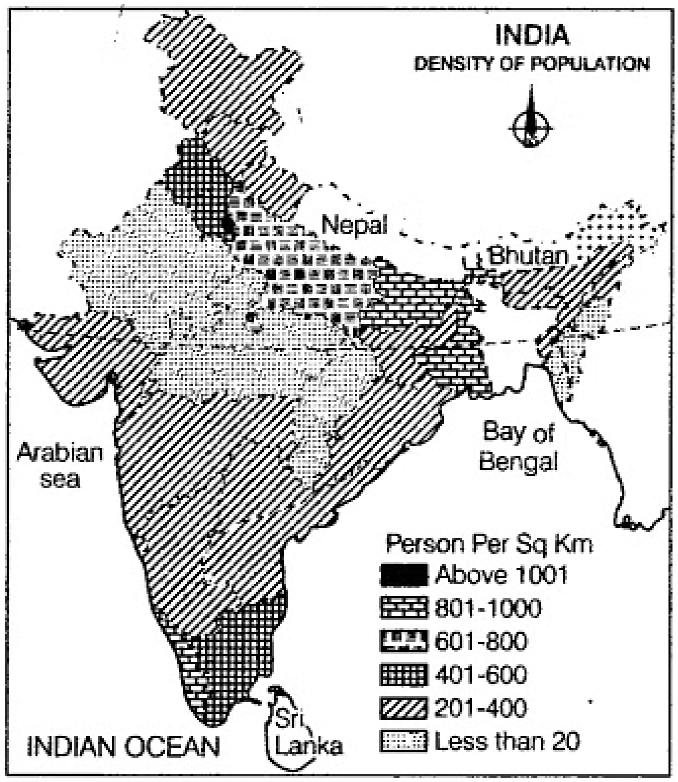

Fig 4 : Cultural map – Population Density Map

31.5. Types of Maps Based on Scale

On the basis of scale, maps may be classified into large-scale and small-scale. Large scale maps are drawn to show small areas at a relatively large-scale. On the other hand, small-scale maps are drawn to show large areas. For example, atlas maps, wall maps, etc**.**

(i) **Large-scale Maps**: Large scale maps show a smaller amount of area with a greater amount of detail. The geographic extent shown on a large scale map is small. Large-scale maps are further divided into the following types Cadastral maps, Topographical maps **(a) Cadastral Maps** : The term 'cadastral' is derived from the French word 'cadastre' meaning 'register of territorial property'. These maps are drawn to show the ownership of landed property by demarcating field boundaries of agricultural land and the plan of individual houses in urban areas. The cadastral maps are prepared by the government agencies to realise revenue and taxes, along with keeping a record of ownership. These maps are drawn on a very large scale, such as the cadastral maps of villages at 1 : 4,000 scale and the city plans at a scale of 1 : 2,000 and larger. (b**)** **Topographical Maps** : These maps are also prepared on a fairly large scale. The topographical maps are based on precise surveys and are prepared in the form of series of maps made by the national mapping agencies of almost all countries of the world . For example, the Survey of India undertakes the topographical mapping of the entire country at 1 : 250,000, 1 : 50,000 and 1 : 25,000 scale. These maps follow uniform colours and symbols to show topographic details such as relief, drainage, agricultural land, forest, settlements, means of communication, location of schools, post offices and other services and facilities.

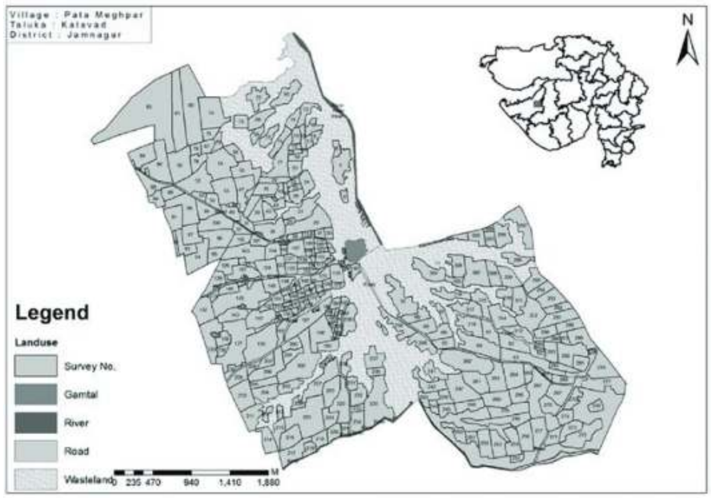

Fig 5 : Large Scale Map – Cadastral Map

(ii) **Small-scale Maps**: Small-scale maps are further divided into the following types Wall Maps Atlas Maps**.** **(a) Wall Maps** : These maps are generally drawn on large size paper or on plastic base for use in classrooms or lecture halls. The scale of wall maps is generally smaller than the scale of topographical maps but larger than atlas maps. **(b) Atlas Maps** : Atlas maps are very small-scale maps. These maps represent fairly large areas and present highly generalised picture of the physical or cultural features. Even so, an atlas map serves as a graphic encyclopaedia of the geographical information about the world, continents, countries or regions. When consulted properly, these maps provide a wealth of generalised information regarding location, relief, drainage, climate, vegetation, distribution of cities and towns, population, location of industries, transport-network system, tourism and heritage sites, etc.

Fig 6 : Small Scale Map – Atlas Map

Check your progress

(v) What is the Physical map ?

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(vi) Explain the lrage scale map?

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31.6. Relief features representation on Map :

In representing physical features relief presentation is also necessary. There are various methods of relief presentation. Each method has its specific features. The methods are contour lines, Hachure, Hill Shading

Contour line: A contour line is a imaginary line which connects points of equal elevation. Such lines are drawn on the plan of an area after establishing reduced levels of several points in the area. The contour lines in an area are drawn keeping difference in elevation of between two consecutive lines constant.

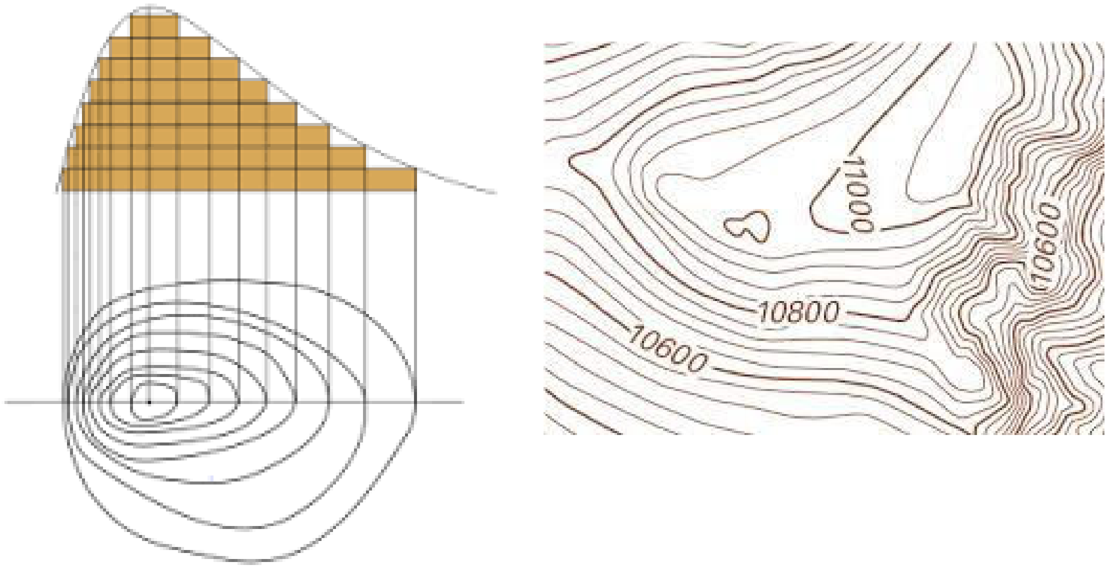


Fig 7 : Contour line

Hachure: Hachure is an older mode of representing relief. They show orientation of slope, and by their thickness and overall density they provide a general sense of steepness. Being non-numeric, they are less useful to a scientific survey than contours, but can successfully communicate quite specific shapes of terrain. They are a form of shading, although different from the one used in shaded maps

Hill Shading

A method of representing relief on a map by depicting the shadows that would be cast by high ground if light was shining from a certain direction. This method is easy for presentation relief features but not useful as contours. It has many demerits.

