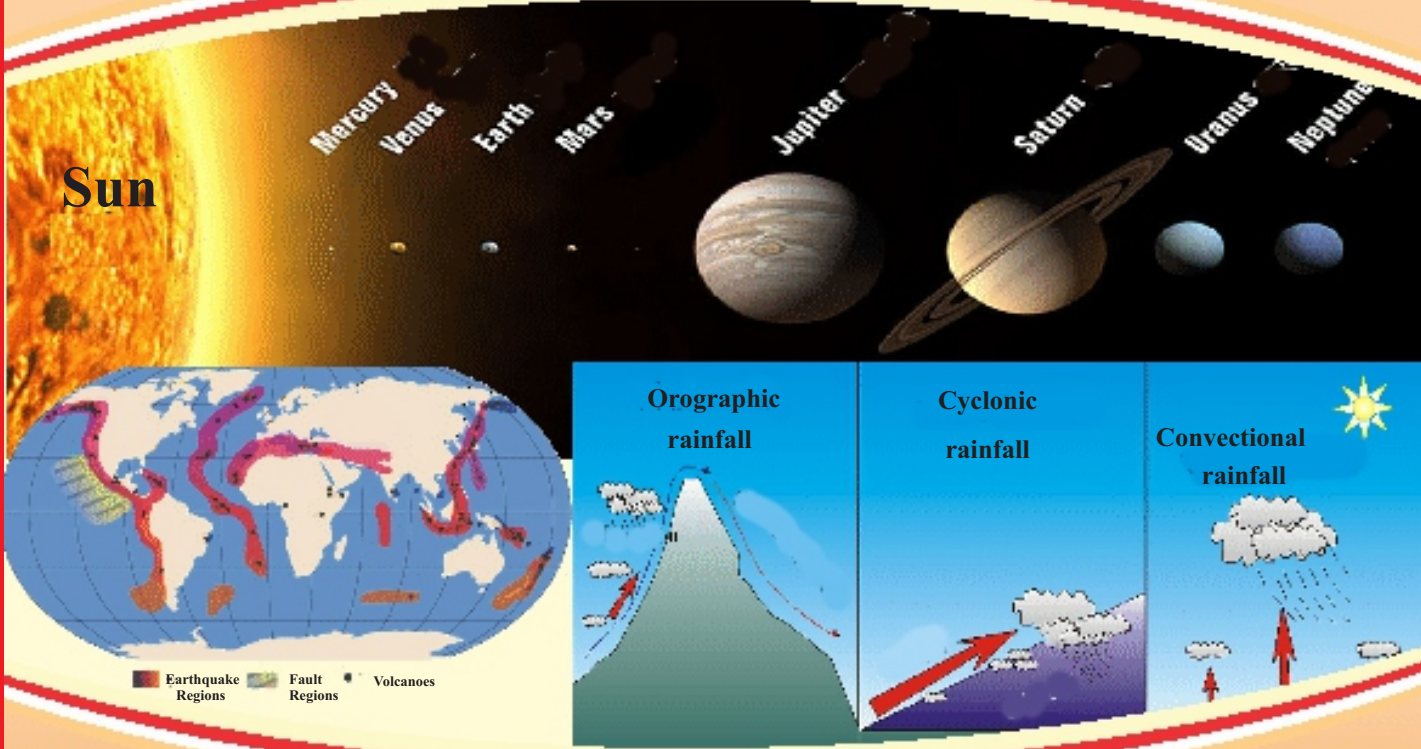


Geography



Geography

Class - 11



Board of Secondary Education Rajasthan, Ajmer

Pathya Pustak Nirman Samiti

Book - Geography

Class - 11

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Preface

The influence of Geography remains from birth to death on the humans beings, flora and fauna. Every aspect of our life, is linked to the various aspects of geography. Multidimensional universe is full of several mysteries that are scientifically studied in geography. Earth is the home of man. The diverse characteristics of various aspects of surface, water, sky interior of earth, organic and inorganic organisms are studied scientifically in geography. In the study of geography great emphasis on man and nature and their relationship. This resulted in two main branches i.e. physical geography and human geography and subsequently many specialized sub branches developed.

Geography has been studied and taught since ancient times in India, Greece, Rome, Arab and China. The present geography is equipped with modern tools and techniques like remote sensing technology, Geographical Information Systems, Global Positioning System, and Digital Mapping. These techniques and tools of geography are playing an important role in welfare of human beings.

Efforts have been made to explain physical geography and physical and natural aspects of India and Rajasthan with the help of colourful pictures, maps, and tables. For the benefit of students, the scientific terms are used and explained in such a way that it could be easily comprehended. I am sincerely thankful to all the reference books, websites, atlas and all the associate authors whose assistance made this task easier. I invite suggestions from teachers and students to improve this book further.

Coordinator

Syllabus

Time: 3.15 Hours

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Lesson - 1

Geography as a Subject

We are under the influence of geography right from our birth and remain so until our death. Every aspect of our life is linked to geography and its different components. Our universe is multi-dimensionally filled with lots of mysteries. Universe which is an epitome of wholeness is still unknown to us.

Universe creates a picture along with gravitational force and other forces which are working within gases, dust particles, millions of stars and their planets, within billion of milky ways and galaxies. When, how and who created these mysterious pictures? What is its shape structure and size are some of the questions that are being constantly sought by human beings. In the entire universe, our milky way or spiral shape Mandakini consists of uncountable stars. Our solar system is a tiny part of this milky way which consists sun and its planets, satellites, meteoroids, asteroids and comets. According to scientists the age of the universe and solar system is estimated to be 14 billion years and 10 billion years respectively and our earth is around 4.6 billion years old. Life began on earth in water, in form of marine vegetation and microscopic organisms, then began the structure of the atmosphere resulting in formation of oxygen and its proportion in atmosphere reached upto 21% and gradually life in form of vegetation and living creatures developed on the earth.

Human beings were the last to emerge on the earth. Its estimated that they appeared about 20 lakhs years ago. Human species who were a native of forest, evolved themselves into civilizations and paved the path of the present development. During

this stage of development humans discovered fire and invented wheel, which served as a mile stone in their development. At every stage of development nature played a role of a friend, nurtured them as a mother and guided them. Human beings utilized the resources according to their needs, choices and capacities. Human proved themselves as the most intellectual species in transforming the earth.

All the activities, events, processes on the earth are due to mutual relationships that are studied in geography. Earth's surface is the base of geography, which is very vivid.

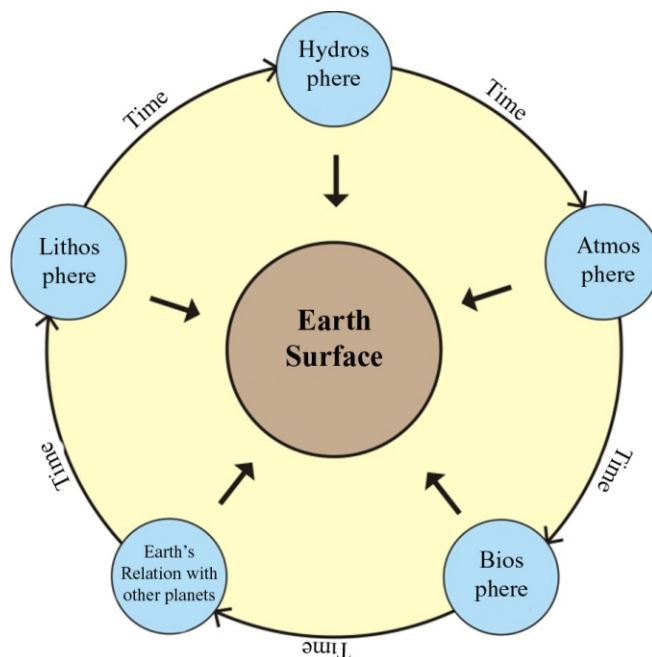


Fig.1.1 : Geography as interdisciplinary and integrated science

A pure organized, logically analyzed and descriptive explanation of earth's surface, which is full of various manifestations is what defines geography. Modern geography developed in an interdisciplinary form which included the combined study of physical, human and social sciences. The subject matter of these sciences keeps interchanging and creates a deep impact, simultaneously.

Meaning and Definition

The word 'Geography' is an English word which is derived from Greek word 'Geography' meaning 'description of the earth'. The word 'geography' was first used by a Greek scholar Eratosthenes in 276-194 B.C. Later Geography, was recognized as the science of earth, on global level. Greeks and Romans proposed the shape of the earth to be either 'flat' or 'saucer shape' whereas Indian astronomical literature often referred all the celestial bodies to be round in shape. This is the reason why its also named as 'Bhugol' in Hindi.

Geography is the study of earth's surface, Space, Variable characters, distribution and spatial relations are studied as the 'World of Man'. Earth's surface is the base where physical human activities and the inter activities takes place. All the activities keep on changing with 'time' and 'place'. The true meaning of the word earth's surface has a very wider scope, which includes Lithosphere, Atmosphere, Biosphere, effect of sun and moon and geological explanation of movements of the earth.

The canvas of the earth is vast, there have been constant changes in the definition and nature as the time change. Its extension has merged out of local spatial characteristics, distribution of patterns, regional and behavioural science of society. Its difficult to delimit its scope in a narrow definition but still **some scholars have made successful attempts**. Some of the best definitions which truly reflects the meaningful structure for society are as follows-

A simple definition in dictionary is 'Geography is a science of man and its mutual relationship with earth's surface. Geologists Varnius, Emanuel Kant and John and George Froster (Father and Son) have presented it in empheritical and scientific form. In which it means to acquire geographical knowledge that comes through, surveys, experiments, newly invented

tools, and comparative study.

In the series of this acquisition of geographical knowledge geographers Humbolt and Ritter of 19th century worked continuously and extended geography as 'Modern Geography. Both the geographers emphasized on 'uniformatism in geography, in which earth is considered as a unit and laid more emphasis on harmony. Humbolt advocated about geography as serial study whereas Ritter favoured regional concept of geography and accepted the harmonious characteristics of earth and presented it as a home of human beings. In the same century German Geography Richtofen and Hettner expressed Geography as a science of differentiation and unique characteristics. They also laid emphasis on spatial relationship.

Richard Heartshorne a geographer in USA in 1959 defined geography as "geography is concerned to provide accurate, orderly, and rational description and interpretation of the variable character of the earth's surface".

This definition truly describes geography in its scientific nature and presents its variable characters in more descriptive form.

Petter Haggett, a british geographer in 1975 describes geography as a study of spatial and mutual relationships among human beings and earth's surface Geography emerged as a sensitive scientific study of variable characters of earths surface. With this humanistic concept of geography constantly developed and it emerged as anthropogenic geographical descriptive science.

Since 1990, geographical knowledge was extensively used in social, cultural, economical and political regions and in the implementation of public policies. This made geography more practical in nature and is been presently seen as human welfare science.

Geography is now considered to provide solution to all human problems, through geographical knowledge. In this way "Geography is an organized, welfare science of variable characters on the earth's surface". This science quenches the thirst of curiosity of human beings and shows the path to future development.

The scope of geography is so vast and attractive that it encompasses the science of entire life. It includes the physical humanistic aspects and its adjustment. The study of physical geography

includes, climate, topography, geomorphology, soils, oceans and vegetation and its natural subject matter includes human and his activities concept of region, historical aspect, population study, habitat, political, agriculture mining, entertainment, transportation, health and sanitation, society and cultural aspects etc. Every activity, under the sky, mutual relationships and their inter relationships are all related to subject matter of geography. Recently with the development of latest technological tools and methods like remote sensing, usage of remote satellites, cartographic methods based on modern computers have accelerated the growth of development. Due to development and usage of advanced technology there has been extensive humanization. This promoted research specially in the area of human survival at its best.

As geography was emerging with more human centric approach, there was an extensive development of branches of human geography, the physical geography was not much in focus.

Geography studies physical and humanistic aspect and their inter-relationship. From the very beginning two distinctive branches of geography emerged (i) Physical Geography

(ii) Human Geography

In later periods (after 1950) these two branches further divided into many sub branches. Each branch developed distinctly and extensively. The main branches and sub branches of geography are as follows :

Branches of Geography Physical Geography

1. Geodesy
2. Geophysics
3. Astronomical Geography
4. Geomorphology
5. Climatology
6. Oceanography
7. Hydrology
8. Glaciology
9. Soil Geography
10. Bio Geography
11. Medical Geography
12. Ecology/Environment Geography
13. Cartography

Human Geography

1. Economic Geography

2. Agricultural Geography
3. Resource Geography
4. Industrial Geography
5. Transport Geography
6. Population Geography
7. Settlement Geography
 - (i) Urban Geography
 - (ii) Rural Geography
8. Political Geography
9. Military Geography
10. Historical Geography
11. Social Geography
12. Cultural Geography
13. Regional Planning
14. Remote Sensing and GIS

Its important to note that cartography statistics, survey, mathematical geography, behavioural geography and remote sensing, GIS are being used in every branch of geography.

These branches are used for resource utilization and conservation at regional and national level development policies.

Physical Geography - An Introduction Meaning, Definition, Subject Matter and Scope.

Physical geography is considered as the main branch of geography. The study of facts and theories of physical geography summarizes the entire science of geography. Geography is a progressive science. Since the mid of the century, there has been constant researches, explorations and inventions which contributed with latest information and facts that revolutionized the development of geography. For example, ventures in the field of geomorphology like origin in the earth formation of the earth's surface, process of mountain building, formation of topography and topographic features, which served as a base to resolve queries about earth's interior its formation and drifting of continents, volcanic eruptions, earthquakes. More and more latest factual details are being highlighted about outer layers of atmosphere and its shape.

There are two major parts of geography - physical or natural environment and humans. The development of special study of the areas and sub areas of a subject is the proof of advancement of any science. With this perspective modern geography is not an exception. Two distinctive branches of

geography were developed as Physical Geography and Human geography. On one hand the elements of physical geography influence human and on the other hand human being as a geographical element influences and changes his environment. The activities of human beings and the cultural environment created by him comes under the scope of study of humans geography. According to **lobeck** the study of geography "The subject matter of geography may be defined as the study of the relationship existing between life and physical environment. The study of physical environment alone constitutes physiography".

Meaning and Definition of Physical Geography

There is no doubt that physical geography is considered to be the main branch of extensive science such as Geography.

In the words of Philip "The tree of geography has its roots in the soil of physical geography. It branches cover every phase of human activity".

Other scholars have considered the study of environment, topographical features, biosphere and atmosphere to be studied under physical geography. Although more attention is given to aspects related to human activities but the importance of physical geography cannot be compromised. This is the main cause, why the fundamental knowledge about physical geography is important while studying any branch of geography. According to Strahler, a famous scholar, physical geography is an integrated study of different earth sciences which studies the human environment.

Earth's surface and topographical features on earth's surface are not uniformly distributed, even there is no even distribution of lithosphere on earth. Hydrosphere is approximately extended two and half times more than lithosphere along with the atmosphere that is surrounding the whole earth. The above mentioned three spheres are integral part of our natural environment and are interconnected. This natural environment interacts with biosphere and is studied under physical geography although not all geographers are unanimous to include biosphere in physical geography, but most geographers also explain physical geography as a description of local models of the elements of

atmosphere, along with this physical geography. It also studies the changes and its causes, in the elements of our environment in reference to space and time. Therefore the biosphere of our earth's surface is the study of physical geography, which includes atmosphere, hydrosphere along with vegetation and animal life possible. (Fig. - 1.1).

In true sense, physical geography was born along with the origin of our earth whereas human geography as a branch of geography developed along with emergence of human beings. Therefore we can say that the history of physical geography is as ancient as the subject geography itself. Geography and physical geography are complementary to each other because physical geography studies earth and geography is the science of earth. Finch and Trewartha advocated geography to be the science of the earth's surface, whereas Arthur Holmes describes geography as a study of human habitat. Therefore the scope of physical geography is very broad and vivid. At present, the study of physical environment includes, the interactions of human beings with the environment. It can be summarized, that the sequential study of lithosphere, hydrosphere, atmosphere and biosphere and its interactions and inter relationships are included in the study of physical geography.

Some definitions of physical geography are as follows:-

According to Kant

"Physical Geography is the first part of knowledge of world, indeed it is essential preliminary for understanding our perceptions of the world."

According to Pierre Byrot

"Physical Geography is the study of visible natural surface..... before the intervention of mankind....."

A. Holmes defines physical geography as "The study of physical environment by itself is physical geography which includes consideration of the surface relief of the globe (Geomorphology), of the seas and oceans (Oceanography) and of the air (Meteorology and Climatology)

A. Holmes in above definition has considered lithosphere, hydrosphere, atmosphere as three elements of physical geography.

In the words of A.K. Lobeck

"Physical Geography is the study of the interrelationship of the physical environment and life."

According to H.R. Cain "The study of the physical environment is called physical Geography."

According to Hammond & Horn "The study of Physical Geography deals with natural phenomena".