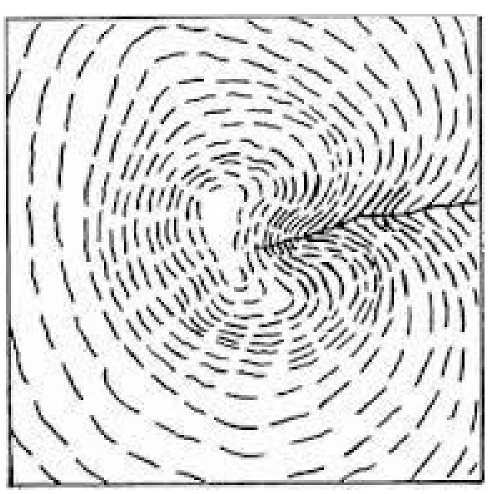


Fig 8: Hachure

Fig 9: Hill Shading

Slope representation on map

The slopes can broadly be classified into gentle, steep, concave, convex and irregular or undulating. The contours of different types of slopes show a distinct spacing pattern

Concave slope: A slope with a gentle gradient in the lower parts of a relief feature and steep in its upper parts is called the concave slope. Contours in this type of slope are widely spaced in the lower parts and are closely spaced in the upper parts.

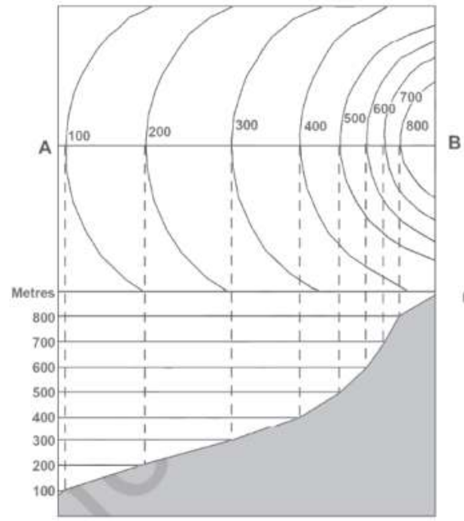


Fig 10 : Concave slope

Convex Slope: Unlike concave slope, the *convex slope* is fairly gentle in the upper part and steep in the lower part. As a result, the contours are widely spaced in the upper parts and are closely spaced in the lower parts

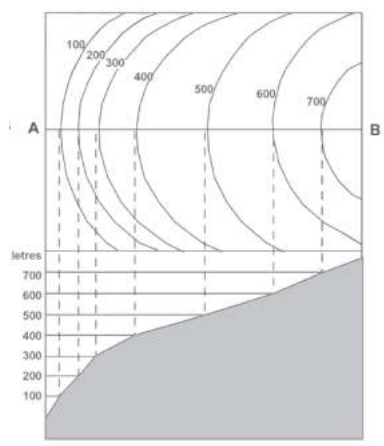


Fig 11: Convex Slope

Valley representation on map : A geomorphic feature lying between two hills or ridges and formed as a result of the lateral erosion by a river or a glacier is called a valley.

'V'-shaped Valley : It resembles the letter V. A V-shaped valley occurs in mountainous areas. The lowermost part of the V–shaped valley is shown by the innermost contour line with very small gap between its two sides and the lowest value of the contour is assigned to it. The contour value increases with uniform intervals for all other contour lines outward.

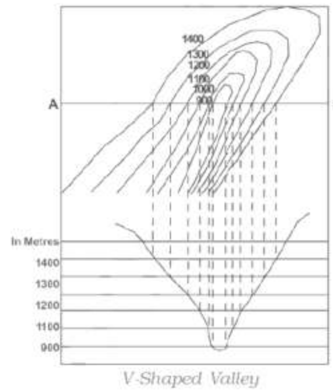
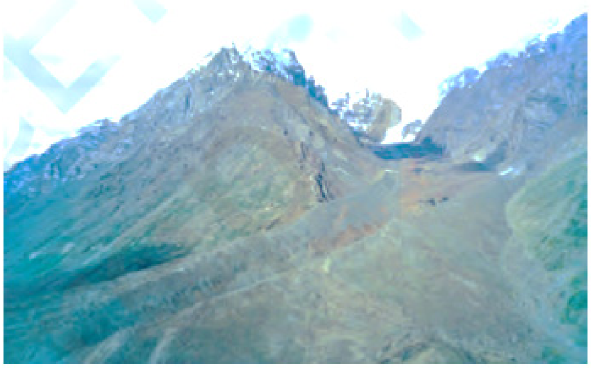


Fig 12: 'V'-shaped Valley

'U' – shaped Valley: A U–shaped valley is formed by strong lateral erosion of glaciers at high altitudes. The flat wide bottom and steep sides makes it resemble the letter 'U'. The lowermost part of the U–shaped valley is shown by the innermost contour line with a wide gap between its two sides. The contour value increases with uniform intervals for all other contour lines outward



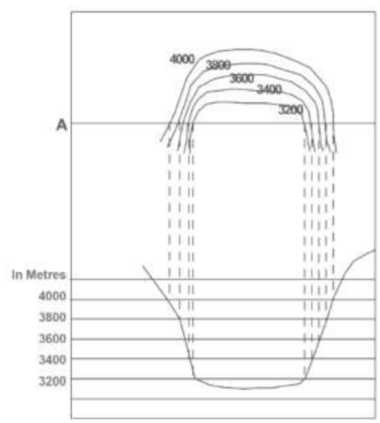


Fig 13 : 'U' – shaped Valley

Gorge : In high altitudes, gorges form in the areas where the vertical erosion by river is more prominent than the lateral erosion. They are deep and narrow river valleys with very steep sides. A gorge is represented by very closely-spaced contour lines on a map with the innermost contour showing small gap between its two sides.

Fig 14: Gorge

Check your progress

(vii) What are the relief presentation methods ?

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(viii) Explain the types of slopes?

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31.6. Summary

A map is a symbolic representation of selected characteristics of a place, usually drawn on a flat surface. The scicne and art of map making is called cartography. Map scale is the key element in differenating sketuch from map. Maps are classifed based on purpose and scale. On the base of purpose , maps are classifed as physical and culural maps. The physical maps shows distribution natural features of earth surfae like mountains, rocks , water , forest and etc whereas cultural maps shows roads , political , etc . On the basis of scale, maps may be classified into large-scale and small-scale. Atlas maps are very small-scale maps whereas landed property map is large scale map. Contour lines, Hachur and Hill Shading are methods of represeantion of relief features on map. V-shped , U-shpaged valley and concave , convex slopes are represnted on map using contour lines

31.7 Model Answers to Check Your Progress

(i) A map is a representation or drawing of the earth's surface or a part of its area drawn on a flat surface. A map is always made according to a scale.

(ii) Major map elements are title ,legend , scale , north arrow and graticlue

(iii) Map scale also express this relationship as a ratio of distances between two points on the map and the corresponding distance between the same two points on the ground

(vi) scale shows map distances and the corresponding ground distances using a line bar with primary and secondary divisions marked on it.

(v) Physical maps show natural features such as relief, geology, soils, drainage, elements of weather, climate and vegetation, etc

(vi) Large scale maps show a smaller amount of area with a greater amount of detail. The geographic extent shown on a large scale map is small

(vii) There are various methods of relief presentation. The methods are contour lines, Hachure, Hill Shading

(viii) The slopes can broadly be classified into gentle, steep, concave,convex and etc

31.8 Model Examination Questions

I. Essay Questions

(1) Explain the major Map Elements?

(2) Explain the functional classification of maps?

(3) What are scales based on classified maps?

(4) Explain the Relief representation methods on Map?

II. Short questions

(1) Explain the concept of Representative Fraction (R. F.) ?

(2) Describe the different types of cultural maps?

(3) How different types of scales represent in Map? Expalin

(4) Explain the concept of Small Scale map and types ?

III. Very short questions

(1) What is Graticule?

(2) What is Cartography?

(3) Atlas Maps

(4) Convex Slope

31.9 Further Readings

R.P.Sharma (2014) , Fundamentals Of Cartography, Concept Publishing Company

Chapter - 32

INTERPRETATION OF TOPOGRAPHICAL MAPS AND WEATHER MAPS

Contents

32.1. Introduction

32.2. Preparation of Topographical Maps

32.3. Interpretation of Topographical Maps

32.4. Weather and weather observations

32.5.Weather Maps and Charts

32.6. Mapping the Climatic Data and Weather Map Interpretation

32.7. Summary

32.8 Model Answers to Check Your Progress

32.9 Model Examination Questions

32.0. Objectives

After studying this unit, you should be able to:

- Know the concept topographic map
- Symbols and signs of topographic maps
- difference between weather and climate and weather symbols and charts
- Weather observation and weather Map Interpretation

32.1. Introduction

Topographical maps, also known as general purpose maps, are drawn at relatively large scales. These maps show important natural and cultural features such as relief, vegetation, water bodies, cultivated land, settlements, and transportation networks, etc. These maps are prepared and published by the National Mapping Organization of each country. For example, the Survey of India prepares the topographical maps in India for the entire country. Weather is the state of the atmosphere, including temperature, atmospheric pressure, wind, humidity, precipitation, and cloud cover. Weather map or chart that shows the meteorological elements at a given time over an extended area.

32.2. Preparation of Topographical Maps

The topographical maps in India are prepared in two series, i.e. India and Adjacent Countries Series and The International Map Series of the World. India and Adjacent Countries Series: Topographical maps under India and Adjacent Countries Series were prepared by the Survey of India till the coming into existence of Delhi Survey Conference in 1937. Henceforth, the preparation of maps for the adjoining countries was abandoned and the Survey of India confined itself to prepare and publish the topographical maps for India as per the specifications laid down for the International Map Series of the World. However, the Survey of India for the topographical maps under the new series retained the numbering system and the layout plan of the abandoned India and Adjacent Countries Series.

The topographical maps of India are prepared on 1 : 10,00,000, 1 : 250,000, 1 : 1,25,000, 1 : 50,000 and 1: 25,000 scale providing a latitudinal and longitudinal coverage of 4° × 4°, 1° × 1°, 30' × 30', 15' × 15' and 5' × 7' 30", respectively. The numbering system of each one of these topographical maps is shown in Fig. 1 . International Map Series of the World: Topographical Maps under International Map Series of the World are designed to produce standardised maps for the entire World on a scale of 1: 10,00,000 and 1:250,000.

32.3. Interpretation of Topographical Maps

Reading of Topographical Maps: The study of topographical maps is simple. It requires the reader to get acquainted with the legend, conventional sign and the colours shown on the sheets. The conventional sign and symbols depicted on the topographical sheets are shown in Fig. 2