It may be concluded that analytical study of distributed elements and their interrelations between physical and biological environment are included in physical geography. According to Strahler physical geography includes all the natural sciences which provides as a base to understand the interactions between physical and biological environments. (Fig. 1.2)

According to him, there is a very narrow zone of life layer which sustains all the interactions between humans and their physical environment. This is a contact zone of atmosphere - lithosphere and atmosphere - hydrosphere. This contact zone is also called Interfaces. There are constant actions and reactions of various physical elements undergoing in this contact zone and the result of these actions and reactions and lot of variation is found in the distribution pattern of elements on biosphere.

According to their belief these spatial differences on biosphere is studied in physical geography. Human thrives on the earth's surface and utilizes the physical environment according to his needs. Therefore its natural for human beings from the very beginning to know and understand, about the spatial differences that surrounds his environment. (Fig. 1.2)

Nature and Scope of Physical Geography

Earth's surface is the centre of study of physical geography. The fundamental knowledge of physical geography is essential to study any branch of geography. In physical environment not only every activity of human beings but every element of the earth is being affected. Physical factual details of air, water and land are integrated and mutually inter-related.

Change is the chief characteristic of physical environment and the study of physical

geography not only includes distribution pattern of spatial differences but also the changes in them. This leads to origin of various physical conditions as result of adjustment and integrations. Physical geography studies the following spheres in their pure form Lithosphere, hydrosphere, atmosphere and biosphere.

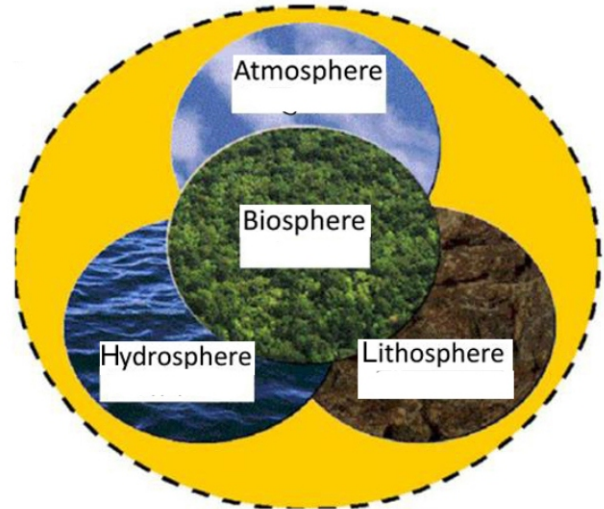


Fig. 1.2 : Interaction of components of Physical Geography

1. Lithosphere :

It is the study of the landform and their structures its present stage and the processes which resulted in the formation of these landforms. In this way, in the geological history, structure of the earth's layer, types of rocks, slopes, endogenetic and exogenetic forces, composition of rocks etc. are all included in the study of lithosphere. Different types of geological shapes are studied in Geomorphology.

The sphere of land on which we actively move and till its depth, at which we have utilized earth's resources, are studied under lithosphere The earth's surface is not even everywhere and there are lot of variations. Some areas of lithosphere are characterized by extensive plains, whereas somewhere there are deep valleys or some areas have huge mountains whereas somewhere there are small islands.

Various geological forces and processes are responsible for formation of continents to different landforms on the earth's surface. The formation of different types of rocks also resulted from these

geological forces thus its also included as the subject matter of lithosphere.

2. Atmosphere :

Air covers the entire earth. Atmospheric conditions on the earth is what that makes survival of organisms possible. This is studied under Atmosphere. The gases present in the atmosphere are the most unique and basic sources we utilize to survive on earth. Atmosphere is also dynamic in nature as its elements. Weather includes short period of changes in atmospheric elements whereas climate is the long term changes in the elements of atmosphere. This include atmospheric structure, composition conditions, height, temperature, pressure, wind velocity, its direction, mode of origin, its types, cloud formation and precipitation.

3. Hydrosphere :

More than 2/3rd of earth's surface is covered with water. Hydrosphere is sphere which includes the study of oceans and water bodies. Water is found in form of small and large reservoirs. The characteristics of water varies with depths. Hydrosphere includes study of oceans and their origin distribution, marine topography, physical and chemical characteristics of water, marine deposits, ocean currents etc. All the above facts are studied as part of the hydrosphere.

4. Biosphere :

A narrow zone between lithosphere and atmosphere where all life forms exist is called Biosphere. The study of biosphere includes all types of organisms which include human beings, animals and vegetation, their origin, their development, distribution, habitat and factors affecting their life cycles inter-relationships between organisms and their environments and their different aspects Lithosphere (geological relief features). Atmosphere (its structure, composition, the elements of weather and climate temperature, pressure, wind, rainfall, types of climates etc.) Hydrosphere (sea, oceans, lakes and components related to these) Biosphere (forms of organisms, humans & animal). Their nutritional processes like food chains ecological parameters and ecological balance etc. are studied in Biosphere.

Soils are formed through gradual processes

and these processes depend on primary rock type, climate and other organic processes and which forms the soil profile. Every component is important for human beings. Landforms provide a base on which human activities take place. Open fields are used for agriculture whereas plateaus are used for extraction of minerals. Mountains serve as a abode of vegetation and serve as a important tourist destinations. Many important rivers have their source of origin in mountains. Climate influence our settlement structure and pattern, our clothing patterns and our food habits. Climate creates a deep impact on vegetation, grass types, livestock raising and industrial growth pattern (some).

Physical geography is developing as an assessment and management of natural resources. It is necessary to understand the relationship between physical environment and human beings to fulfil this objective. Physical environment provides resources and man uses these resources to ensure his economic and cultural development. Extensive use of resources with technological know how has created ecological imbalance in the world. Therefore, knowledge of physical environment is essential for sustainable development which underlines the importance of physical geography.

Important Points

1. Physical geography is the main branch of geography. The two main aspects of geography are - Physical or natural environment and humans.
2. Study of living creatures and their physical environment and relationships among them is the subject matter of geography and study of physical environment is physical geography some definitions related to physical geography includes study of only physical environment while others include biological environment too. Its subject mater includes - Lithosphere, Hydrosphere, Biosphere, New contact zone or Interfaces. The study of physical geography is centered around earth's surface.
3. As the specialization in geography increased, many branches of emerged out of physical geography. Main branches of physical

geography are-Geomorphology, Astrology, Climatology, Meteorology Ecology, Oceanography Hydrology, Glaciology, Geometry, Geophysics, Ecology, Bio-Geography etc.

Exercise

Multiple Choice Questions

1. The branch of physical geography which studies temperature, pressure, direction and speed of winds, humidity is :
(A) Astrology (B) Oceanography
(C) Pedology (D) Climatology
2. The component of physical geography which is controversial is :
(A) Atmosphere (B) Hydrosphere
(C) Lithosphere (D) Biosphere
3. The two main branches of geography are :
(A) Agriculture and Economic geography
(B) Physical and Human geography
(C) Plant and Organisms geography
(D) Weather Geography and Climatology
4. Which geographer has first used the word 'geography'?
(A) Eratosthenes (B) Herodotus
(C) Strabo (D) Ptolemy
5. The age of the earth is :
(A) 4.8 billion years (B) 5.0 billion years
(C) 4.6 billion years (D) 3.9 billion years

Very short type questions :

6. What do you mean by 'Universe'?
7. What is meant by 'Solar System'?
8. What is 'Milky way'?
9. What is meant by 'Earth's Surface'?
10. What is 'Biosphere'?

Short Question :

11. Define geography.
12. What is the objective of geography?
13. What do you mean by 'spatial differentiation'?
14. Differentiate between physical and human geography.

15. What is meant by 'Inter-disciplinary sciences'?

Essay type :

16. 'Geography is that tree that has its roots in physical geography'. Critically analyze the statement.
17. Explain the scope and subject matter of Physical Geography.
18. Do you agree that - 'The present geography is now more human centric' - Examine critically.

Answer Key

1. D 2. D 3. B 4. A 5. C

Lesson - 2

Earth as a Planet

Earth is the third planet from the sun in our solar system, geographically and geologically it is the only planet where the melody of life could be heard than other planets. In such a vast universe its not possible that the life do not exist other than earth. But the present day facts and evidence indicates life to be present only on earth. Life is present on the earth because of its definite distance from the sun and ideal solar radiation received. This type of stage is called Goldilocks zone. In which with an appropriate distance from the sun, water is available in liquid form as that on earth. Scientist are constantly working to discover more planets similar to earth and some planets have already been discovered where earth like environment may be possible and human species may become- "**multi-planet**" species. That day will serve as revolutionary era for earth and humanity.

Origin of the Earth

Many philosophers and scientists have propounded many hypothesis regarding the origin of the earth. One of the most early and most famous hypothesis is of Immanuel Kant. In 1769 Laplace a mathematician, modified this hypothesis as "Nebular Hypothesis". According to this hypothesis the origin of the solar system is from the cloud of primordial matter which was revolving slowly around the sun, Later in 19th century Chamberlain and Moulton postulated that another star passed near to the sun. This resulted in detaching of some matter from the sun due to gravitational force applied by the other star. As the star moved farther, the detached matter starting revolving round the sun

and this material with the passage of time formed of planets. Firstly, Sir James Jeans and Sir Harold Jeffrey supported this hypothesis. Although some arguments were in favour of companion star of sun. These arguments are called 'Binary Theories'. In Russia, in 1950 Otto Schmidt and Carl Weizsacker of Germany presented a modified version of Nebular Hypothesis. According to them, the sun was surrounded by a nebula which was primarily made up of hydrogen helium and dust particles. These dust particles in the Nebula were undergoing friction and collision which resulted into formation of flat disc of cloud which started revolving a round the sun and accretion process formed planets. After this the scientist around world not only tried to solve the mysteries of earth and other planets, thus made an attempt to solve the problems regarding the origin of the universe.

Origin of Universe :

In reference to the origin of universe 'Big Bang Theory' is most widely accepted. Its also called 'Expanding Universe Hypothesis'. In 1929 Edwin Hubble proved that our universe is expanding.

Galaxies are moving apart from one another. You can experiment, to understand this concept of expansion. Take a balloon and mark some points on it as galaxies. When you will blow up the balloon, you will observe the points marked on the balloon are also moving apart. Similarly galaxies are moving further away from one another, resulting in expansion of universe. You will also observe that not only the distances between the points are

increasing but points are also growing in size but this is not a factual reality.

Scientists believe that galaxies are constantly moving apart from one another but observations do not prove this. Therefore the example of a blowing balloon is correct only to some extent. According to Big Bang theory the expansion of universe is in following stages -

- (i) In the beginning, all the substances and the material which formed the universe, were present in form of singular atmosphere its volume was extremely subtle and the temperature and density was infinite.
- (ii) Due to Big Bang, there was a massive explosion. This caused extensive expansion. Scientists believed that origin of universe occurred about 14 billion years ago. Universe is still expanding. Some energy is transformed into matter because of expansion. The universe expanded extensively in micro second after the bang. Later the speed of expansion reduced. Atom was formed in the first three minutes of Big Bang.
- (iii) After the Big Bang during the 3,00,000 years temperatures drastically decreased and atomic formation occurred. Universe then became transparent.

The expansion of Universe means constantly increasing distances between galaxies. Hoyle has named it as 'Steady State Concept'.

According to this hypothesis Universe never remained in a static position. Although with numerous theories about expansion of universe, many scientists support the expansion theory.

Formation of Star

Initially the distribution of energy and matter was not equal in universe. As there was differences in density, the gravitational forces also acted differently which resulted in accumulation of matter. This formed the basis of formation of galaxies. There are millions of stars in a single galaxy. The extension of galaxies are so vast that it's measured in thousands of light years. The diameter of a single galaxy is thousand to one lakh 50 thousand light years. The formation of a galaxy is thought to be from accumulation of huge cloud

which is called Nebula, growing Nebula developed clusters of gases respectively. These clusters kept on getting bigger and formed dense gaseous bodies which led to the formation of stars. It is believed that stars were formed about 5 to 6 billion years ago.

Light year is not a unit of time but of distance. The speed of light is 3,00,000 kms per second. In one year, light will travel 9.5 million kms. This is called light year. The average distance between earth and sun is 14 crore 98 thousand kms. In reference to light-year, this distance is covered in 8 minutes.

Formation of Planets

The planets were formed in the following stages :

- (i) Stars are clouds of intertwined clusters of gases in a Nebula. The gravitational force of these intertwined clusters of gases formed the core. The clouds of gases and dust particles started revolving a round core and a rotating disc was formed.
- (ii) Condensation of gaseous clouds began in the next stage and congruence of accumulated material which was in the form of balls developed 'Planetesimals'. Process of Collision resulted in formation of huge bodies and they combined together under the impact of gravitational force. Smaller bodies in larger number is Planetesimal.
- (iii) In the last stage as these smaller planetesimal augmented some huge bodies were formed as planets.

Solar System

There are 8 planets in our solar system. Nebulas are considered as a source of origin of entire universe, its collapse and formation of core began 5 to 5.6 million years ago and the planets were formed about 4.6 to 4.56 million years ago.

In 8 planets, Mercury, Venus, Earth and Mars are called Inner Planets as they are situated between sun and asteroid belt. Other four planets are called Outer planets . The first four planets are also called Terrestrial planets. It means that alike earth these planets are formed of rocks and minerals are

Table 2.1 - Solar System								
Planet	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Distance*	0.387	0.723	1.000	1.524	5.203	9.539	19.182	30.058
Density@	5.44	5.245	5.517	3.945	1.33	0.70	1.17	1.66
Diameter#	0.383	0.949	1.000	0.533	11.19	9.460	4.11	3.88
Satellite	0	0	1	2	67	62	27	14

* The distance from the sun is in the form of celestial unit. Therefore if the mean distance of earth is 14 crore, 95 lakh. 98 thousand kms it is one celestial unit.

@ density gram per cubic centimeter (gm/cm)

diameter = If equatorial diameter is 6378.137km = 1

- (i) Terrestrial planets were formed very close to parent star as the gases were not able to get condensed. The formation of Jovian planets took place at much greater distance.
- (ii) Solar waves were stronger near sun. Therefore extracted more gases and dust particles from terrestrial planets. Solar waves were not stronger near Jovian planets and could not extract much gases from them.
- (iii) As the terrestrial planets were smaller. They had weaker gravitational force too and as result the extracted gases couldn't remain on the planet.

denser comparatively. Other four planets are made up of gases and are also called Jovian Planets. Jovian means similar to Jupiter. Most of these planets are larger than terrestrial planets and have a dense atmosphere made up of hydrogen and helium. All planets were formed together about 4.6 to 4.56 ago million years ago.

Our solar system consists of 8 planets, 183 satellites, lakhs of asteroids, comets and large number of dust particles and gases.

Moon

Moon is the only natural satellite of our earth. Many theories about the origin of the moon were presented like that of earth. In 1838, Sir George Darwin postulated that the earth and the moon were a single revolving celestial body. This entire celestial body changed in form of double (Thinner at the center and thicker at the edges) shape



Fig. 2.1 : Solar System and Planets

Till now Pluto was also considered to be a planet. But International Astronomical Organization in its meeting (August, 2006) declared Pluto to be a 'dwarf planet'. There are five satellites of the planet Pluto. Some factual details about the planet are given in table 2.1.



Fig. 2.2 : Moon

and then got disintegrated. According to them the moon is formed of same material where Oceanic Trench of Pacific is situated presently.

However scientists do not accept any of these theories. It is believed that earth's satellite, our moon, is formed as a result of giant impact which is called Big Bang. It is believed that just after the formation of earth, a celestial part which was about 3 times bigger than Mars, disintegrated into universe.

This material which was separated because

of the collision, started revolving round the earth and the present day Moon was formed. This incident of origin of the moon occurred about 4.44 million years ago.

Origin of Earth :

Earth was rocky, hot and deserted and the atmosphere was composed of Hydrogen and Helium. This was very different from the present day atmosphere. There were some incidents and activities that caused the transformation of rocky,

Table 2.2 : Geological Time Scale

Eons	Era	Period	Epoch	Age/ Years Before Present	Life/ Major Events
	Cainozoic (From 65 million years to the present times)	Quaternary	Holocene Pleistocene	0 - 10,000 10,000 - 2 million	Modern Man Homo Sapiens
		Tertiary	Pliocene Miocene Oligocene Eocene Palaeocene	2 - 5 million 5 - 24 million 24 - 37 million 37 - 58 Million 57 - 65 Million	Early Human Ancestor Ape: Flowering Plants and Trees Anthropoid Ape Rabbits and Hare Small Mammals : Rats - Mice
	Mesozoic 65 - 245 Million Mammals	Cretaceous Jurassic Triassic		65 - 144 Million 144 - 208 Million 208 - 245 Million	Extinction of Dinosaurs Age of Dinosaurs Frogs and turtles
	Palaeozoic 245 - 570 Million	Permian Carboniferous Devonian Silurian Ordovician Cambrian		245 - 286 Million 286 - 360 Million 360 - 408 Million 408 - 438 Million 438 - 505 Million 505 - 570 Million	Reptile dominate-replace amphibians First Reptiles: Vertebrates: Coal beds Amphibians First trace of life on land: Plants First Fish No terrestrial Life : Marine Invertebrate
Proterozoic Archean	Pre-Cambrian 570 Million - 4,800 Million			570 - 2,500 Million 2,500 - 3,800 Million	Soft-bodied arthropods Blue green Algae: Unicellular bacteria
Hadean				3,800 - 4,800 Million	Oceans and Continents form - Ocean and Atmosphere are rich in Carbon dioxide
Origin of Stars	5,000 - 13,700 Million			5,000 Million	Origin of the sun
Supernova				12,000 Million	Origin of the universe
Big Bang				13,700 Million	

hot and deserted place, into a place where there is availability of water and favourable environment.