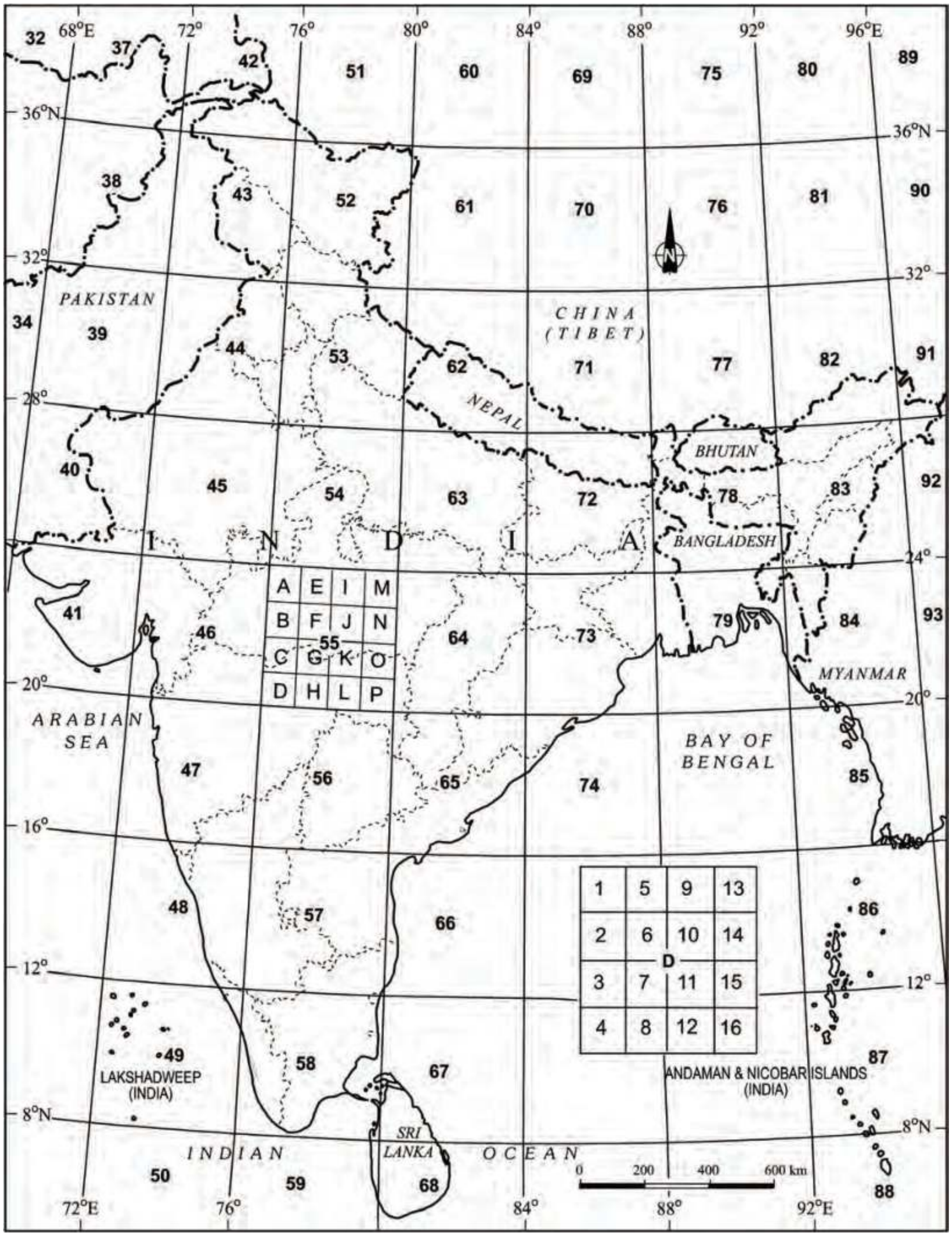


Fig 1 : Reference Map of Topographical Sheets Published by Survey of India

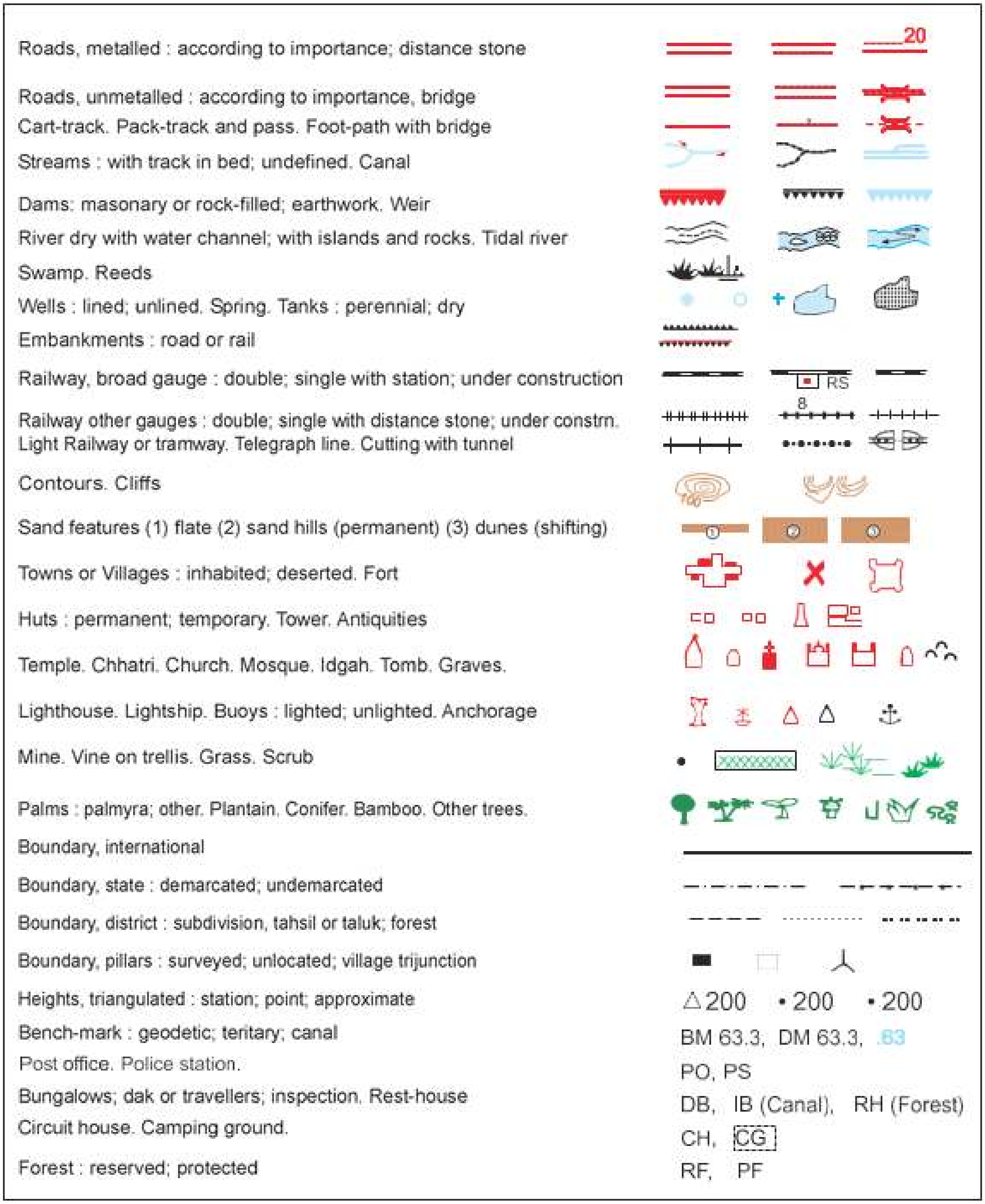


Fig 2: Conventional sign and signals

Knowledge of map language and sense of direction are essential in reading and interpreting topo-sheets .You must first look for the north line and the scale of the map and orient yourself accordingly. You must have a thorough knowledge of the legends / key given in the map depicting various features. All topo-sheets contain a table showing conventional signs and symbols used in the map (Figure 2). Conventional signs and symbols are internationally accepted; so, anyone can read any map anywhere in the world without knowing the language of that particular country.

A topographic sheet is usually interpreted under the following heads:

Marginal Information: It includes the topographical sheet number, its location, grid references, its extent in degrees and minutes, scale, the districts covered, etc.

Relief of the Area: The general topography of the area is studied to identify the plains, plateaus, hills or mountains along with peaks, ridges, spur and the general direction of the slope. These features are studied under the following heads :

- Hill : With concave, convex, steep or gentle slope and shape.
- Plateau : Whether it is broad , narrow, flat, undulating or dissected.
- Plain : Its types, i.e. alluvial, glacial, karst, coastal, marshy, etc.
- Mountain : General elevation, peak, passes, etc.

Drainage of the Area: The important rivers and their tributaries and the type and extent of valleys formed by them, the types of drainage pattern, i.e. dendritic, radial, ring, trellis, internal, etc.

Land Use: It includes the use of land under different categories like :

- Natural vegetation and forest (which part of the area is forested,whether it is dense forest or thin, and the categories of forest found there like Reserved, Protected, Classified / Unclassified).
- Agricultural, orchard, wasteland, industrial, etc.
- Facilities and Services such as schools, colleges, hospitals, parks,

Transport and Communication: The means of transportation include national or state highways, district roads, cart tracks, camel tracks, footpaths, railways, waterways, major communication lines, post offices, etc.

Settlement: Settlements are studied under the following heads :

- Rural Settlements: The types and patterns of rural settlements,.e. compact, semi-compact, dispersed, linear, etc.
- Urban Settlements: Type of urban settlements and their functions, i.e. capital cities, administrative towns, religious towns, port towns,hill stations, etc.

Occupation: The general occupation of the people of the area may be identified with the help of land use and the type of settlement. For example, in rural areas the main occupation of majority of the people is agriculture; in tribal regions, lumbering and primitive agriculture dominates and in coastal areas, fishing is practiced. Similarly, in cities and towns, services and business appear to be the major occupations of the people.