In the next few of segments you will come to know that how did life begins on earth about 460 crores years ago. (Table 2.2)

The structure of earth is in form of layers. The material from the outer layers of atmosphere till the core of the earth are not similar. Atmospheric matter is of least density.

There are many zones from earth's surface to the core of the earth and the matter of every zone has its own characteristics.

Development of Lithosphere :

The planetesimal and other celestial bodies are mostly formed of mixture of dense and lighter substances. This is known to us through the study of meteors. The collection of many planetesimals formed planets. Similar process resulted in the formation of the earth. When the matter was being accumulated under the impact of gravitational force, the collective celestial bodies affected the matter. This generated lot of heat. This process continued and the matter started to melt. This happened during and just after the origin of the earth. Due to excess heat, earth partially remained in a semi-molten state, high temperature caused separation of light and heavy metals. This segregation resulted in moving of heavier material (like iron) to centre of the earth and lighter materials moved towards the surface of the earth or upper regions of the earth. Gradually, over the time it became solid and turned into smaller size. Later it formed the crust of the earth. The process of segregation of lighter and heavier material is called differentiation. During the formation of moon, due to giant impact the temperature of earth increased again and generated heat, this was the second stage of differentiation. The earth was divided into different layers because of this differentiation. Many layers are found from crust to its core like Crust, Mantle, Outer Core. Inner core. The density of the earth's matter increases from the upper to inner region.

Comets

Comets are the most attractive celestial bodies of our solar system. They revolve a round the sun in their fixed elliptical orbit. The nucleus part of

of the comet is made of solid rocks in which minerals, glacial crystals, dust particles are covered with gases like carbon-di-oxide, carbon-monoxide and methane. Some of the comets have lakhs of kilometers long orbits whereas taking hundreds of years to come near to the sun.

When comets come near to the sun the matter and gases found in them, expand in opposite direction to the sun due to extensive heat and forms the 'tail of the comets. It can be lakhs of kilometers long. Some scientists believe that comets are the source of water and life on earth.

Meteor :

Smaller and larger particles of rocks found between two planets Mars and Jupiter are called Asteroids. As these asteroids enter the gravity zone of earth they pass through earth's atmosphere. Due to friction it catches fire. Meteors move towards the earth's surface, from the atmosphere and are called 'Shooting Stars'. Only the ashes reaches the earth surface. When these meteoroids are not burnt in the atmospheric layers due to friction, it collides with the earth surface like a bomb and causes heavy loss of life and property. Huge craters are developed in Arizona Province of America and Siberia (Russia) due to the collision of meteoroids and several kilometres of area was under the impact.

Development of Atmosphere and Hydrosphere :

The present composition of Atmosphere is contributed by Nitrogen and Oxygen. The present day atmosphere is formed in three stages. Its first stage of formation include decline of primordial atmospheric gases. In the second stage the steam and water vapour released from the earth's interior. In the last stage, the composition of atmosphere was affected by the photosynthesis process of biosphere.

Hydrogen and Helium which were the part of initial atmosphere depleted due to waves near the earth. This caused the origin of present day atmosphere. In the beginning in atmosphere there was excess of water vapour, nitrogen carbon-di-oxide, methane and amonia, free oxygen was very less. The process through which the gases of interior of the earth reached to its surface is called Degassing. Constant volcanic eruptions caused increase in water vapours and gases. Along with the cooling of the earth, condensation of water vapours

started. As the carbon-di-oxide present in the atmosphere dissolved, the temperature started to decrease.

Thus resulting in more condensation and more rainfall. The rainwater started accumulating in trenches on earth's surface, which formed the oceans. The oceans present on the earth were formed almost 50 crore years after the origin of the earth. By this we know that oceans are 400 crore years old. The life emerged after 380 crore years. Although the process of photo-synthesis started about 250 to 300 crore years ago. Increase in oxygen due to photo-synthesis is the gift of the oceans. Gradually, the oceans got saturated with oxygen and the atmosphere was filled completely with oxygen about 200 crore years ago.

Origin of Life :

The last stage of origin of the earth is related to origin of life and its development. It is undoubtful that the initial atmosphere was not suitable for any development of life. Modern scientist, describe the origin of earth as a chemical process, firstly, in which complex organic molecules were formed and then their aggregation occurred. This aggregation repeated itself (capable of recreating itself) and was able to transform non-living matter into living matter. The inprints of our life on our earth are found as fossils on rocks of different times. The Blue green algae of present day is similar to that of 300 million years old microscopic structure. It is imaginable that in earlier time simple structure algae would be in existence. It is believed that the development of life began about 380 crore years ago. From the unicellular organism to the present day human. The essence of development of life can be derived from geological period scale which is depicted in the form of Geological time scale. (Table 2.2)

Important Points

1. There are two categories of planets in solar system:
(A) Inner Planets (Mercury, Venus, Earth & Mars)
(B) Outer Planets (Jupiter, Saturn, Uranus, Neptune)
2. With suitable distance from the star and favourable solar radiation, water can be

available in liquid form, which increases the possibility of life. This is also called Goldilocks zone. The life on earth is possible as it comes under this zone.

3. Many other planets with an environment similar to that of earth, have been discovered where humans, plants, organisms can thrive and a new earth can be formed. This work will be considered as revolutionary period for humanity.
4. As per Modern view, the origin of universe is considered to be from Big Bang Theory. From its beginning, every energy and all the powers were centered at one place. In which there was giant explosion and the energy was spread all around. After this, due to impact of gravitational forces and agglomeration of outer materials, stars, planets and nebulas, galaxies were formed. Our solar system was also formed in the last stages of this process.
5. The entire history of the earth is divided into four big eras. The last of the eras, Cenozoicera witnessed emergence of humans or animals like humans.

Exercise Multiple Questions

1. Earth's position from the sun is :
(A) On Fourth place (B) On Second place
(C) On Third place (D) On First place
2. The correct position of the inner planets is :
(A) After Jupiter
(B) From Jupiter to Uranus
(C) Saturn to Neptune
(D) From Mercury to Mars
3. The natural satellite of the earth is :
(A) Moon (B) Titan
(C) Aryabhata (D) Chanakya
4. The speed of light per second is :
(A) 4 lakh km (B) 3 lakh km
(C) 3.6 lakh km (D) 4.3 lakh km
5. The highest temperature, density and pressure is found on earth :
(A) Near the earth's surface

- (B) Middle of the earth
- (C) Upper part of the atmosphere
- (D) Centre of the earth

Very Short Questions :

6. What is the other name of rocky sphere?
7. Which astrologist discovered 'Expanding Universe'?
8. What is Nebula?
9. What are asteroids?
10. What is Dwarf Planet?

Short Type Questions :

11. What is Expanding Universe Hypothesis?
12. What is the contribution of Fred Hoyel astrologist?
13. Explain the difference between Terrestrial and Jovian planets.
14. What is Goldilocks Zone?

Essay Type Questions :

15. Critically analyze Big Bang Theory.
16. Explain solar system.
17. Describe Geological line scale.

Answer Key

1. C 2. D 3. A 4. B 5. D

Lesson - 3

Earth : Form, Motions, Location and Calculation of Time

Man has been a curious creature since the beginning. Along with the development of civilization man tried to know more about his environment, earth and sky. In ancient period entire Universe was considered to be 'earth centric' and earth was considered, to leg fixed, flat and disc shaped. In Indian texts like 'Vedas', 'Aryabhatta' (text written by Aryabhatta) earth was described as round ("Khagol, Bhugol") in shape. Great Indian astronomer Aryabhatta described earth round in shape as a ball and inclined on its axis, moving from west to east direction. This causes day and night formation. Aryabhatta and Bhaskaracharya presented scientific fact about sun and moon eclipses and gravity, about which the European scholars came to know in 15th-16th century. Although European scholars, Pythagoras and Aristotle described earth a round in shape but this was later forgotten by the scientists. After this astronomers named Copernicus and Galileo in 16th century, described sun to be in the center of the solar system, earth and other celestial bodies to be round in shape and the daily and annual movements to be from west to east direction.

It is a scientific fact that earth is spherical in shape, which can be proved with number of examples like round shaped shadow during every eclipse, visibility of round shape of all celestial bodies from different angles, all celestial bodies to be in a curve during horizontal position. After the study by Apollo and many other artificial satellites it has been proved that earth is round in shape but as its also flat at the poles is considered to be in 'Oblate Spheroid' form. Similarly the circumference of the

earth was calculated through on easy technique by a greek scholar Eratosthenes in 256 B.C. which was equal to present day scientific calculation. Indian scholars too presented their calculations related to age, perimeter, diameter and radius of the earth which are very similar to present day scientific calculations.

The facts of the earth based on scientific calculations are presented in the Table No. 3.1.

Table No. 3.1.
Some important facts about earth

1. Equatorial linear diameter	12,756 km
2. Polar diameter	12,713 km
3. perimeter	Equatorial Linear 40,077 km
4. Polar Perimeter	40,000 km
Total area	510 million sq. km
(i) Land area	149 sq. km (29.22%)
(ii) Oceanic area	361 sq. km (70.78%)
Volume of earth	416 million cubic km
Density of earth	5.517
Mass of earth	5.882×10^{21} tonne
Weight of earth	6.600 billion tonne
Curvature on earth's surface	7.98" per mile

The Motion of the Earth :

There are two important movements of the

earth which causes formation of day and night and seasons. (Fig. 3.1)

1. Rotation :

The earth rotates in 24 hours on its axis which causes day and night. The part of earth which faces sun experiences day and other part has night. This movement is from west to east due to which sun rises in east and sets in west. As the earth rotates west to east the direction of the movement of all stars and constellations appear to move in east to west direction. The bulge on the equatorial region and flatness on the poles is caused due to this motion of the earth. (Centrifugal force). Beside this, these motions of the earth causes changes in the direction of winds and currents. The daily motion is maximum on equator (1600 km per hour), it gets reduced on 45° North and South latitudes (1120 km per hour) and becomes almost zero on poles.

The axis of the earth instead of making right angle with its orbital plane, makes an inclination of 23½°. This inclination of 23½° remains in the same direction as the earth revolves round the sun. As a result of this inclination of the earth, north and south pole faces sun turn by turn, due to this, both the hemispheres get the benefit of different seasons. If this inclination would have not been there, the duration of day and night would have been same and the change of seasons also would not have been possible.

2. Revolution :

The second important movement of earth is its yearly journey around the sun in west to east direction, on its axis. The orbit of the earth is about 965 million km long which is been completed with a speed of 29.6 km per second in 365¼ days. The orbit of earth is elliptical instead of being round due to which the distance between earth and sun keeps on changing. The average distance between earth and sun is 150 million km. When earth is at the maximum distance from the sun (152 million kms) it is called (147 million kms) Perihelion position. In the Perihelion position the earth completes its journey comparatively much faster around the sun. Contrary to this, the earth takes longer time to revolve round the sun in Aphelion position. Change of seasons are possible because of revolution. Due to the changes in the motions and positions of the



Fig. 3.1
Position of the earth

earth, there is distribution of solar radiation on the earth.

3. Solstices and Equinoxes :

There is light on one part of the earth and the other part remains in darkness. The illuminated part is separated, from darker part through 'circle of Illumination'. The earth remains in the position of Summer Solstice and Winter Solstice on 21st June and 22nd December respectively. The sun shines vertically on 21 June and 22 December on Tropic of Cancer and Tropic of Capricorn respectively. As the earth is inclined on an angle of 23½°, these positions are witnessed in both the hemispheres. As the sun shines vertically over Tropic of Cancer. There is summer season in northern hemisphere and vice versa in southern hemisphere. There is influence of winter season in the southern hemisphere. The position is reversed on 22 December. The sun rays vertically shines over Tropic of Capricorn, due to which there is summer in southern hemisphere and winters in northern hemisphere. The vertical rays of the sun effect the central part between Tropic of cancer and Tropic of Capricorn (23½° Northern Hemisphere - 23½° Southern Hemisphere). These two points work as conducting points.

Solstices provide mobility to earth and the positions of sun, stars and constellations also undergo changes. These changes are indicators of life, benevolence and newness. During Solstices many countries in the world celebrate many festivals. 'Makar Sakranti' has special significance

in our country. Our entire country celebrates this transforming festive days with lot of hilarity. Sun is worshiped on this day and sesame and jaggery is eaten.

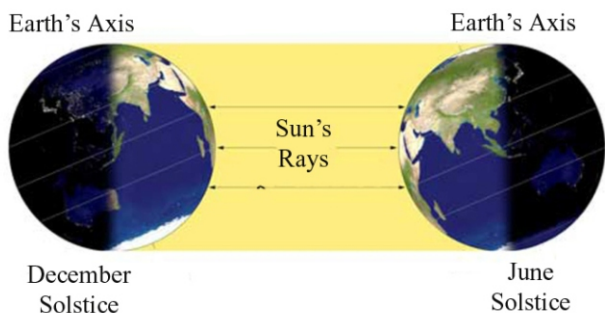


Fig. 3.2 : Solstice Positions

Equinoxes : On the earth, the sun is perpendicular to the equator on 21st March and 23rd September. In this equinox position the day and night on earth are of equal duration. Spring begins in the Northern Hemisphere from 21st March, and that is why its called Spring Equinox.

Winter Solstice (December 21)

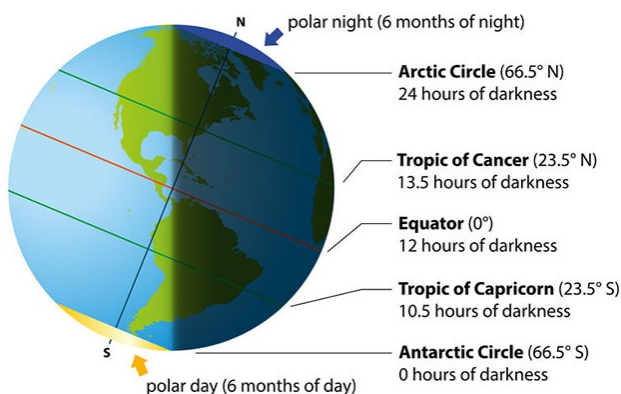


Fig. 3.3 : Position on Winter Solstice

In this stage the circle of illumination divides the entire earth in equal parts from pole to pole. The part that faces the earth, remains in light while the other part, opposite to it remains in dark. During the equinox the sun rises before 6 am in the east and sets almost at the same time in the west. (Fig. 3.1, 3.3)

Latitudes and Longitudes :

Latitudes and longitudes are imaginary lines on the globe, which runs from east to west and from north to south respectively. The grid formed due to these lines are important to find ones location, its called earth's grid". Latitudes and Longitudes intersect each other on right angles.

Latitude :

Equator divides the earth into two equal hemispheres, northern and southern hemispheres. The latitudes are determined north and south, parallel to the equator.

Their angles are determined from the centre of the earth. As the latitudes move away north and south to the equator, the size of these latitudinal circles is reduced equator is indicated as 0° and north and south pole 90° latitude is found in northern hemisphere and 90° in southern hemisphere. The distance between the latitudes is 111 km which is increased at the poles due to their flatness. To find the accurate location of a place, degrees are divided into minutes, minutes into seconds. Like the location of Mumbai will be written as 18°55'08" (18 degrees, 55 minute and 8 seconds).

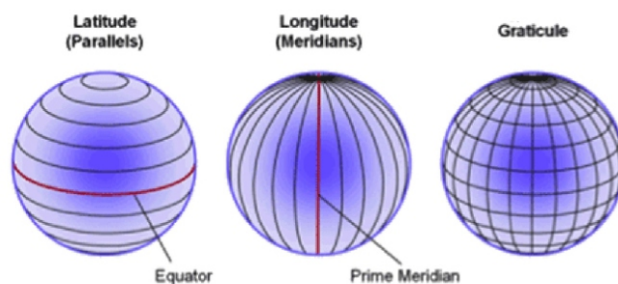


Fig. 3.4 : Latitude, Longitude and Earth Grid

The latitudinal globe is divided into equal divisions by 0° Equator, North of this is 23½° North latitude as Tropic Cancer, 66½° north latitude as Arctic circle and 90° North pole in the form of centre or point. In the same, south of equator 23½° southern latitude as 'Tropic of Capricorn, 66½° southern latitude as 'Antarctic Circle and 90° south in form of centre or point. The area between 0° to 30° north and south is called 'Lower Latitudinal Area' and the area north and south between 60° to 90° is

called 'Higher latitudinal Area'. Similarly, 'Tropical Climatic Belt' lies between 0° to $23\frac{1}{2}^{\circ}$ north and south latitudes, the region between $23\frac{1}{2}^{\circ}$ to $66\frac{1}{2}^{\circ}$ north & south latitudes lies in North & South Temperate Climatic Zone and from $66\frac{1}{2}^{\circ}$ to 90° north and south latitudes, lies the Cold Climatic Zone

In the same way the zones of plants and living organisms are also determined through the instruments positions of sun, stars and moon etc. Presently the correct position of latitude is determined with the help of GPS (Global Positioning System)

Latitude : The imaginary lines which runs from north to south direction on the globe are called Longitude. The line that runs from north to south near London is called 'Greenwich' or 'Prime Meridian' which is indicated with 0° . There are 180° - 180° east and west longitudes on both of its sides which is 360° in total number. These longitudes are determined at the angular distances from the centre of the globe. The opposite of the Prime Meridian (0°) is the 180° 'International Date Line' Longitudes have the maximum distance between them, near the equator. As the longitudes move away from the equator towards the poles, their distances starts decreasing. All longitudes meet at a central point which is at the poles. It means that the difference between the two longitudes at the equator is 111 kms. This difference at 30° North and South latitudes is 96.5 kms, at 60° North and South longitude it is 55.4 km, at 80° north and south it is 19.3 km and this difference turns to be zero at 90° North and South centres of poles.

Similar to latitudes, longitudes are divided into degrees minutes and seconds. For example the longitudinal extent of Mumbai is $72^{\circ}54'10''$ (72 degrees, 54 minutes and 10 seconds). When we move in towards east from Central or Prime Meridian, 4 mins at every longitude and an hour (60 mins/ at 15° longitude is increased. The local time at every longitude remains the same. In the same way when every 360° longitude changes into a complete circle, it makes 'Great Circle' Equator is also considered as a 'Great Circle'. 'Great Circles' are those circles which divide the earth into equal divisions they are 181 in total number.

Time : Earth is circular and there are 360° in this circle. Every degree is called longitude. Longitudes are considered to be those imaginary lines which runs from North pole to South pole. All the places located at a longitude will have noon at the same time therefore we also call longitudes as Meridians.

Earth rotates 360° in 24 hours. In this way it moves 15° in an hour. In the same way it covers one longitude in 4 minutes. Earth rotates from west to east. Therefore the place which is located in the east will observe the sunrise first. Madras city of our country is situated on 80° E longitude when its 6:00 am during a sunrise in Madras it will be 5:00 am at the place which is situated 65° West of Madras. The sunrise will be observed at that place after an hour. If we know Greenwich and our local time, we can easily calculate our longitude, for example if presently its 12:00 noon at Greenwich and in our local watches it is 6:00 pm, and as we are definitely east of Greenwich and our longitude is $15 \times 6 = 90^{\circ}$.

Local Time : The time of every place which is calculated according to its longitudes, is called local time of that place. At this point, the sun-dial shows almost exact time. The local time is related to the position of the sun during noon. Due to this all the places located on the same longitude will observe noon on the same time and there is no difference in their local timings. Cities situated on east and west will be on different meridians. Therefore these places will observe noon at different timings. It is obvious that places situated at east and west locations will observe differences in their local time. Local time will always be according to noon (when sun shines overhead) of sun dial.

Standard Time : Local time of a place is may be suitable for its own city but when we travel and reach to other place, there may be difference in timing. In this position, in order to maintain the timings, as we move in east or west directions, we have to adjust are watches 4 mins ahead or behind, as we cross every longitudes. A standard time is considered in every nation to resolve this problem.

For standard time, for a nation a longitude is considered as a standard Meridian "The standard meridian of England is 0° which crosses over Greenwich. Mostly a nation considers the local time

of a suitable place, as the standard time for whole nation. The longitude of that city is very important for it. All the watches of the nation are adjusted according to the time of that city. In this way when the timing of the special place is considered for the whole country, its called standard time. In our country the timing $82\frac{1}{2}^{\circ}$ E longitude is considered as the standard time for the whole country, if you are at a fixed place which is at $82\frac{1}{2}^{\circ}$ longitude, then the noon at your place and your watch will show 12:00 noon same time.

But if your location is in the east of this line, then your watch will show 12:00 after its noon at the local place and if the place is in the west, then it will be earlier. If local time is considered instead of standard time for a place, then it will create lot of inconvenience in day to day activities. In every country the standard time and international time i.e. Greenwich time, difference is kept always as whole or one and a half hour for example the time difference from Greenwich of Pakistan is of 5 hours and that of India is $5\frac{1}{2}$ hours.

Time Zones : If a country has more east and west extension, considering one standard time for the whole country will not solve the problem as the places which are situated to the east and to the west will have time difference of 4 to 5 hours. This time difference in local time can be observed in the countries like Canada and USA. It is difficult for ships to keep a record of the local time of places. In order to remove this inconvenience the entire earth is divided into 24 divisions. Each division is called

zone. In each zone there is a standard time. These time zones are divided in 24 parts, so that there is an hour difference within every zone. Every time zone has 15° longitudes.

Canada is extended more in east to west direction. Therefore it has 5 time zones. Every time zone has one standard parallel and the local time at that meridian is the standard time of that entire time zone. The local time of 60° , 75° , 90° , 105° and 120° of 5 regions of Canada are considered as the standard times of those 5 time zones. USA has four time zones, in its major region. These are called Eastern, Central, Mountainous and Pacific time. In this 75° , 90° , 105° and 120° longitudes are considered to be standard meridians. Alaska and Hawaii Island, which are the parts of USA, fall in different time zones. In the same way Europe is also divided into 3 different time zones and Russia in 11 time zones with a difference of an hour each.

The time zones are broadest at the equator. It becomes narrower towards the poles, even the time zones joins at poles in form of a centre or a point.

International Time : The longitude, which crosses near a place called Greenwich, in London is internationally considered as prime meridian.

Prime Meridian

It is considered as 0° longitude and the calculation of longitudes to its east and west is done from this meridian, like 15° East longitude and 15° West longitude. Its important to note that 180° east and west longitude are the same line.

The calculation of all the time zones are done on the basis of this Prime Meridian. The uniformity in timings at Global level is done with the help of Greenwich, that is the reason why its called International time.

International Date Line : You are acquainted with the fact that, as we travel west of Prime Meridian, we have to deduct 4 minutes for each longitude as we cross if we are traveling in the east we have to add 4 minutes as we cross each longitude therefore if we complete one circle around the earth i.e. cross 360° longitude, by the time we complete, we would have adjusted our watches 24 hours ahead. Therefore this creates a difference of a day. When we are moving from east



Fig. 3.5 : Time Zones

to west, a day will be deducted and when we are moving west to east, a day will be added, something similar happened with Captain Cook, when he returned home after completing his world tour, he thought he made a mistake in calculation by one day. To get over this inconvenience all nations unanimously considered International date line with 180° longitude. A day starts with this line. When imagined in this way. The error in calculation of a day while traveling across the world, was also rectified.

If its Monday for a place which is situated west of this line that is Asia, then it will be Sunday for the places situated on east like America.

When a ship crosses this line and sails towards America. The people on the ship have to repeat the same day, on which they have crossed the 'date line, it means that if they have crossed the International date line on Sunday. So the next day will be Sunday for them instead of Monday and if they cross the line and sails towards Asia then they have to subtract a day from their calendar. If they crossed the line on Sunday, so the next day for them would lie Tuesday, instead of Monday.

Position of the International Date Line :

If we look carefully, we will observe that this is not a straight line. (Fig. 3.6) What is the reason behind it? This line does not cross over 180° longitude from its one end to the other in a straight way. It is a Zig Zag line as it avoids many islands which are been crossed over by 180° longitude in Pacific Ocean which are under the administration of a single country. Therefore if international date line would have been considered as 180° longitude. some places on the island would witness two different dates on the same day which could have created a great confusion, and due to this reason International date line is in Zig Zag shape as required instead of straight line of 180° longitude.

When we look carefully at picture of international late line we will observe that its first bend is towards east. In Bering strait, which is between Siberia and Alaska, it moves away from 180° and turns towards east. To its further south, it turns towards west to avoid the Aluetian Islands. This causes difference in the dates of Siberia and Alaska. If its 15 July in Siberia then its only 14 July in Alaska 180° longitude almost passes through the

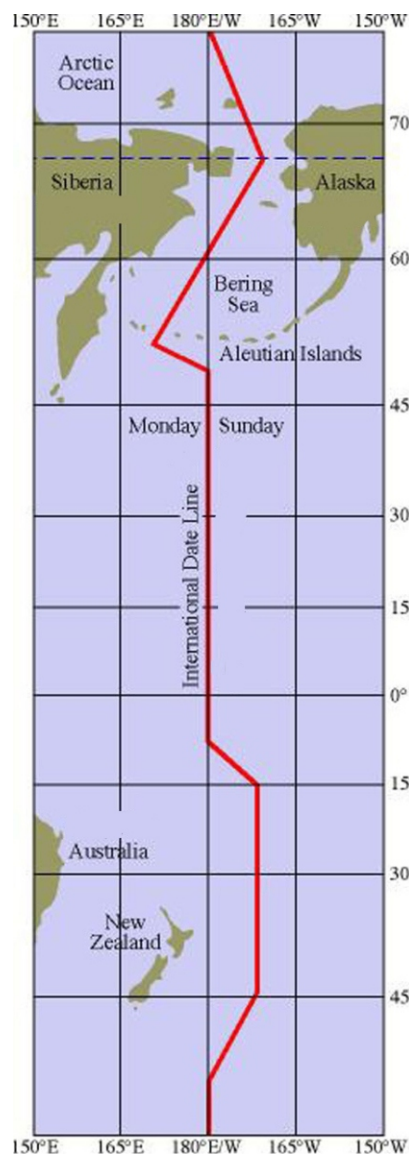


Fig. 3.6 International Date Line

centre of an island in an Fiji island groups which causes lot of inconvenience in the island. So in southern hemisphere this line avoids the Fiji and Togo Islands and runs across them. These island have to mark the date which is followed in New Zealand.

Equation of Time : The duration during which a planet completes its one revolution on its axis and comes back at its place, where sun is shining over head is called a Solar Day. But the orbit of earth is elliptical

in shape instead of being round. Due to this, the earth is sometimes very near to the sun and sometimes its very far from sun. During the winter season, when earth is comparatively near to the sun its called Perihelion position. Exactly opposite to this, when earth is at maximum distance from the sun its called Aphelion position. Its important to note that these positions do not effect the change of seasons. It depends on the position on the elevation of the sun in the sky, that is the angular position and solar radiation which is being received. When the earth is in Winter Solstice the speed of revolution of the earth is bit faster. Contrary to this the duration of Solar day keeps on increasing and decreasing.

Therefore two types of time may be witnessed.

Apparent Time : When sun shines vertically over a central meridian. Then all the places situated on that line will observe the time to be 12:00 noon.

Due to this constant increase and decrease, in reference to calculation of time the solar day will not be very convenient. To calculate time with the help of sun, Sun Dial is used. We have to bear the inconvenience of keeping the time, completely consistent, according to the position of the sun because the clocks need to be adjusted ahead or behind according to the sun.

Mean Time :

In daily day to day practice, the clocks cannot be frequently adjusted ahead or behind in terms of time. It means that the clocks do not show the time according to the position of the sun but shapes the mean time. Thus, time calculated like this is not considered as real time and the duration of the observed day also varies, Yes, if the duration of all such days of the year is added and their mean is calculated, the duration of real day be will be certain. This day is the Mean Solar Day and the time we use is based on this. Our clocks are also adjusted according to this Mean time. This time is called the Clock Time.

In comparison to Mean Solar Day, normal Solar day may be of longer or shorter duration. The difference which is calculated between them is called time equation. This is mostly given in marine records.

It is clear that the speed of the sun is not always the same. Sometimes its ahead of apparent time and sometimes it is behind it. If the sun vertically shines overhead after (2:00 the time equation will be positive (+) and if the sun is shining vertically overhead before its 12:00 the time will be negative (-). These four dates are 16 April, 15 June, 1 September and 25 December. The time equation of these dates is zero. On these dates when its 12:00 in watches, the sun dial also shows the same time, therefore Apparent time and Mean time are same. To indicate the values of time equation, a special table is prepared. Ships sailing on the sea routes specially need to know this.

Important Points

1. The earth has two main movements - Daily or Rotation, Second, Yearly or Revolution. Both these movements cause lot of changes on the earth's surface, like formation of day and night and change of seasons.
2. The sun remains fix and the earth revolves round it from west to east direction on its elliptical orbit, through which the positions of Summer and Winter Solstice are formed. During Summer Solstice, sun shines vertically over the tropic of Cancer and summers season prevails in northern hemisphere and winter prevails in southern hemisphere. Exactly opposite to this happens during Winter Solstice.
3. Latitudes and Longitudes are imaginary lines marked on the globe. Latitudes run from east to west and Longitudes run from north to south. These lines forms 'Geo Grid' through which exact location on earth could easily be determined.
4. All longitudes are circles (360°) and then form great circles (180°). 181th Great circle is Equator.

Exercise

1. The international date line passes through the longitudes is :
(A) 0° longitude (B) 150° longitude
(C) 180° longitude (D) 82½° longitude
2. The time at which, the clocks of the entire country are set, is called :
(A) Local Time (B) Mean Time
(C) Apparent Time (D) Standard Time
3. Which country has maximum number of time zones?
(A) Russia (B) Canada
(C) China (D) USA
4. Equinox means :
(A) Sun shines vertically over Tropic of Cancer
(B) Sun shines vertically over Tropic of Capricorn
(C) Sun shines vertically over Equator

(D) Sun shines vertically on Tropic of Cancer and Capricorn

5. The time is calculated for all time zones through :
- (A) From 180° longitude
 - (B) From '0' Prime Meridian
 - (C) From 90° E longitude
 - (D) From Greenwich Place

Very Short Type Questions :

- 6. What is the angle of inclination of the earth?
- 7. When does the speed of rotation is maximum on the earth?
- 8. What is the maximum distance between the sun and the earth called?
- 9. What is the speed of revolution?
- 10. What is the total number of longitudes?

Short Type Questions :

- 11. Which longitude is the basis of drawing International Date Line?
- 12. What is the location determined for Prime Meridian?
- 13. What is the total number of time zones of Canada and why?
- 14. Which device is used to find the local time?
- 15. Mention the name of the line on which a new day is observed towards its west and towards its east when the previous day is still there.

Essay Type Questions :

- 16. Compare local and Standard time.
- 17. 'The authentic time of a country or region is actually a local time of a particular meridian, Clarify this statement in reference to India.
- 18. What is International Date Line? Explain its importance.

Answer Key

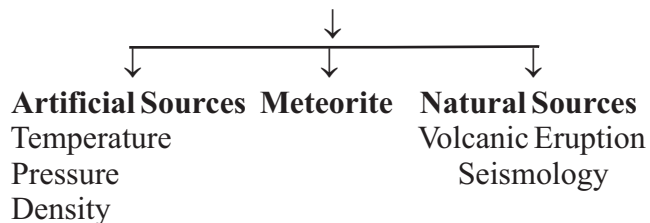
1. C 2. D 3. A 4. C 5. B

Lesson - 4

Interior of the Earth

The interior of the earth is invisible and inaccessible. Man has been able to know the interior part of the earth for few kilometers through the actions of drilling and mining. Due to the rapid increase in temperature along with depth, it becomes almost impossible to mine or drill deeply. The high temperature of the earth's interior can melt any device used for drilling therefore drilling is limited upto a certain depth therefore it becomes very difficult to know directly about the earth's interior; There are other sources of information about interior of the earth like eruption of lava from volcanoes and gases, but it is difficult to know about the depth at which this magma comes out. More scientific and authentic information about the structure of the earth is obtained from Seismology. The sources which provide information about the interior structure of the earth can be categorized into following classes -

Sources of information of earth's interior



1. Artificial Sources :

(a) Temperature :

It has been proved by geological surveys that there is constant increase of temperature of 1°C

at the depth of every 32 meters towards the centre of the earth. According to this rate of increase in temperature with increasing depth, all the substances should be found in the liquid state in the earth's core but this does not actually happens. With the increasing depth, due to rapid increase in pressure, the melting point of rocks also increases simultaneously and the rate of increase in temperature inside the earth's crust keeps on declining towards the centre of the earth. According to this calculation the temperature of the core of the earth is more than 2000°C.