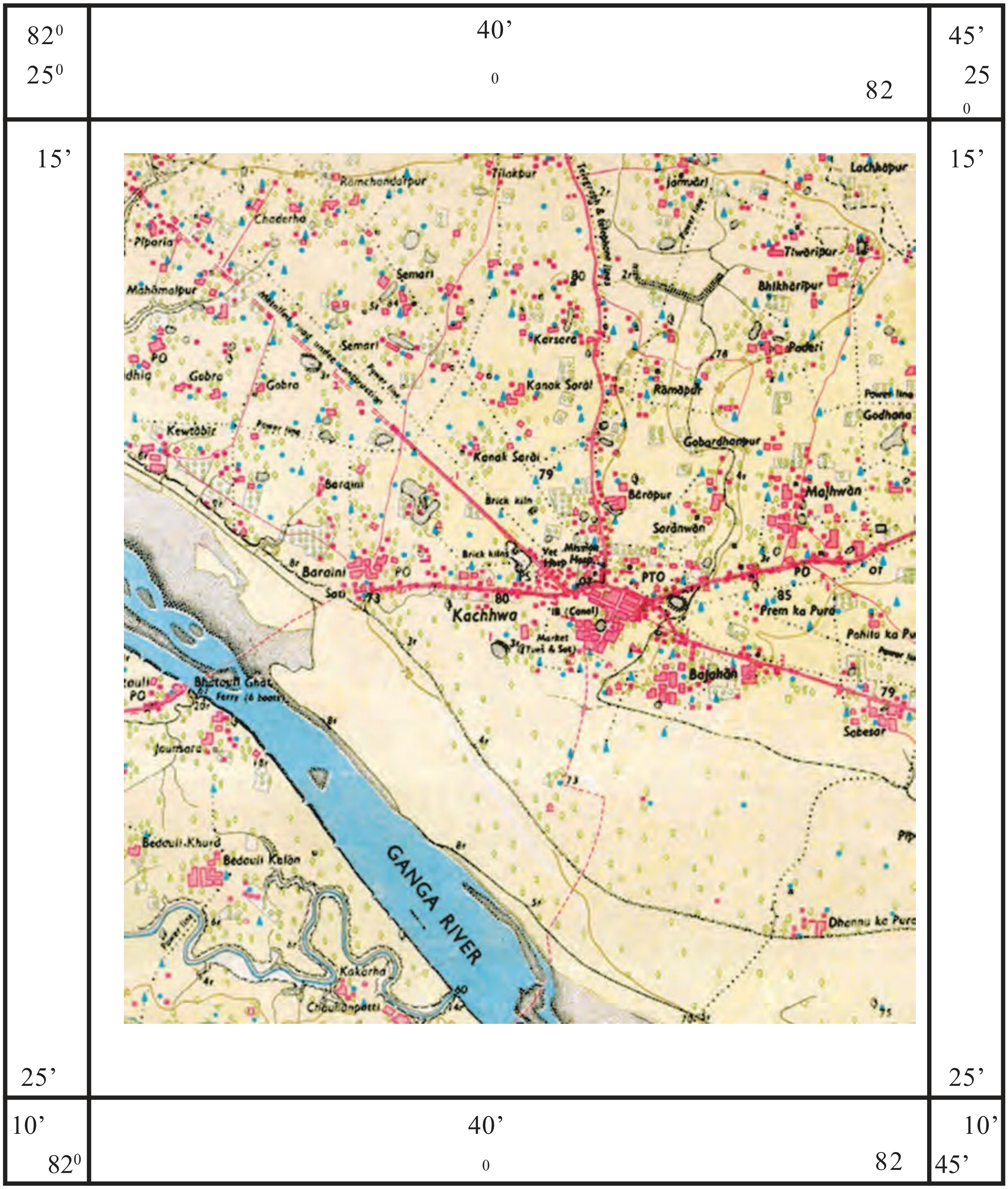


Fig 3

Uttar Pradesh

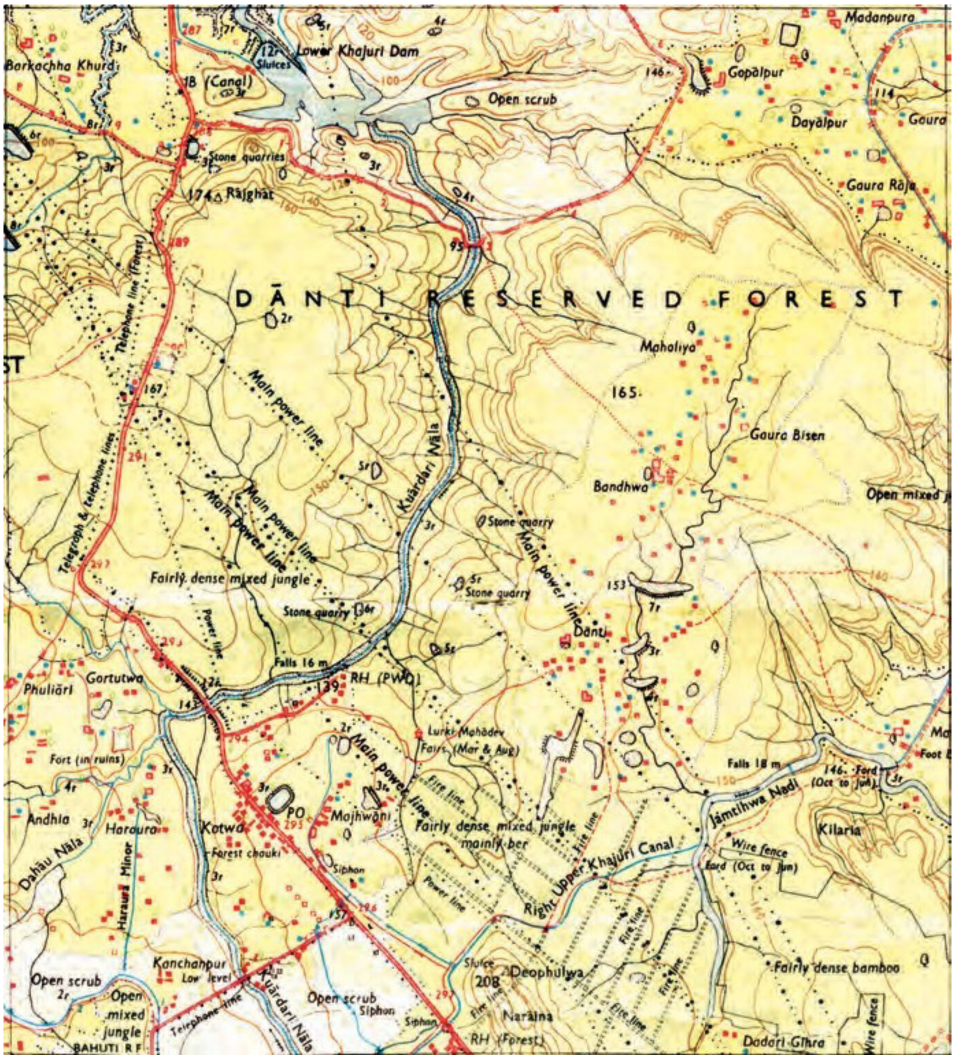
Mirzapur and Varanasi District *Part of 63K/12*

Fig 3

Uttar Pradesh

Mirzapur and Varanasi District *Part of 63K/12*

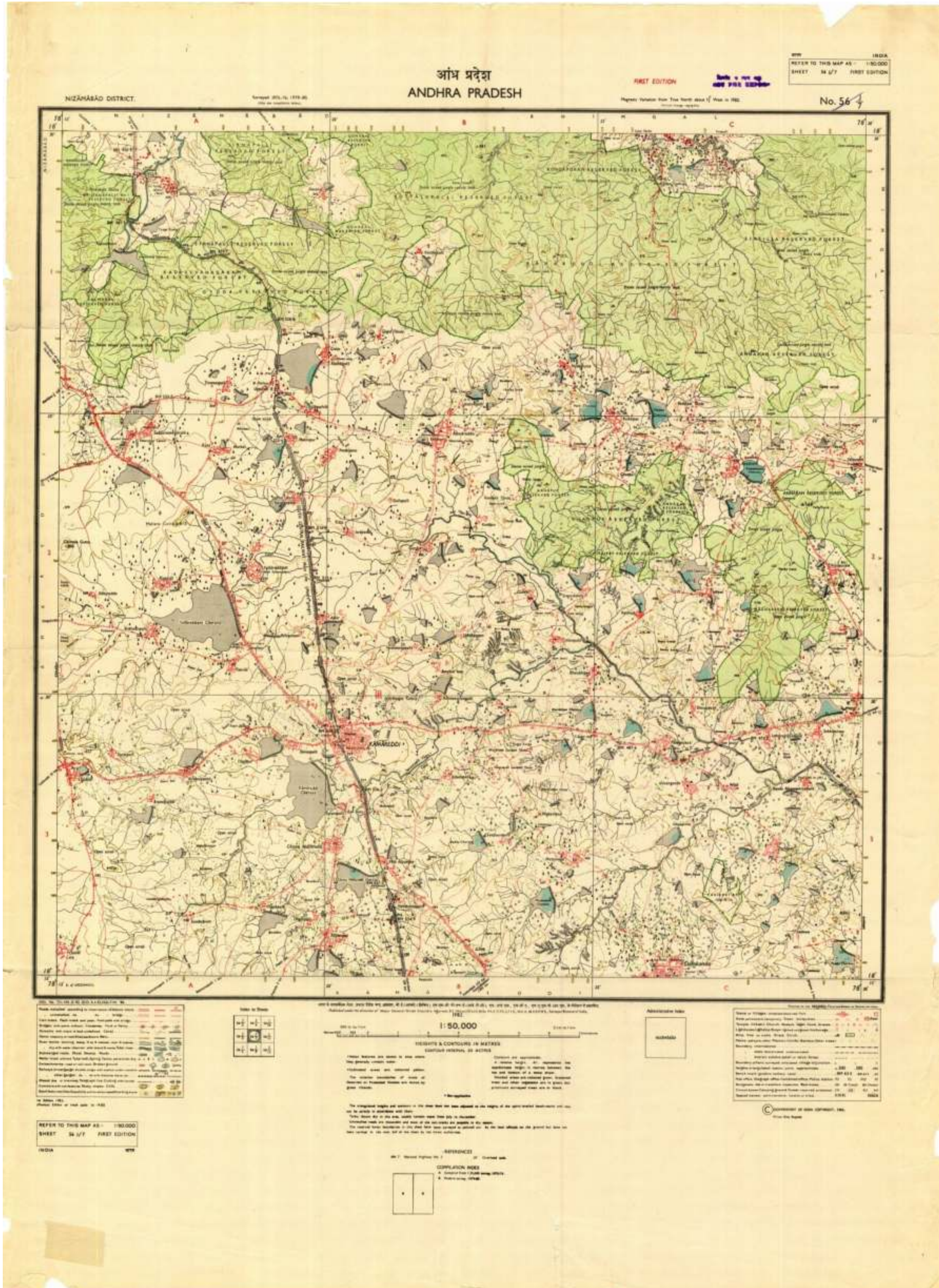
82^0 25^0	35’ 82^0	40’ 25^0
5’		5’
25^0 0’ 82^0	35’ 82^0	25^0 0’ 40’



R. F. 1: 50,000

Part of the Topographical Sheet No 63K/12

Fig 4



Check your progress

(i) What is topographical map?

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(ii) What type of Information can be Interpreted from topological maps?

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32.4 Weather and weather observations

The day-to-day conditions of the atmosphere at a place with respect to elements like temperature, rainfall, etc. is called the weather of that place. Major elements of weather includes Wind speed Humidity ,Temperature, Rainfall, Thunder, Snow, Lightning. It differs from climate, which is all weather conditions for a particular location averaged over about 30 year. Meteorology is science that deals with the atmospheric phenomena and weather of a region and especially with weather and weather forecasting.Weather is influenced by latitude, altitude, and local and regional geography. Various instruments are used for measuring different weather phenomena. Some of the common but important weather instruments are listed in table 1

Table 1 : Weather Instruments

S. No	Element	Measuring Instrument
1	Temperature	Thermometer
2	Atmospheric Pressure	Barometer
3	Wind (Direction)	Wind Vane
4	Wind (Velocity)	Anemometer
5	Rainfall	Rain Gauge

Weather Observations

Globally, meteorological observations are recorded at three levels, viz. surface observatories, upper air observatories and space-based observation platforms. The World Meteorological Organization (WMO), a specialised agency of the United Nations, coordinates these observations.

Surface Observatories

A typical surface observatory has instruments for measuring and recording weather elements like temperature (maximum and minimum), air pressure, humidity, clouds, wind and rainfall. Specialised observatories also record elements like radiation, ozone atmospheric trace gases, pollution and atmospheric electricity. These observations are taken all over the globe at fixed times of the day as decided by the WMO and the use of instruments are made conforming to international standards, thus making observations globally compatible.

In India, meteorological observations are normally classified into five categories depending upon their instruments and the number of daily observations taken. The highest category is Class-I. Typical instrumental facility available in a Class-I observatory consists of Maximum and minimum thermometers, Anemometer and wind vane, Dry and Wet bulb thermometer , Rain gauge and Barometer. Observations are taken in these observatories normally at 00,03,06,09,12,15,18,21 hours (Greenwich Mean Time) around the globe. However, for logistic reasons, some of the observatories take limited number of daily observations upper air observation during daytime only.