(b) Pressure :

The increasing pressure of the thick layers of the earths interior causes increase in density towards the centre of the earth. It obvious that substances present at the core should be in liquid form because of high temperature, but due to excessive pressure the liquid substance behave as solid. Therefore because of excessive heat and excessive pressure, rocks are like solid plastics.

(c) Density :

Due to constant pressure exerted towards the centre of the earth and due to heavy substances, the density of layers also increases. According the gravitational theory of Newton, the calculated density of the earth is 5.5 (density of earth's surface 2.6-3.3 gcm³ and average density of the earth's centre 11gcm³)

2. Meteorite Shower :

Meteorite are part of our solar system. They

were scattered in the space during the origin of planets. Sometimes these meteorite falls on earth's surface. This process is called Meteorite Shower. The study of meteorite reveals that it contains Nickle and Iron. Earth is also a member of Solar System. The earth has magnetic property. This property has originated in earth due to the mix of Nickle-Iron in its interior part.

3. Natural Sources :

(a) Volcanic Eruption :

From the substances erupted from the volcano and magma, it is clear that the some part of the earth's interior is hot and is in the state of magma.

(b) Evidences of Seismology :

This is a science which studies the seismic waves by using seismograph. Earthquakes are sudden vibrations which are produced in the earths interior. Focus is the place in the earths interior from where it has been originated. Seismic waves are actually the path adopted by the earthquakes's vibrations during an earthquake. These seismic waves are of three types. Primary (P) waves are fastest. They can travel through solid liquid and gases. Secondary (S) waves can travel only through, solids material but they cannot pass through liquid. Surface (L) waves move mainly along the surface

that reaches near the focus of earthquake in the end. These waves are very destructive. The shadow zone is the area of the earth, from angular distances of 105° to 140° from the epicenter of the earthquake where no seismic wave is recorded. (Fig.4.1).

On the basis of the path and velocity of seismic waves the information about interior of the earth is obtained. It is observed at the Seismograph stations that these waves follow a curved path which proves that car vature is due to variation in density in interior of the earth.

As the density inside the earth crust increases, the waves (P and S) being carvature inside the core of the earth and disappear as they reach the surface of the earth (Fig. 4.1) As 'S waves do not pass through liquid and disappear from the depth of more than 2900 kms, it is proved that earth is in a liquid state beyond 2900 kms of depth which is extended near the core of the earth. As there is difference in density of rocks, so there is difference in the traveling speed of the seismic waves. On the basis of the above facts three layers of the earth's interior are recognised-

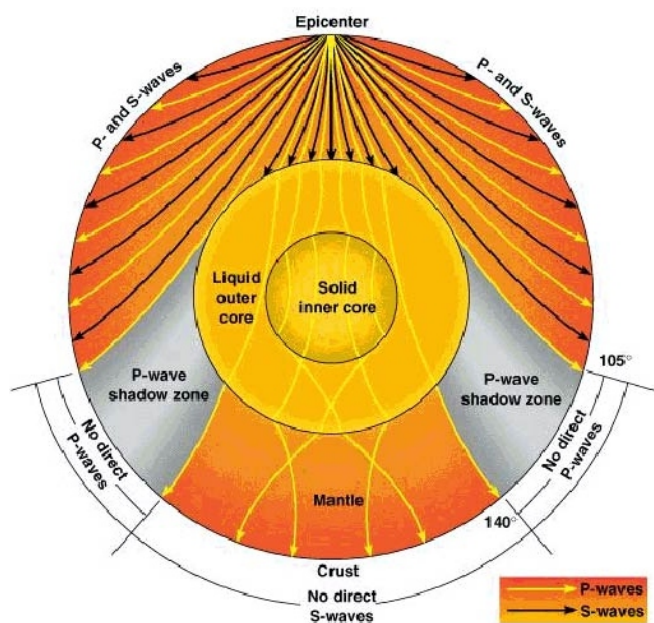


Fig. 4.1 : Paths of Seismic Ways

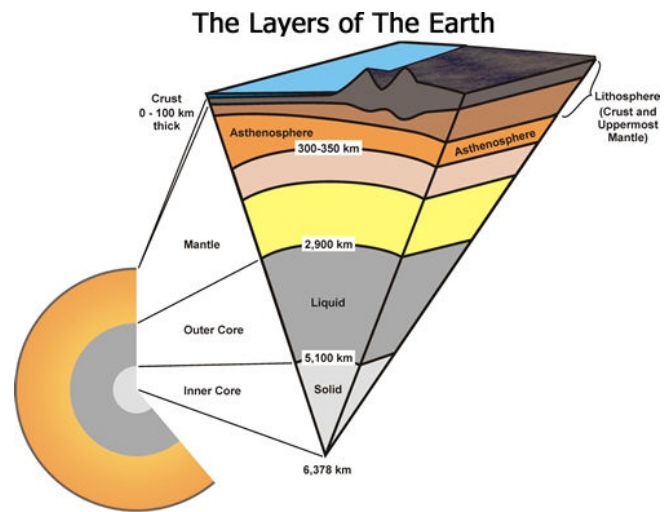


Fig. 4.2 - Interior structure of earth according to Seismology.

1. The Crust :

This the outer most layer of the earth and its average thickness is 30 kms. This layer is made of lighter rocks and its density is 3 gms per cubic centimeter.

2. The Mantle or substratum :

Mantle is extended upto the depth of 2900 kms from the crust of the earth. The upper part of Mantle is called Asthenosphere. The lava which reaches the earth's surface during volcanic eruptions has its source from this Mantle 'S' waves disappear after the depth of 2900 km, therefore Mantle is made up of solid rocks.

3. Core :

The part of the earth's interior which is extended between 2900 km to 6371 kms of depth is the most interior part of the earth. Its density is 11 gms per cubic centimeters 'S' waves can not reach to this region. This layer is divided into 2 parts - outer core which is in liquid form and extends from 2900 to 5150 kms, the second part is inner core which is much dense and extends from 5150 km to 6371 km of depth.

identified three layers under the crust.

1. Sial :

It refers to the earth's crust upper most layer and is made up of rocks abundant in (Silica) (Silica - Si) and Aluminum (al) therefore it is called Sial. Its average density is 2.9 and average depth ranges from 50 to 300 kms.

2. Sima :

This layer is mainly composed of rocks Silica (Si) and Magnesium (ma) therefore its called Sima (Si+ma=sima). Its density varies between 2.9 to 4.7. Its depth ranges from 1000 to 2000 kms.

3. Nife :

This layer has abundance of Nickel (ni) and Ferriun (Fe). Therefore it is called Nife (ni+fe=nife). Its density is about 11 and it extends till the core of the earth.

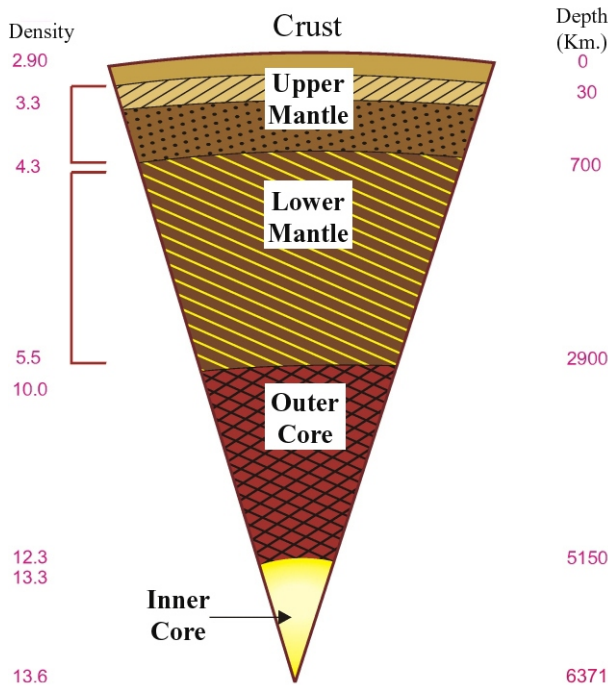


Fig. 4.3 : Depth & Density of Interior Layers of the earth

Classification of Suess

According to Suess, the upper part of the earth is made up of sedimentary rocks. On the basis of chemical composition of rocks, Suess has

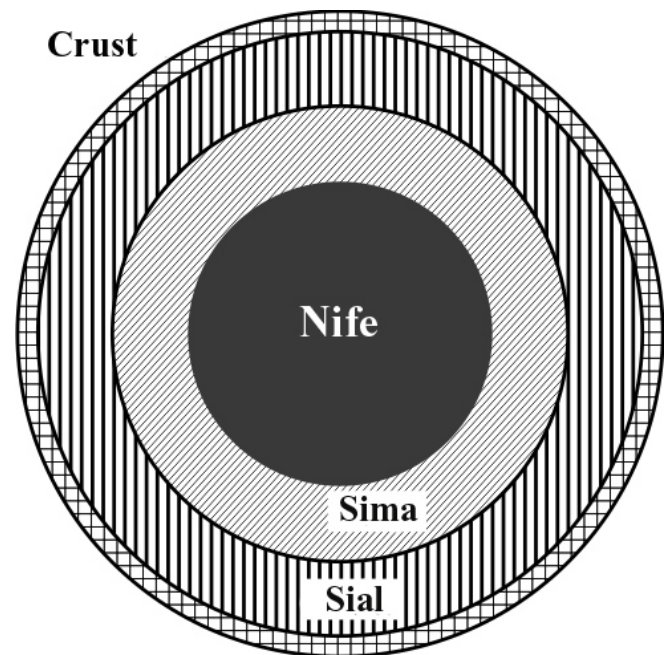


Fig. 4.4 : Interior Structure of the Earth according to Suess

Van der Gracht's Classification

Van-der-Gracht has proposed 4 layers of the earths interior which can be categorized as follows :

1. Outer Silica Crust : The thickness of this layer beneath the continents is about 60 km, beneath Atlantic Ocean it is 20 kms. and beneath the Pacific

Ocean it is 10 kms. The density of this layer varies between 2.75 to 3.1. This layer is composed of Silica, Aluminium, Potassium and Sodium.

2. Inner Silicate layer and mantle :

The thickness of this layer is between 60 to 1200 km. Its density varies between 3.1 to 4.75. This layer is composed of Silica, Magnesium and Calcium.

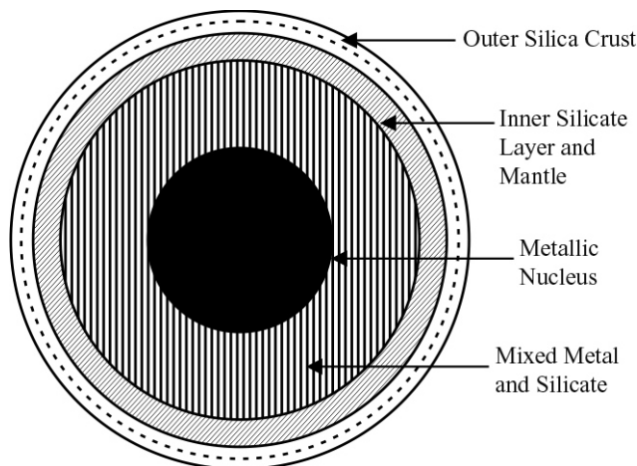


Fig. 4.5 : Interior Structure of the earth by Van der Gracht

3. Zone of mixed metals and silicate :

The thickness of this layer is between 1200 to 2900 km. Its density is from 4.75 to 7.8. This layer is formed of a mixture of Nickel, Iron, Silica, Magnesium.

4. Metallic nucleus :

This layer extends from 2900 km to the core of the earth. Its density is more than 11. This layer is formed of Nickel and Iron.

Important Points

1. The main reason for the limited information of the earth's interior is the limited access to it.
2. Main sources of information about earth's interior are temperature, density pressure, meteor shower, volcanic eruptions and evidences of seismology.
3. On the basis of scientific analysis of velocity and seismic paths of seismic ways, three

layers of earth's interior are determined :

- (a) Crust (b) Mantle (c) Core

4. Classification as given by Suess :

- (a) Sial (b) Sima (c) Nife

5. Classification proposed by Van der Gracht :

- (a) Outer Silica Crust
 (b) Inner silicate layer and mantle
 (c) Zone of mixed metals and silicate
 (d) Metallic Nucleus

Exercise

Multiple Choice Questions

1. The components of Sial layer are :
 (A) Silica - Magnesium
 (B) Sodium - Aluminium
 (C) Silica - Aluminium
 (D) Silica - Iron
2. The maximum thickness of the outer most layer of the earth according to Vander & Gracht :
 (A) 1200 km
 (B) 60 km
 (C) 2900 km
 (D) 200 km
3. The statement which is wrong in reference to the classification given by Sues is :
 (A) Density of upper layer is 2.7
 (B) The density of Sima is less than 4.7
 (C) Nife consist of magnetic quality
 (D) Sial is floating on Nife
4. Interior of the earth is classified as Sial, Sima and Nife by :
 (A) Van der Gracht
 (B) Dally
 (C) Homes
 (D) Sues

5. Which of the following is the direct source of information of earth's interior?
(A) Seismic Waves
(B) Gravitational Force
(C) Volcanic Eruptions
(D) Magnetism of Earth

Very Short Type Questions :

6. Name the direct sources through which we can get the information about the earth's interior?
7. What is Seismology?
8. What are seismic waves?
9. Why our knowledge is so limited regarding the interior of the earth?
10. What are the major components of Nife?

Short Type Questions :

11. Name the layers of the earth's interior classified on the basis of seismological evidences.
12. What are the characteristics of Earth core?
13. Write the characteristics of 'Sial'.
14. What is 'Substratum'? Give its characteristics?
15. Name the different layers of earth's interior suggested by Van-der-Gracht.

Essay Type Questions :

16. Explain the views of vander Grachat regarding interior of the earth.
17. Explain the view of suess regarding interior of the earth.
18. Describe the earth's interior on the basis of evidences of Seismology.

Answer Key

1.C 2.B 3.D 4.D 5.C

Lesson - 5

Origin of Continents and Oceans

Continents and oceans are landforms of first order. Different theories are propounded regarding their origin by many scholars. Out of which two theories have been widely accepted - 'Continental Drift' and 'Theory of Plate Tectonics'.

Continental Drift Theory :

Although hypothesis regarding the drifting of the continents was presented by Francis Bacon in 1620, Snyder in 1885, F.G. Taylor in 1910, but the theory was postulated in 1912 by a German, Alfred Wegner, a German scientist Wegner was a climatologist who was interested in solving the problem of the changes in climates.

The two evidences in form of availability of coal in Antarctica and glaciation in the deserts provided Wegner with two assumptions :

1. Climate zones were shifted and land area remained stable.
2. Climatic zones remained stable and land area shifted.

Wegner based his hypothesis on the second assumption and specified that during the Carboniferous period, all the continents were in form of one landmass which was called Pangea by him. It was surrounded by water on all its side, which was named by Wegner as 'Panthalasa'.

According to Wegner, this 'Pangea' was formed of sial and was floating freely on oceanic floor named 'Sima' by him. The division of Pangea took place in Carboniferous Period. (Fig. No. 5.1)

During the first division, Tethys geosyncline was formed. The northern part of which was called



Fig. No. 5.1 : Pangea and Panthalasa

Angaraland (Lauracia) and southern part was called Gondwanaland. In due course of time, the westward and the equatorward drift of this division and its broken crustal parts led to the present position of the continents Wegner proposed two forces responsible for this drift.

1. Gravitational force and Force of buoyancy : Due to these forces the drift of continents was towards equator which resulted in the formation of India, Australia and Madagascar.

2. Tidal Force : This force caused the Westward drift of the continents which caused the formation of North and South America.

According to Wegner the space created due

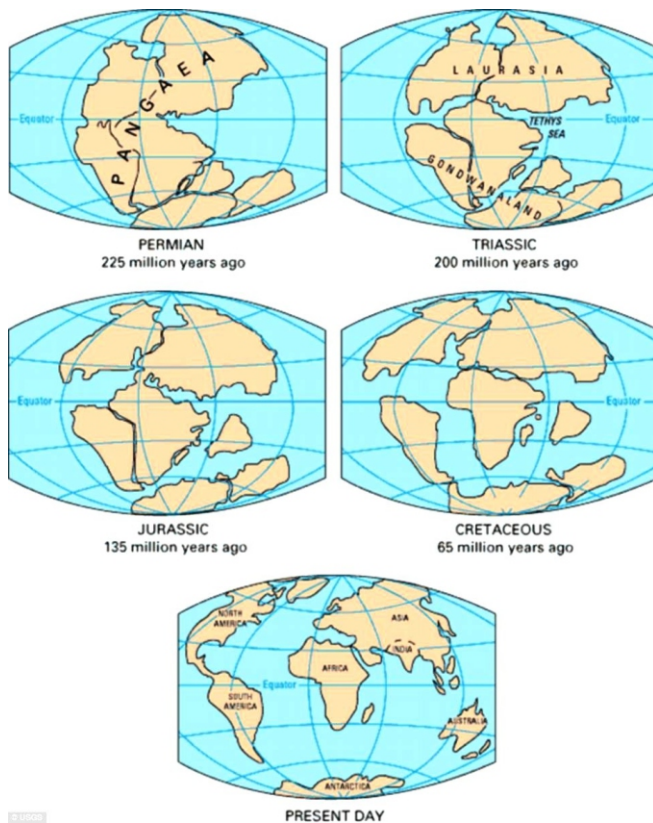


Fig. 5.2 : Continental drift of Pangea

separation North and South America, resulted into the formation of Atlantic Ocean and division of Australia and Antarctica led to the formation of Indian Ocean and rest of the water body 'Panthalasa' was named as 'Pacific Ocean'.

Evidences in the support of the theory :

1. Geographical Evidences :

(a) JIG-SAW FIT in Atlantic coast.

The coastal margins of Africa and South America which face each other have unique similarity. Both the coastal margins of Atlantic Ocean can be easily re-fitted together. This was named as JIG SAW FIT by Wegner. According to him, the Western African Bulge in Caribbean Sea and North Eastern region of South America could be joined with gulf of Guinea Coast. (Fig. 5.3)

(b) Alignment of Mountains :

If the coastal margins of the drifted continents are joined then there is similarity in the alignment of all eras of mountains. This alignment is clearly visible in Caledonian, Hersian & Alpine mountain ranges.

(c) Origin of Young Fold Mountains :

Wegner proposed that the Rockies, Andes, Alps and Himalayan mountains were earlier the sites of geosynclines. The sediments of these geosynclines were folded up, due to excess of pressure.

2. Geological Evidences :

(a) Structural Similarities :

The structure of rocks of both the coasts of Atlantic Ocean bear a lot of similarities which prove that these coasts were once joined together.

(b) Stratigraphical Similarities :

The sequential similarities in the types of rocks of both the coasts of Atlantic Ocean prove that the coasts were joined earlier.



Fig. 5.3 : Coastal Similarity

3. Evidences of Geodesy :

The evidences of Geodesy prove that Greenland is drifting towards Canada which proves the drifting of continents.

Biological Evidences

(a) Paleontological Similarities :

Another evidence which proves that the Atlantic coasts were once joined, was the similarity in the fossils of the plant and animal species. (Fig. 5.5)

(b) Biological Habits : According to biologists,



Fig. 5.4 : Alignment of Mountains

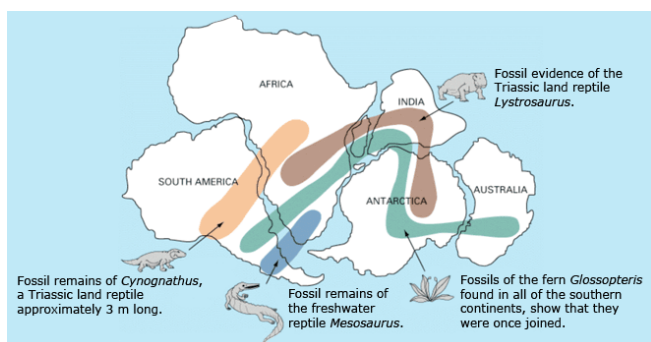


Fig. 5.5 : Palaeoclimatological Similarity

researchers have proved that creature named 'Liming' keep moving towards western direction and ultimately drown themselves in the Atlantic Ocean, its believed that these creatures must be following their habit of moving towards the west when North America was joined to Europe.

5. Palaeoclimatological Evidences :

The effect of glaciation during carboniferous period in India, South America, Africa and Australia, proves that this could only be

possible if these countries would have been joined together as a one landmass.

Criticism of Continental Drift Theory :

1. Geographical Criticism :

(a) The concept of JIG-SAW Fit is erroneous, because of joining the Brazilian coast with Guinea Coast, will leave a gap of 15°.

(b) Mid-Atlantic ridge is a hurdle in joining two coasts. This was not explained by Wegner.

(c) The two processes i.e. drifting and folding as explained in this hypothesis are contrary. On one hand Wegner proposed that sial is floating on sima, on the other hand it has proposed that due to pressure exerted on the deposited sediments, folds were created.

2. Geographical Criticism :

According to Geologists there are negligible structural and stratigraphical similarities regarding the composition of rocks on both the coastal margins of Atlantic Ocean. Hence these evidences can not be regarded a sufficient evidence to prove that the coasts were joined.

3. Geodesical Criticism :

According to Wegner, the westward drift of the continents is due to gravitational force exerted by Sun and Moon. Whereas the mathematicians have proved that the force which is required for the westward drift of the America will be ten billion times more to what it is at the present day. Mathematician critics believed that it is impossible for this force to exist and if this would be possible then this force would cause disturbance in the rotation of the earth.

4. Biological Criticism :

The critics consider the biological evidences negligible.

5. Paleoclimatological Criticism :

Steers pointed out that in north western Africa, Boston in USA (which was at the equator at that time) and Alaska of deposits like 'Tillite' have been found, which belong to Ice Age. The Analogue of Continental Reconstruction of Wegner do not provide sufficient explanation for discrepancy indicated by Steers.

Despite of many short comings, the importance of this principle is due to the fact that it provided a basis for universally accepted scientific theory of plate tectonics, which reinforces the theory of continental displacement.

Plate Tectonics

Plate tectonics theory has been rendered in relation to the origin of continents and oceans on the basis of many researches related to Sea floor spreading, Magnetism and Seismic surveys during 1960's. Harry Hess (1960) has been considered as the father of 'Sea floor spreading theory'.

Plate :

The word 'Plate' was first of all used by Tuzo Willson to describe the outer layer of the earth. This is a combined unit of crust and Upper Mantle, which is also known as 'Lithosphere'. Its thickness is 100 km and is extended over both continents and oceans. This outer plate is similar to rigid, thin, and brittle reversed soup plate.

According to the principle, the entire lithosphere is divided into 6 major and 20 minor plates, which are moving converging, diverging and colliding in respect to each other, this causes

tectonic movements like earthquakes, volcanic eruption, and formation of trenches. This entire sequence of movement of plates is called plate tectonics.

Major Plates :

There are many discrepancies regarding the total number of Tectonic Plates, but Morgan has divided the entire Lithosphere into 6 major and 20 minor plates. The 6 major plates are as follows : (Fig. 5.6)

1. Indo-Australian Plate: This plate includes Indian sub-continent and land crust of Australian, the souther-western oceanic crust of Indian and Pacific Ocean.

2. Eurasian Plate : This is the only plate which is entirely made up of continental crust. This plate is extended in Mid Atlantic Ridge, Alps-Himalayan series of mountain range and island arcs in east.

3. African Plate : Its a combined continental and oceanic plate. It is extended to India in east, Antarctica in south, Mid Atlantic Ridge in west and till Eurasian plate in north.

4. American Plate : This includes the continental crust of North and South America, oceanic plate of Mid Atlantic Ridge in the east. It is



Fig. 5.6 : Tectonics Plates of the World

extended upto the western margins of the America and meets with Pacific Plate. It is in the westward drift as a whole unit and due to this there is no tectonic movements on the eastern margins of America.

5. Pacific Plate : It is extended from East Pacific Rise to entire Pacific Ocean, it is the only plate which is entirely made of oceanic crust.

6. Antarctica Plate : The major part of Antarctica Plate is snow covered. This plate extends all around Antarctica and to all mid oceanic ridges.

Types of Plates : On the basis of structure the plates are of three types :

1. Continental Plates : The plate which consists of entire or most of land is called Continental Plate.

2. Oceanic Plate : The plate which covers entire or most of the oceanic bottom is called Oceanic Plate.

3. Continental - Oceanic Plate : The plate on which the extension of both land and oceanic bottom is found is called continental- Oceanic Plate.

Plate Margins :

All the tectonic activities, of the interior of the earth are concluded on these plate margins. These plate margins are of three types. (Fig. 5.7)

1. Constructive Plate Margins : Along these plate margins two plates diverge, which creates empty place. Through which the magma erupts out

and solidification of lava results into regional expansion. Due to this reason it is called constructive Plate Margins. Such plate margins are formed near Mid Atlantic ridge.

2. Destructive Plate Margin :

In the plate margins, due to convergence of two plates, one plate overrides over the other plate and other plate undergoes subsidence. The front part of the incised plate melts as it enters the Mantle. Therefore it is called destructive Plate margin. This melted substance erupts out from the weaker margins of crust and forms island arcs. The series of volcanic eruptions and island arcs are extended on the margins of Pacific Oceanic Plate.

3. Conservative Plate Margins : In these plate margins the two plates pass along the sides of each other. Here, there is no erosion of any plate, neither any new material is created, only transform faults are formed. Hence it is called conservative margin. In the western region of North America, there are two transform boundaries near Andrias fault.

Causes of the movement of Plates : The radioactive substances generates geothermal energy, which rises in the form of convection currents in the interior of the earth and causes movement of the plates. The conventional currents just beneath the plates causes horizontal movements of the plates. Eruption of magma in the region of mid continental ridges and reaching of plates by subsidence in mantle along convergence margins are the main works of convectional current.

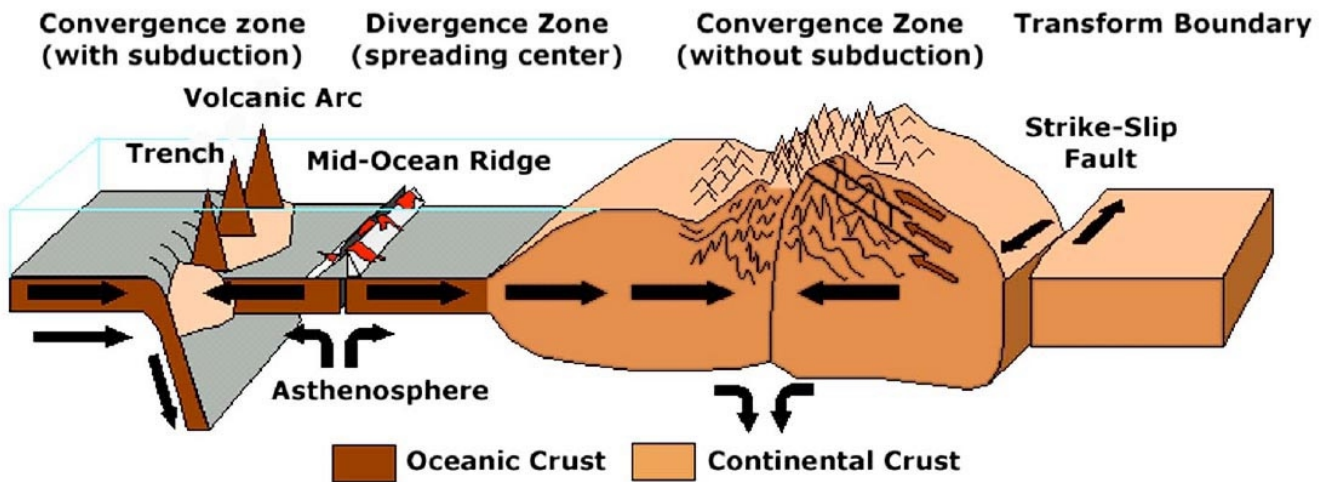


Fig. 5.7 : Types of margins of plates and their activities

Evidences of Plate Tectonics :

1. Sea Floor Spreading : Gaps are created due to divergence of two plates moving in opposite directions. In these gaps, the magma emerges out due to convective currents and thus deposits in the form of lava which forms new layers of rocks. Due to continuity of this process new crustal layers keep on forming. This results in spreading of Sea floor. Like the lava comes out from both the sides of Mid Oceanic Ridge and forms new crusts. With the concept of Sea Floor Spreading, the hypothesis about instability of the continents and oceans is also proved.

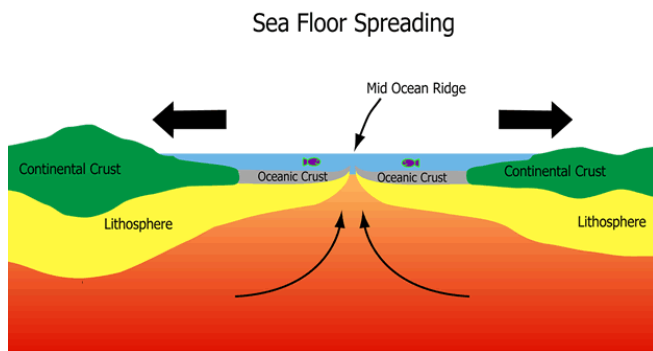


Fig. 5.8 : Sea Floor Spreading

2. Continental Drift : The new discoveries of Paleomagnetism and Sea floor Spreading, have strengthened the fact that the continents and oceans basins were never fix and stable.

On the basis of these discoveries, the information about Continental drift, prior to the last 20 million years, is available.

3. Broadening of Rift-Valleys : Those plate boundaries which have rift valleys, are getting broader. Red Sea and the Gulf of Eden is expanding at the rate of 1 cm per year. The Gulf of California is also expanding.

4. Other Effects : There are other effects of Plate tectonics which have been explained in the description of points earlier in this chapter. These effects include incidents of earthquakes, volcanic eruptions, mountain building, formation of island festoons etc.

Therefore it can be concluded that most of the geographers, geologists and geo-scientists are accepting the theory of continental drift. Presently,

propelling force, as the only force for the drift is still controversial.

Recent research studies have revitalized the concept of convection current theory in the context of plate tectonics.

Thus the plate tectonic theory has not only strengthened the continental drift theory on the basis of scientific evidence but also it can explain many processes like earthquakes, volcanic eruptions and formation of island arcs.

Important Points

1. Continents and Oceans are called the first order landforms.
2. The basis of Wegners Theory of continental drift, is that climatic zones remained fix and landmass drifted.
3. Wegner described continental margins as Sial to be floating on Sima.
4. According to Wegner all the continents were in a form of one landmass called 'Pangea' and, it was surrounded on all sides by Panthalasa 'a vast ocean.
5. Gravitational force of moon caused the westward drift of the continents and force of buoyancy caused drift towards the equator.
6. Jig-saw-fit of Atlantic Coast, alignment of mountains, structural similarities, Geodesy evidences, biological evidences, Paleontological and Paleoclimatological evidences proves the Continental Drift Theory.
7. The word 'Plate' is used for outer layer of lithosphere. The entire sequence of movement of plate is called 'Plate tectonics'.
8. Continental and Oceanic Plates - Indo-Australian, Eurasian, African, American and Pacific Antarctica Plate.
9. Effects/Evidences of Plate tectonics - Sea floor spreading. Continental Drift, broodening of rift valleys.

Exercise

Multiple Choice Questions

1. The vast ocean surrounding Pangea was :
(A) Atlantic (B) Panthalasa
(C) Tethys (D) Arctic

2. According to Wegner, the direction to which the continents were drifted was :
 (A) South and North
 (B) East and Equator
 (C) North and west
 (D) West and Equator
3. The fact only related to Plate Tectonic is :
 (A) JIG-SAW FIT (B) Pangea
 (C) Tethys (D) Arctic
4. 'Pangea' was composed of :
 (A) SIAL (B) SIMA
 (C) Nife (D) Sial and Sima
5. The word 'Plate' was first used by :
 (A) Finch (B) Tuzo Wilson
 (C) Wegner (D) Griffith Taylor

Very Short Type Questions :

6. What is 'Pangea'?
7. Describe the types of plate margins?
8. Which ridge is an hurdle in Jig-Saw-Fit of Atlantic coasts?
9. What do you mean by 'Panthalasa'?
10. What is the average thickness of the Plate?

Short Type Questions :

11. Write the geological evidences of Continental Drift Theory.
12. What is meant by 'JIG-SAW-FIT'?
13. At which plate margins the process of formation of Island Arcs occurs Island Arcs?
14. Name the major plates of the earth.
15. Which forces are responsible for the drift of the continents according to wegner?

Essay Type Questions :

16. Critically describe the Continental Drift Theory of Wegner.
17. Describe the global Plates and give evidence about Plate tectonics.
18. Write an essay on Plate Tectonics.

Answer Key

1. B 2. D 3. C 4. A 5. B

Lesson - 6

Rocks

The upper layer of the earth known as crust, is made of combination of different mineral elements. In simple language the word 'rock' is used for a hard substance but according to a geologist - All those substances which formed our earth's crust, no matter it may be as hard as granite or as soft as clay, are called rock. In a combined form the mixture of all the minerals in a solid form in crust is called 'Rock'. The types of rocks are as follows :

1. Igneous Rocks
2. Sedimentary Rocks
3. Metamorphic Rocks

1. Igneous Rocks : During the formation of the earth, the rocks formed by cooling and solidification of hot and liquid magma and lava, are called Igneous Rocks. These were the first rocks to be formed. That is why it is called 'Primary Rocks'. The initial crust of the earth is made up of Igneous Rocks. Therefore all the rocks are formed from Igneous Rocks. There are no fossils in these rocks. The upper most part of earth crust which is 16 km thick, contains 95% of Igneous Rock.