Upper air Observatories

Radiosonde sensors measure upper-air conditions such as atmospheric pressure, temperature and humidity, wind speed and direction. Radiosonde, is a hydrogen filled balloon with instruments attached. The balloon is released into the atmosphere and as it ascends readings are transmitted back to the surface station. IMD’s present Upper air observational network comprises 39 radiosonde and 62 pilot balloon observatories spread all over the country. Systematic upper air observations began in the Department in 1905 at Shimla. An upper air observatory was started in 1912 at Agra.

Space-Based Observations

Weather satellites make comprehensive and large-scale observations of different meteorological elements at the ground level as well in the upper layers of the atmosphere. The geo-stationary satellites provide space-based observations about weather conditions .For example, The Indian National Satellite (INSAT) provides valuable observations of temperature, cloud cover, wind and associated weather phenomena

32.5 Weather Maps and Charts

A weather map is the representation of weather phenomena of the earth or a part of it on a flat surface. It depicts conditions associated with different weather elements such as temperature, rainfall, sunshine and cloudiness, direction and velocity of winds, etc. on a particular day. Such observations being taken at fixed hours are transmitted by code to the forecasting stations. The central office keeps a record of the observations, which forms the basis for making a weather map. The upper air observations which are procured from hill stations, aeroplanes, pilot balloons, etc. are plotted separately. Since the inception of the Indian Meteorological Department, the weather maps and charts are prepared regularly. Meteorological observatories transmit the data to the Central Observatory at Pune twice a day. Data is also collected on ships plying on the Indian seas. A good progress has been made in the field of weather forecasting and observation with the establishment of weather observatories in Antarctica, the International Indian Ocean Expedition, and the launching of rockets and weather satellites**.**

Weather Charts: The data received from various weather observatories are in plenty and detailed. As such, they cannot be incorporated in one single chart unless the coding designed to give the economy of expression is used. These are called synoptic weather charts and the codes used are called meteorological symbols. Weather charts provide the primary tools for weather forecasting. They help in locating and identifying different air masses, pressure systems, fronts and areas of precipitation.

Weather Symbols The messages received from all the observatories are plotted on the map using weather symbols standardised by the World Meteorological Organisation and the National Weather Bureaus. (Figures 5 and 6) To facilitate the interpretation of the plots, each element occupies a fixed position to the station circle as given in Figures 5 and 6. The Beaufort scale, officially known as the Beaufort wind force scale, is a descriptive table. It depicts the force of wind by a series of numbers, typically from 0 to 12 (fig 6)

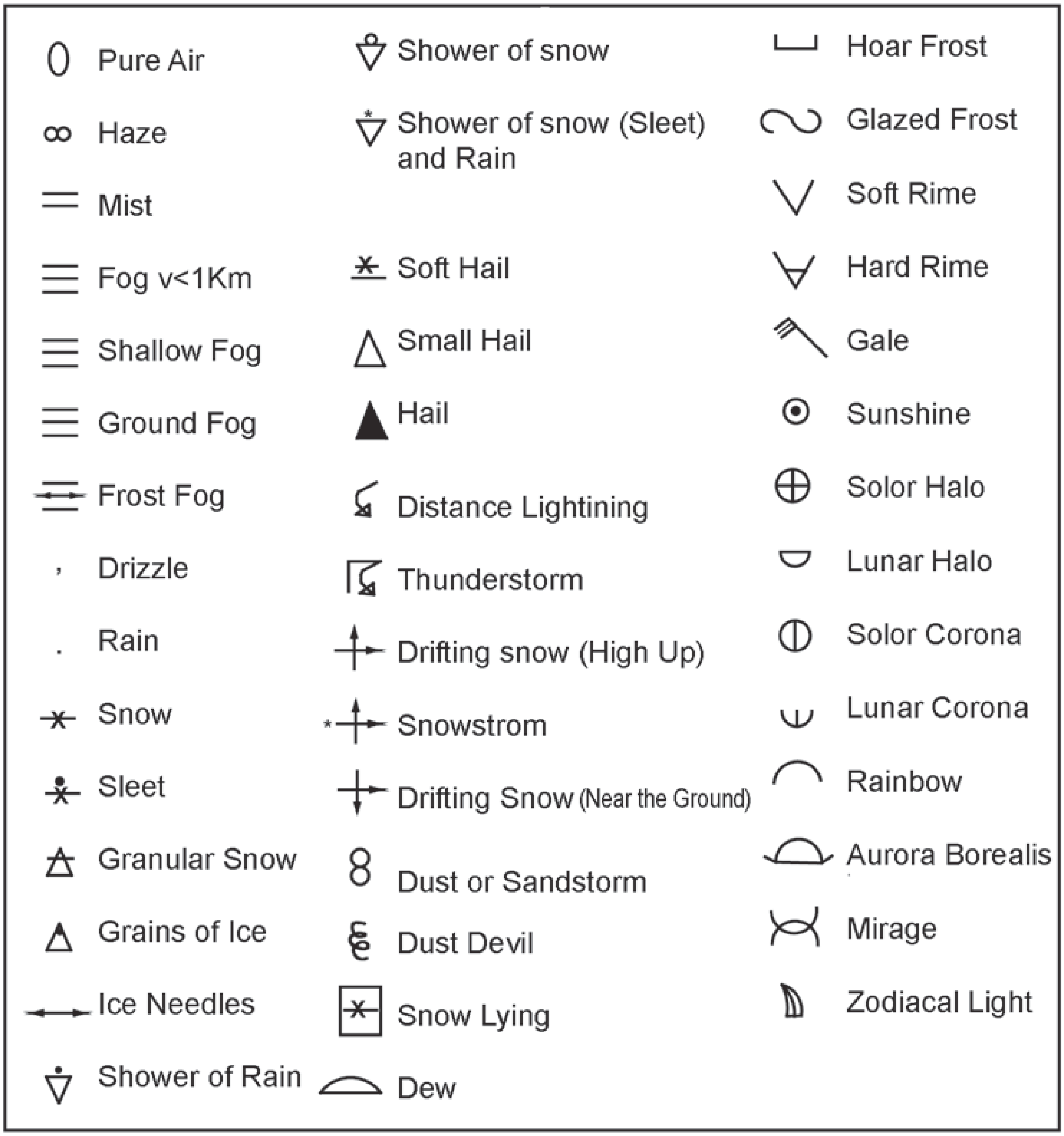

Fig 5 Meteorological Symbols

Check your progress

(iii) Define Weather, what are the major elements of weather?

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(iv) What is Weather Map?

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32.6. Mapping the Climatic Data and Weather Map Interpretation

Much of the climatic data is represented by line symbols. The most common of these are the isometric lines. These lines are depicted on the map as isopleths. The Isopleth can be interpolated for places having the same mean values of temperature, rainfall, pressure, sunshine, clouds, etc. Some of these lines and their uses are mentioned below:

Isobars : Lines connecting places of equal air pressure.

Isotherms : Lines connecting places of equal temperature.

Isohyets : Lines connecting places of equal amount of rainfall over a given period of time.

Isohels : Lines connecting places of same mean daily duration of sunshine.

Isonephs : Lines connecting places of same mean value of cloud cover.

On the basis of the above information, we can analyse a weather map and understand the general pattern of weather conditions prevailing in different parts of the country. In Fig. 7 the general weather conditions prevailing in India during the month of May are plotted. There is a general increase of pressure towards the north and north-east. Two low-pressure centres can be identified with one over Rajasthan and the other over the Bay of Bengal. The low pressure centre is well developed over the Bay of Bengal marked by concentric isobars, with the lowest air pressure being 996 mb. The southern part of India has overcast skies. The central part of India, on the other hand, has generally clear skies. In the southern part of the eastern coast, the winds are mostly from the land to the sea, flowing in an anti-clockwise direction. Also, read Fig. 9 and find out the temperature and pressure conditions in July.