Major characteristics of Igneous Rock

1. These rocks do not have layers.
2. These rocks are non-porous.
3. These rocks are granular
4. There are no fossils in these rocks.
5. These rocks are very hard.
6. The effect of physical weathering is more than chemical weathering on these rocks.
7. Metallic minerals are found in these rocks.

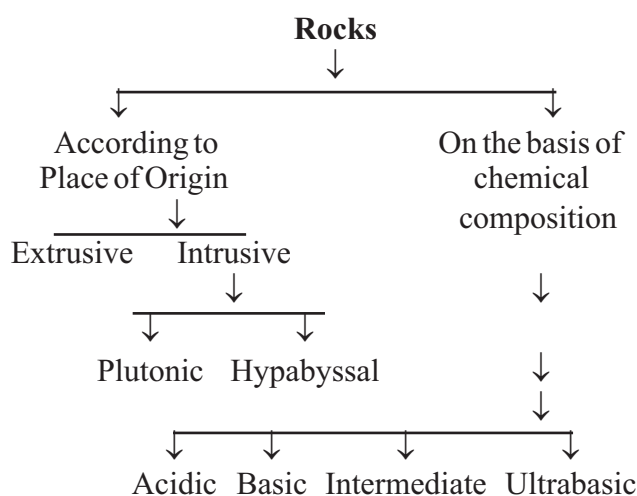
On the basis of composition, colour, size of particles, shape and place of origin, the igneous rocks are classified into following categories. (Table 6.1)

1. Classification on the basis of place of origin.

(A) Intrusive Igneous Rocks : These rocks are formed inside the earth's crust by solidification of magma. As the Igneous Rocks are cooled down slowly, very large size of crystals are formed. According to depth, it is of two types :

(i) Plutonic : These rocks are formed when the Magma gets cooled and solidifies at greater depths of the earth. Due to greater depths, the rocks get cooled down very slowly which causes formation of large size crystals. Granite is its perfect example.

Table 6.1
Classification of Igneous



(ii) **Hypabyssal** : When the magma solidifies in cracks and joints in the layers of the earth's interior, these types of rocks are formed. The size of crystals as smaller in size as it cools down a little faster. In the form of Hypabyssal rocks, magma takes the shape of phacolith, Lacolith, Lopolith, Dyke, sill etc. (Fig. 6.1)

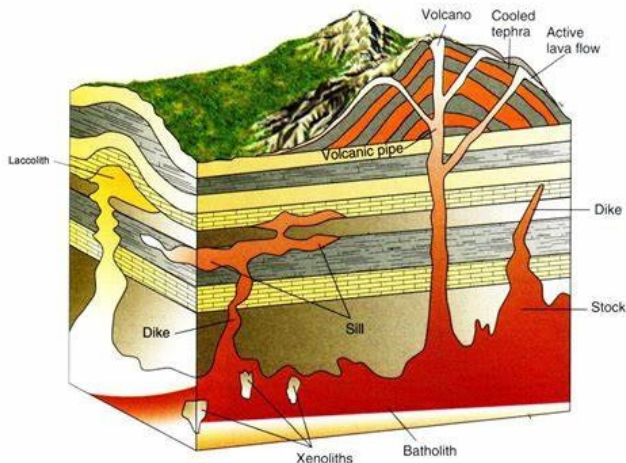


Fig. 6.1 : Igneous Rock

(B) **Extrusive Igneous Rocks** : The rocks are formed with the solidification of lava on the surface of the earth. As it cools down very fast, it has large size crystals. Grabo and Basalt are the best examples of Extrusive Igneous Rocks.

2. Classification on the basis of Chemical Composition :

(A) **Acidic Rocks** : These rocks have more than 65% of Silica. These rocks are hard and strong Granite is its major example.

(B) **Basic Rocks** : The Silica content-in these rocks varies between 45% to 55%. They are alkaline. Basalt and Grabo are its major example.

(C) **Intermediate Rocks** : In these rocks, the Silica content is in between the Acid and the Basic rocks. Diorite is its best example.

(d) **Ultra Basic** : Silica content in this rock is found less than 45% Peridotite is the main example of this type of rock.

Magma is of three types :

1. Basaltic (Temperature : 1000° - 1200°C)
2. Andocitic (Temperature : 800° - 1000°C)
3. Rhyolitic (Temperature : 650° - 800°C)

Sedimentary Rocks :

The forces of denudation have been working on the earth from the time of its origin in which due to weathering and erosion, the rocks are disintegrated at the same place of their occurrence or they are deposited at some other place. The loose material from different rocks like rock powder fossils of organisms and plants are deposited in layer after layer, led to the formation of sedimentary rocks. These rocks are extended over 75% of the entire surface of the earth.

Characteristics :

1. There are many layers in these rocks.
2. These rocks have porous.
3. Fossils are found between layers of the rocks.
4. These rocks undergo weathering at faster pace.
5. These rocks are almost soft.

These rocks are formed of different types of sediments and many factors are responsible for its formation. Therefore the basis of classification of rocks are as follows : (Table 6.2)

(1) Classification on the basis of type of sediment in formation of rocks.

(A) **Clastic Rocks** : The sediments or loose material during weathering and erosion, are deposited in form of layers. with time, it combines to form sedimentary rocks, sand stones, conglomerate, Clay and Loess are its major examples.

(B) **Organic Rocks** : The fossils of animals and plants are dominant in composition of this type of rocks. It is further divided into three types.

(i) Limestone Rocks :

The remains of the creatures with limestone content and the limestone dissolved in water, forms these types of rocks. Dolomite is this type of rock.

(ii) **Carbonaceous Rock** : On burying of the layers of sediments of vegetation in tropical areas these rocks are formed. Rocks including coal are included in this category.

(C) **Chemically formed sedimentary rocks** : When there are soluble rocks in the way of flowing water, the water dissolves the soluble rocks and carries it along with it and deposit it at some other place, through which these rocks are formed. clay, soapstone, rocksalt are its major examples.

(2) Classification on the basis of composition.

(A) Aqueous Rocks : These rocks are formed in aquatic regions because of deposition of sediments. On the basis of location of deposition, these are of three types : sea rocks, lake rocks and riverine rocks.

(B) Aeolian Rocks : These rocks are formed because of transportation and deposition of sediments by wind. Loess is its best example.

(C) Glacial Rocks : These rocks are formed with deposition of pebbles and boulders transported and deposited by Glaciers. These are called Moraines.

Metamorphic Rocks : Rocks which are formed because of changes in its structure and properties without undergoing disintegration or dissolution are called Metamorphic rocks. These rocks may be original, igneous, sedimentary or metamorphic. This metamorphism may be due to water, heat or pressure or by all three.

Characteristics of Metamorphic rocks :

1. These are secondary rocks as they are metamorphism or change in form of other rocks.
2. These rocks are comparatively harder and more than consolidated.
3. It has dominance of metallic minerals. Thus they have more economical value.
4. These rocks are non-porous rocks. They are simply divided into following divisions :

1. Thermal Metamorphism : During the volcanic eruption when the lava travels through volcanic vent, the nearby rocks get metamorphised due to extreme heat. This is called Thermal Metamorphism.

2. Dynamic or Regional Metamorphism: This type of metamorphic activity takes place in a larger region in which both contraction and heat effect the rocks. This type of metamorphism occurs in the region of folded mountains.

3. Hydro Metamorphism : In this type of metamorphism the liquid formed by mixing of water with chemical substances brings change in the mineral of the rock. It is called Hydro Metamorphism.

4. Thermo Hydro Metamorphism : When

there is hot water on the rocks then due to heat and pressure rocks get metamorphosed.

Classification of Metamorphic rocks :

The original rocks which are changed into metamorphic rocks, are classified as follows :

S.No.	Original Rocks	Metamorphic Rock
1.	Igneous Rocks	
	1. Granite	Gneiss
	2. Basalt	Amphibolite
	3. Gabbro	Serpentine
2.	Sedimentary Rocks	
	1. Sandstone	1. Quartzite
	2. Limestone	2. Marble
	3. Shale	3. Slate
	4. Coal	4. Graphite, Diamond
3.	Metamorphic rocks	
	1. Slate	1. Schist
	2. Schist	2. Phyllite

Important Points

1. The solid mixture of different minerals on earth's crust is called rock.
2. Rocks are of three major types - Igneous, Sedimentary and Metamorphic.
3. The cooling down of magma and its solidification at the time of origin of the earth is called Igneous rocks.
4. Igneous rocks do not have fossils, layers and are non-porous.
5. Sedimentary rocks consist of layers, fossils and porous. These are comparatively softer.
6. Due to the effect of water heat and pressure, the original rocks changes its forms and are called metamorphic rocks. These rocks are more consolidated and have more metallic minerals.

Exercise

Multi Choice Questions

1. Which of the following is an igneous rock:
(A) Gneiss (B) Marble
(C) Diamond (D) Slate

2. Original rock is :
 (A) Igneous (B) Stratified
 (C) Sedimentary (D) Metamorphic
3. The rocks which do not contain fossils are:
 (A) Sedimentary (B) Secondary
 (C) Igneous (D) Metamorphic
4. Which of the following is a metamorphic rock:
 (A) Granite (B) Marble
 (C) Basalt (D) None of the above
5. Which of the following is a sedimentary rock:
 (A) Granite (B) Limestone
 (C) Basalt (D) Marble

Very Short Type Questions :

6. Give two examples of Igneous rocks?
7. What is a rock?
8. Give the metamorphic form of any two sedimentary rocks.
9. Define the term rock.
10. Define sedimentary rock.

Short Type Questions :

11. What are the characteristics of Igneous rocks?
12. Give the characteristics of Sedimentary rocks?
13. Write the characteristics of Metamorphic rocks.
14. Write the names of the metamorphic rocks formed of Sedimentary rocks?
15. Write the names of metamorphic rocks formed from Igneous rocks.

Essay Type Question :

15. Classify rocks and describe in detail about metamorphic rocks.
16. Classify & describe igneous rocks.
17. Classify Sedimentary rocks and describe them in detail.

Answer Key

1. D 2. A 3. C 4. B 5. B

Lesson - 7

Earthquake and Volcanoes

Earthquake

The earth's crust constantly undergoes change due to endogenetic and exogenetic forces. Earthquake is a major sudden disaster caused due to endogenetic forces. The vibrations of the earth's crust is called Earthquake.

According to F.J. Monkhouse, the progression of devastating elastic waves in all the directions, due to the process of movement and adjustment of earth's layers is termed as 'Earthquake'. In simpler words, the earthquake can be defined as "Sudden vibrations on any part of the earth's crust caused due to endogenetic forces of the earth, is called Earthquake".

Causes of origin of earthquake : A temporary disequilibrium in any region of the earth causes earthquake. The factors that causes imbalance in this equilibrium of the earth are as follows:

1. Faulting : Due to the tension and contraction caused due to endogenetic forces, the rocks are cracked or fractured, which is called Faults. Earthquakes occur during such processes.

2. Volcanism : It is the major cause of an earthquake. During the volcanic eruption, the trapped gases pushes and gushes out with intense heat. This causes vibration on earth's surface.

A Etna, Krakatoa, Vesuvius, volcanoes caused devastating earthquake during their eruptions.

3. Water load : According to some scientists, due to the construction of dams, the accumulated water creates enormous weight, this

creates disturbances in layers of earth beneath the bottom of reservoir, which causes earthquakes. In December 1947, there was a massive earthquake in Koyna district of Maharashtra, it is believed that this earthquake was caused due to 'Koyna Dam'.

4. Contraction of the Earth : Some scientists proposed that, the contraction of the earth's crust is the major cause of the earthquake. According to them due to the constant radiation of heat from the interior of the earth there is loss of heat and the earth is cooling down when this process occurs rapidly and intensely, it causes earthquakes. Dana, Jeffery supported this belief.

5. Isostatic adjustment : Generally there is a state of equilibrium maintained between different geological landforms like mountain, plateau, plains and oceanic trenches, sometimes there is momentary disturbance in this equilibrium beds, this causes earthquakes.

The earthquakes in Himalayan regions are mostly caused due to this reason.

6. Elastic Rebound Theory : According to Prof. F.S. Reed rocks are like elastic, in nature and can be stretched upto a limit, after this it breaks. The broken parts regions it previous positions, which causes earthquakes.

7. Plate tectonic : Different plates at their margins converges diverge or transform. During these processes, the movements of plates causes earthquakes.

8. Other reasons : Besides the above mentioned causes, expansion of gases, disintegration of sea cliffs on coastal areas of sea, collapsing roof of the caves, generates earthquake

which causes minor effects. Besides these man-made causes include Atomic blasts. Blasts in the mining regions, deep drilling also generates earthquakes which affect the local regions. Fig. 7.1

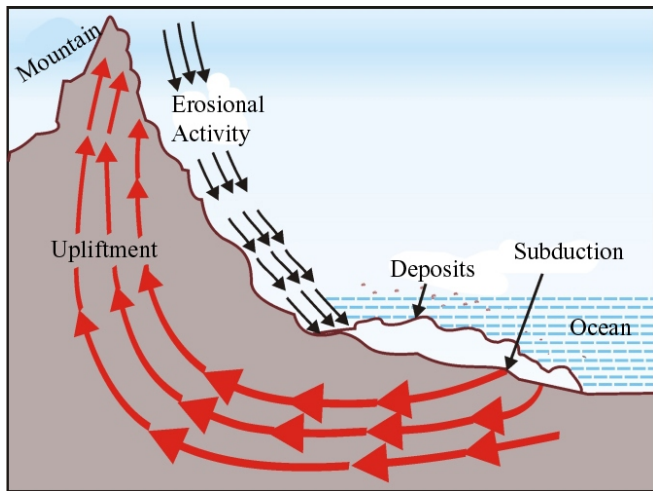


Fig. 7.1 : Isostatic Adjustment

Seismology : In seismology earthquake waves are measured through seismograph. The place of origin of an earthquake is called Focus.

The point of earthquake, which is perpendicular to the 'Focus is where the earthquake tremors are felt first is called 'Epicenter'. (Fig. 7.2)

Earthquake Waves : Due to the shock, at the focus of the earthquake, rocks vibrate which generate tremors. According to the progression pattern and the speed of the waves, its divided into three parts- P-Waves, S-Waves and L-Waves.

1. P-Waves : These are also called Primary Waves. These waves travel from the earthquake focus to the earth's surface, and are first to reach. The speed of these waves varies between 6-13 km per second when these waves pass through rocks. Vibrations in the rock particles is to and fro in direction of wave progression. These waves can

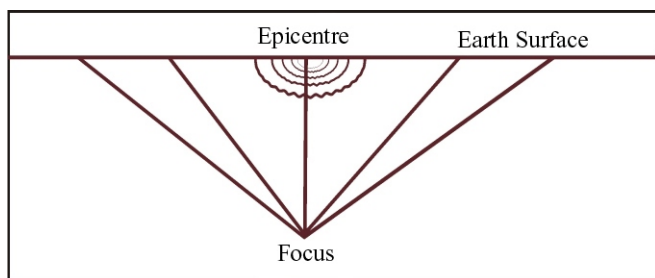


Fig. 7.2 : Focus and Epicentre

pass through all the these mediums solid, liquid and gas.

2. S-Waves : These are called Secondary Waves. The average speed of these waves is between 4 to 7 km per second. When these waves passes through rock particles, the direction of the movement of the particles is perpendicular to the progression of the waves. These waves can only pass through solids. They disappear in liquids.

3. L-Waves : These waves travel longest distances on earth's surface and progress only around the epicenter on the earth's surface. This is the reason why its called Longitudinal or Surface Waves. These waves travel at the speed of 3 kms per second. They causes enormous damage in the earthquake region. All the three waves are recorded at the Epicenter. Therefore the difference between them is not much known. But as the speed of these waves is different, the time for them to reach the epicenter is also different. Therefore these waves reach one after another, whereby can be clearly differentiated. (Fig. 7.3)

Pg and Sg Waves : They are similar to the P and S in property. But their speed is lesser. These waves progress near the earth's surface.

P* and S* Waves : The speed of these waves are more than Pg and Sg. These waves progresses in the middle region of the earth.