In Figures 8 & 10 the general weather conditions during winters in the month of January are plotted. There is a general increase of pressure towards the north from south. Most of the country has clear skies with a high-pressure region developing to the eastern side of India. The highest pressure isobar of 1018 mb passes through Rajasthan

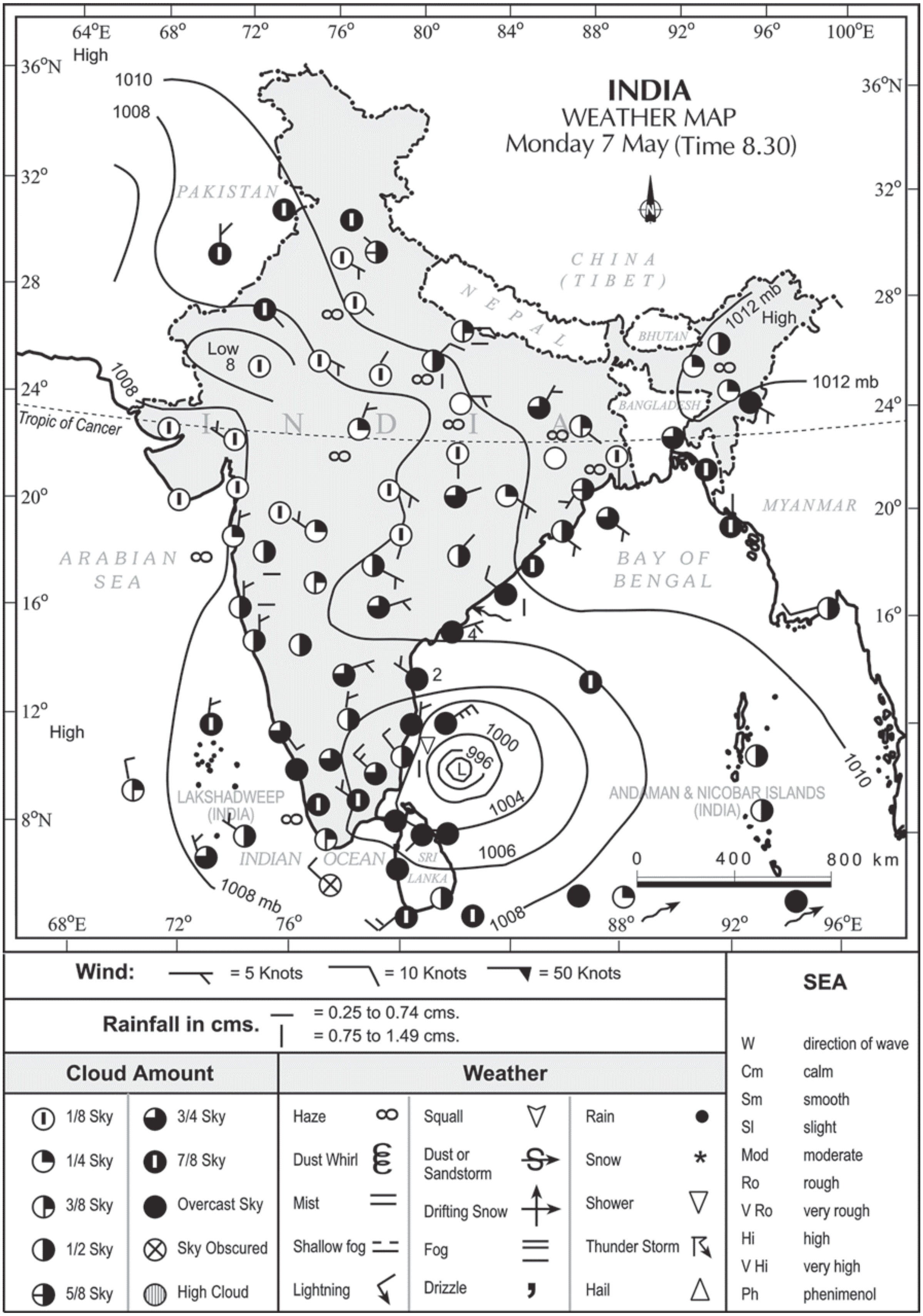

Figure 7 Indian Weather Map (for the month of May)

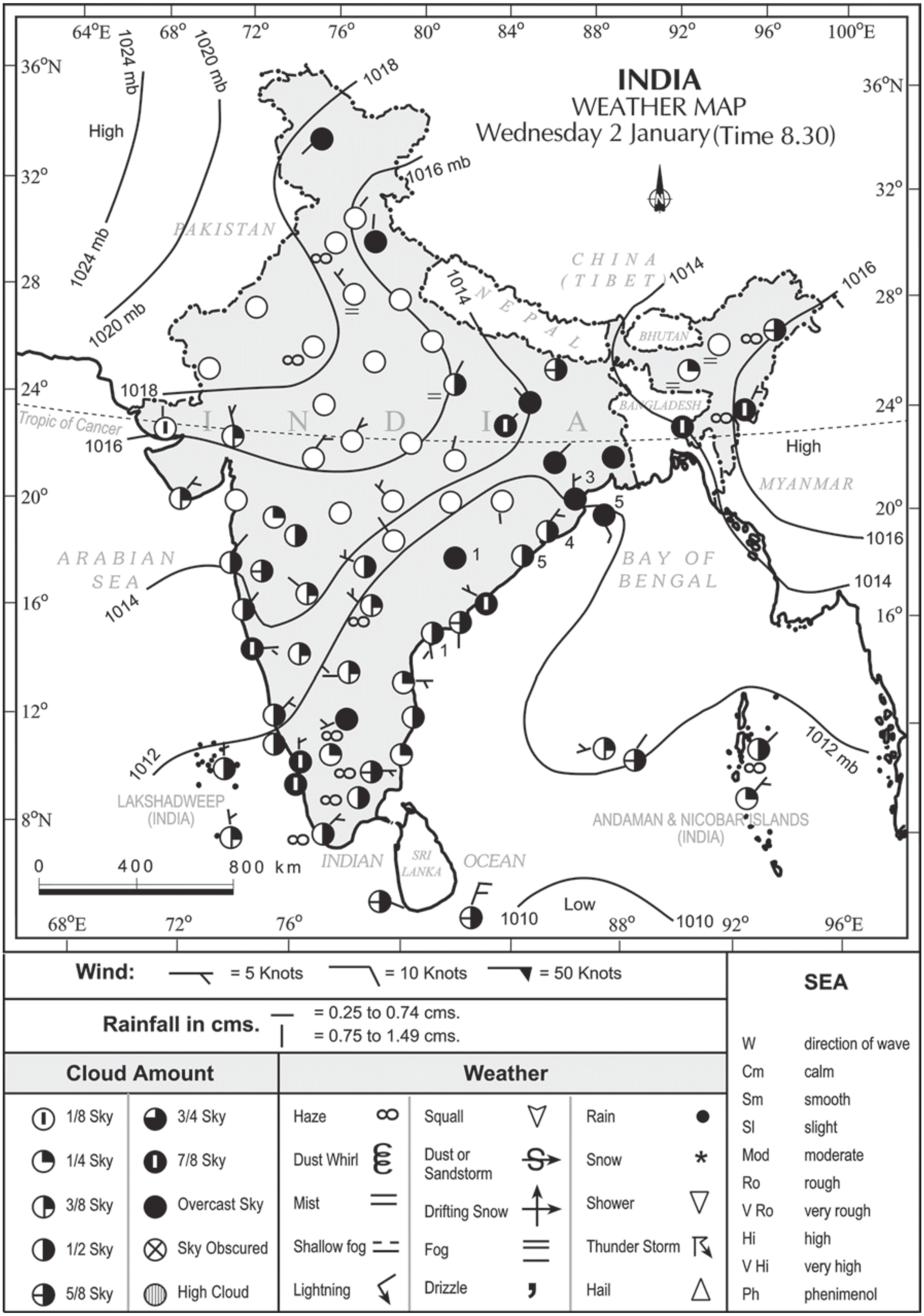

Figure 8 Indian Weather Map (for the month of January

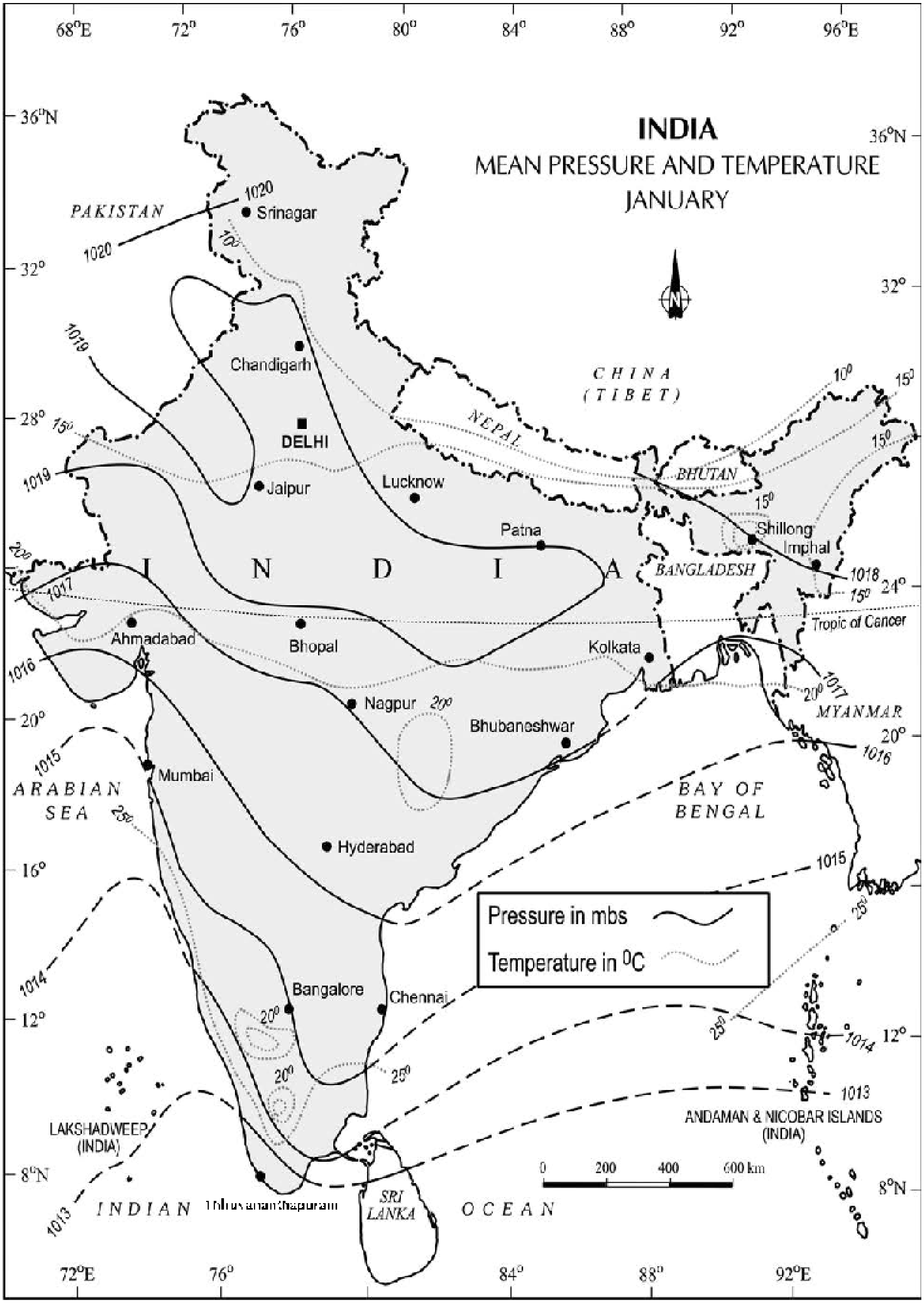

Figure 8 Indian Weather Map (for the month of January

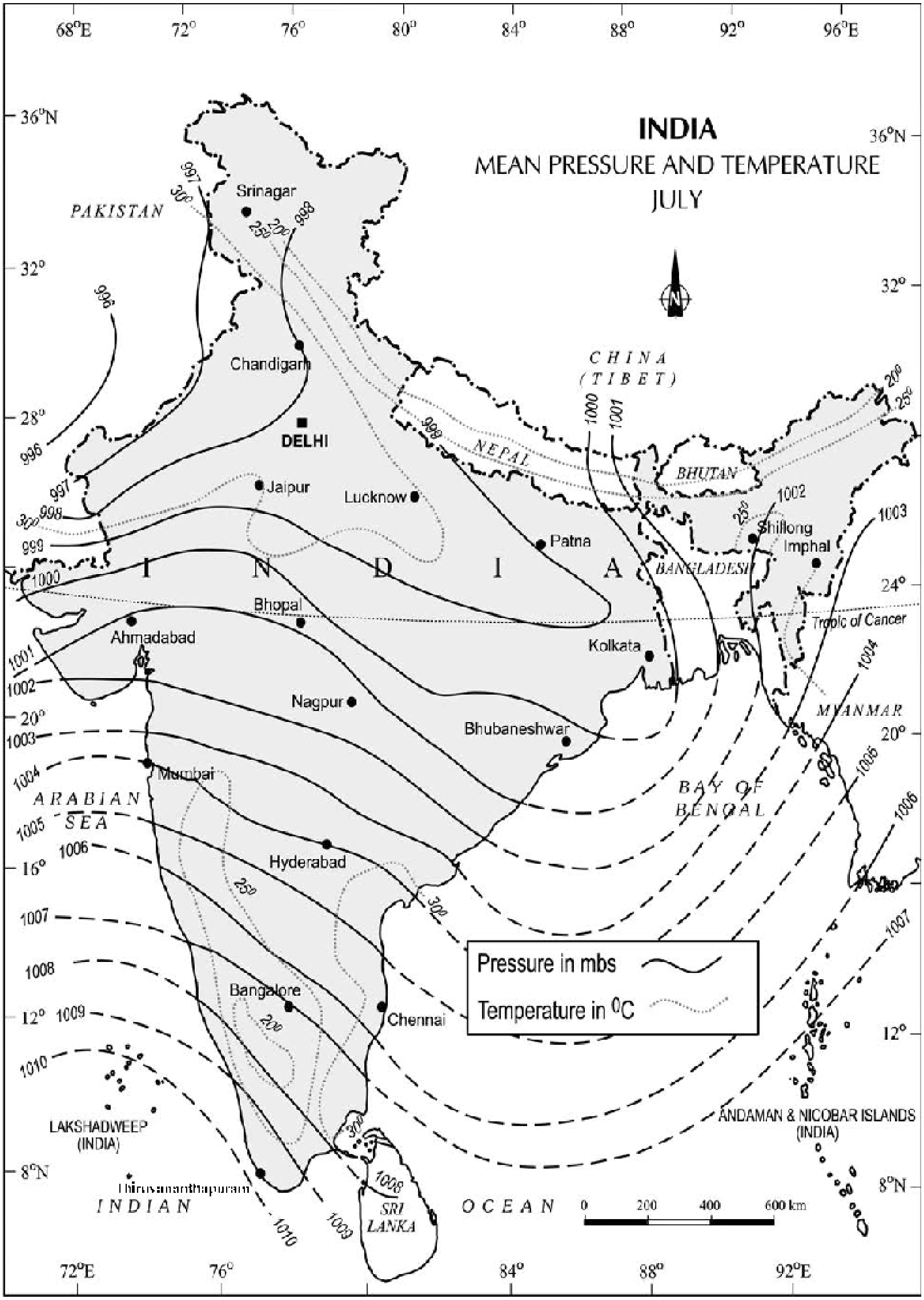

Figure 10 Mean Pressure and Temperature (July)

Check your progress

(v) What is thermos ?

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(vi) What is Isonephs ?

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32.7. Summary

Topographical maps are topographical maps are large scale maps , these maps are prepared by Survey of India (SOI) for India. The location , Scale, Hill ,Plateau Plain Mountain, drainage, , Land Use, Settlement , Transport and Communication of particular place or area can be interpreted from the topographical maps. Weather is 24 hours observation of temperature, rainfall ,etc of particular place. The major elements of weather are Wind speed Humidity, Temperature, Rainfall, Thunder, Snow, Lightning. Globally weather observations are recorded at three levels, viz. surface observatories, upper air observatories and space-based observation platforms. The observed weather data presented in maps , charts and symbols. These weather maps and charts helpful in study the weather pattern and forecast the weather phenomena of particular place.

32.8 Model Answers to Check Your Progress

(i) Topographical maps, also known as general purpose maps, are drawn at relatively large scales. These maps show important natural and cultural features such as relief, vegetation, water bodies, cultivated land, settlements, and transportation networks, etc.

(ii) It includes the topographical sheet number, its location, grid references, its extent in degrees and minutes, scale, Relief of the Area ,Drainage of the Area, Land Use, Settlement , Transport and Communication

(iii) 24 hours observation of temperature and rainfall etc. of a place is called weather .Major elements of weather includes Wind speed Humidity ,Temperature, Rainfall, Thunder, Snow, Lightning

(vi) A weather map is the representation of weather phenomena of the earth or a part of it on a flat surface on a particular day .

(v) Lines connecting places of equal temperature of a place is called Isotherms

(vi) Lines connecting places of same mean value of cloud cover of a place is called Isonephs

32.9 Model Examination Questions

I. Essay Questions

(1) Explain in detail about what information interpreted from topographical maps?

(2) What are the major weather observation methods?

(3) Interpret the given weather map?

II. Short questions

(1) What type of Relief identified in topographical map?

(2) Explain upper air observation in India?

(3) What is Beaufort scale?

III. Very short questions

(1) what is Anemometer

(2) what is Storm and its effect ?

(3) what are isohyets?

32.10 Further Readings

- Savinder Singh (2013), Geography of India, Pravalika Publication , Allahabad
- Nelson Petrie (2016) , Analysis and Interpretation of Topographical Maps, The Orient Blackswan