Types of Earthquake : Many types of earthquake affect different areas of the earth. On the basis of nature and causes of earthquake. They are classified under different categories -

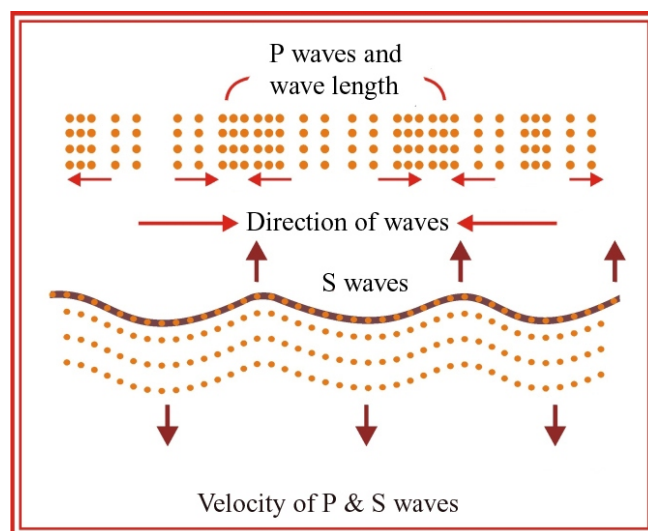


Fig. 7.3 : Seismic waves

1. Artificial Earthquake : These earthquakes are caused due to human activities. These earthquakes affect the local area and are less intense. For example - Mining, Atomic blast, Underground Atomic Experiments.

2. Natural Earthquake : These earthquakes are caused naturally and are active. Its different types are as follows :

(A) Volcanic Earthquake : Those earthquakes which are caused during volcanic eruptions are called Volcanic Earthquakes. Earthquakes occurred during Etna, Vesuvius, Krakatoa Volcanic eruptions are examples of Volcanic Earthquakes.

(B) Tectonic Earthquake : These earthquakes are structural, which are originated due to plate tectonics tension and contraction. These types of earthquakes are not generated at greater depths.

(C) Isostatic Earthquake : These earthquakes are caused due to imbalance in the isostatic balance of the earth. These types of earthquakes occur in the areas of young fold mountains like Himalayan Region, earthquakes in Hindukush and Nepal in 2015.

(D) Plutonic Earthquake : The earthquakes that occur very deep inside the earth are called Plutonic Earthquake. Not much is known about the origin and intensity of these Earthquakes.

3. Types of Earthquakes on the basis of Location.

(A) Land Earthquake : Earthquakes occurring on land are called Land earthquake. Most of the earthquakes of Mid Continental Plate are of this category.

(B) Marine Earthquake : The earthquake that occurs in the marine regions are called Marine earthquakes. These earthquake cause huge oceanic waves which are called 'Tsunami' in Japanese language. Due to massive earthquake in 2011 near. Honshu island of Japan. Fukushima city was completely destroyed.

World Distribution of Earthquake :

Most of the earthquakes occur in new fold mountain region, volcanic regions and coastal margins. These are those places, where isostatic balance is disturbed or the crust is weaker. Earthquakes occur at the plate margins. The major earthquake belts of the world are as follows :

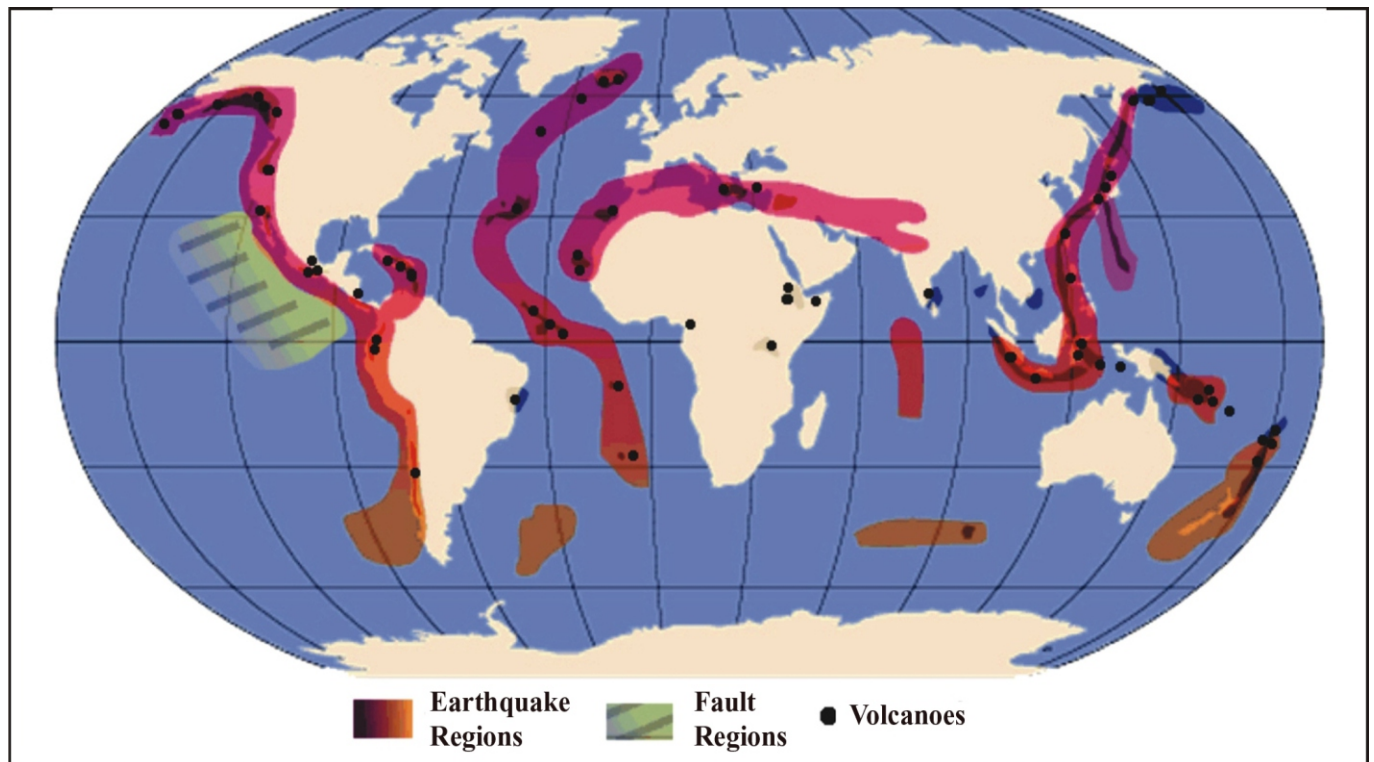


Fig. 7.4 : World distribution of Earthquake and Volcano

(1) Circum Pacific Belt :

This is the most extensive earthquake region of earthquake in the world 2/3rd of the entire earthquakes of the world occur in this region. This belt in form of arc, is situated in Pacific Ocean around continents and Oceans. The four major conditions of occurrence of the earthquakes are present here ie. ground bounding waters, new fold mountains, volcanic regions, divergence of plate boundaries. These include the western margins of North and South America. From Kamchatka peninsula of Asia to eastern Asian islands and Japan, Taiwan Philippines.

(2) Mid Atlantic Ridge Belt : This belt is situated near the Mid Atlantic Ridge in Atlantic Ocean which extends from western Island group of Atlantic Ocean to Bouvet island in the south. One of its branch extends from Nile valley to Great Rift Valley of Africa. Most of the earthquake occur in these regions due to metamorphism, formation of faults and volcanic eruptions Maximum earthquake occur near equator.

(3) Mid-Continental Belt : Its also called Mid-Equatorial belt. Earthquake occur in this region due to fault formation and isostatic balance. 21% of the entire earthquakes of the world occur in this region. This belt include from Portugal to Himalaya, Tibet and Southern, eastern islands groups. Indian earthquake region is part of this belt. The major regions are Italy, China, Asia Minor, Hindukush, Himalaya, Alps, Myanmar.

Effects of Earthquakes :

Earthquake is a natural disaster, which cause devastating effects on the earth's crust. The intensity of the earthquake is measured on Richter scale. It has 0 to 9 points. Each point ahead produces 10 times more intensity and 31.6 times more energy than the previous point. This system is, experience oriented system. It is seen in the context of the effects on human beings, which is from 1 to 12. Earthquakes bring devastating effects for humans. It has more harmful effects than benefit. So its a curse for humans.

Loss due to Earthquake

1. There is enormous loss of life and property due to earthquakes. Lot of people die, houses, dams, reservoirs gets destroyed.
2. Earthquakes breaks the rocks of the earth the

course of the rivers change, the transport system get damaged. High intensity earthquakes destroys the entire city.

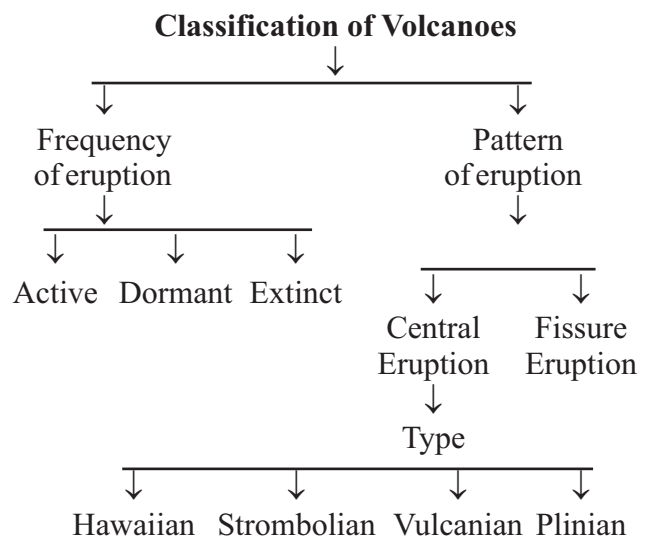
3. Earthquake cause Tsunami waves in sea, which submerge the coastal regions.

Benefits of Earthquake :

1. The Earthquake uplift the regions which positively impacts the climate of the region.
2. Fertile grounds emerges out of marine areas, which is useful for agricultural work. When the coastal areas subsides down, the harbours becomes deeper.
3. Earthquake helps to know more about internal structure of the earth.

Vulcanism :

Volcano is a sudden geological activity originated due to geological forces, in which gas, rock material and hot molten lava erupts out from fracture or a ridge. According to Wooldridge and Morgan. "**Volcanicity is an action which includes all the processes of earth's interior and exterior**".



In simple words vulcanicity is a very wide term which includes, the process of rock material formation, its flow, deposition and its solidification.

Causes of Vulcanicity :

(1) Isostatic Disequilibrium : Due to isostatic disequilibrium structural changes occur in geological areas, which causes volcanic activity.

(2) **Formation of Gases** : The water seeps into the earth's interior from cracks and fractures, this water is converted into steam and works as a propelling force during eruption.

(3) **Increase in temperature in earth's interior** : The radioactive minerals present in earth's interior constantly undergoes fission and releases enormous energy resulting in high temperature. Due to high temperature, rocks gets weaker and increases in volume, later volcano erupts from weaker margins.

(4) **Decrease in Pressure** : The upper layers of the interior of the earth remains in the solid state because of extensive pressure, as soon as pressure is released the rocks melts. This causes volcanicity.

(5) **Plate Tectonic** : The movement of plates, on earth's crust also causes eruption of volcano. When the plates are colliding, this process of volcanicity is more probable.

Types of Volcanoes : Volcanoes are classified on two basis :

(1) Frequency of Eruption (2) Nature of Eruption.

The classification on the basis of frequency of eruption is given in the following table.

(a) **Active Volcano** : In these types of volcanoes, eruptions occur frequently. Etna and Strombolian of Italy are the example of active volcano.

(b) **Dormant Volcano** : In these types of volcanoes. The volcanic eruptions occurs after dormant period. Vesuvius volcano of Italy is dormant type volcano in which the volcanic eruption occurred in 1631, 1812, 1906 & 1943.

(c) **Extinct Volcano** : The volcanoes in which there have been no eruption since very long period of time and its vent is filled with water, its called as extinct volcano. Mt. Popa of Myanmar, Koh-i-Sultan of Iran are the example of Extinct volcano.

(2) Classification of Volcanoes on the basis of pattern of volcanic eruption.

(a) **Central Eruption Type Volcanoes** : The volcanic eruptions in which the eruption is through a vent and a creator, its called central Eruption Volcano.

On the basis of emergence the central eruption type of volcanoes are classified as follows :

(i) **Hawaiian Types of Volcano** :

In this type of volcano, explosion is lesser and eruption is of silent type. The main reason behind this is thickness of lava and lesser intensity of gases. The example of these type of volcanoes are

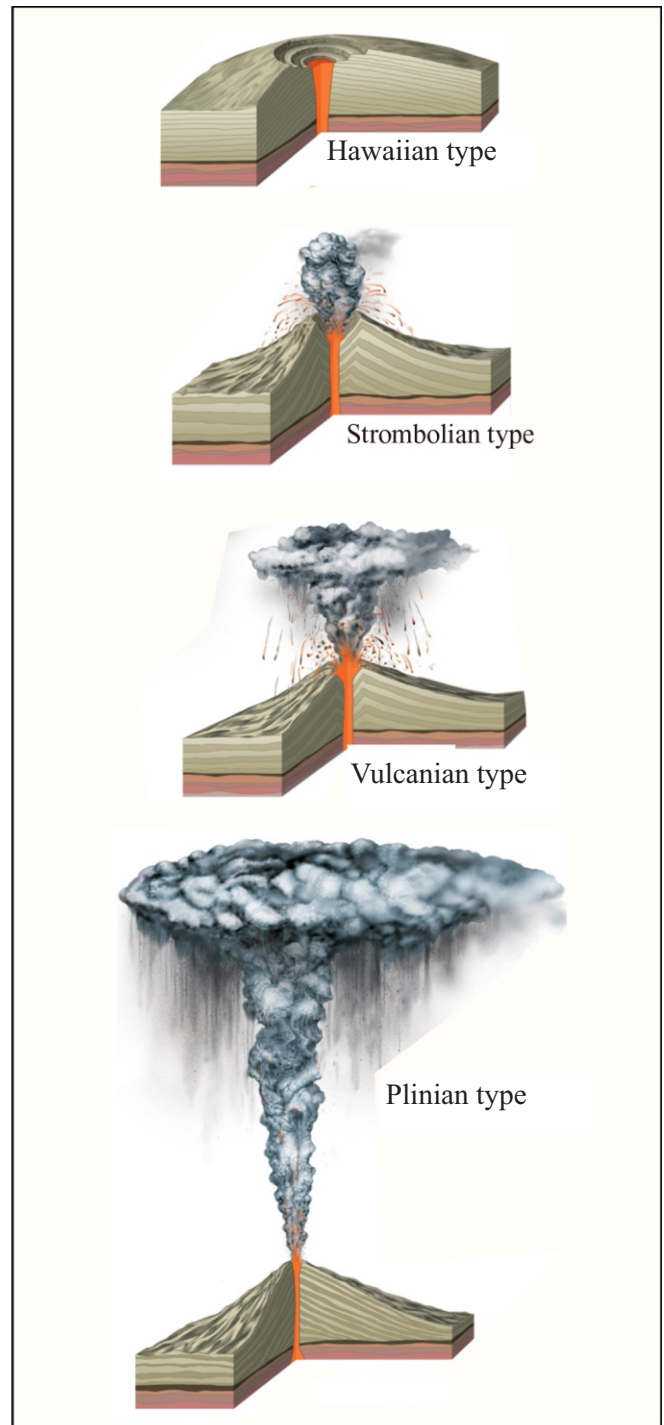


Fig. 7.5 : Types of Volcano

more in Hawaiian Islands. Therefore these types of volcano are name Hawaiian type of volcano.

(ii) Strombolian type of Volcanoes : The lava, in the these types of volcano is much thicker and erupt with greater intensity. Sometimes the eruption is explosive thus the volcano having this type of eruption and the volcanic eruption similar to this type is named strombolian type volcanoes.

(iii) Volcanic type of Volcanoes : The eruptions in these volcanoes is with huge explosion and eruption is of very great intensity and after the explosion, gases ashes, gases with dust, are emitted out in form of huge block cloud. It resembles the shape of a cauliflowers from a distance.

These types of volcanoes are named after the 'Volcano (the name of a volcano) which is located in the Lepari Island Group.

(iv) Plinian Type : In these types of volcanoes, the lava eruptions are most explosive and fierce and its also most devastating. In Martinique group of islands. The explosive volcano named 'Pelee' is located and the volcanoes with similar eruption type is named after this volcano.

(B) Volcanoes with Fissure Eruptions : In these type of volcanoes, the lava erupts selently from the fissures. The lava is mostly thinner resulting into formation of lava plateau. Columbian Plateau, Deccan Plateau are made up of Volcanic eruptions from fissures.

Material ejected out of Volcanoes :

1. Gases and water Vapour : Along with the eruption of earthquake, Carbon-di-oxide, water vapour, Sulphur-di-oxide, carbon-monoxide, Hydrochloric Acid, Amonia Chloride etc. gases are emitted out. Fumaroles are the sources of hot water, through which hot vapours and water are ejected out. Gases, acids and sulphur gushes out in form of jet. 'Solftara' is the name of one such fumarole.

2. Solid Material : The volcanic eruptions include eruptions like dust particles, ashes to huge bolders.

3. Liquid Material : The liquid rocks beneath the earth's surface is called Magma and when it comes out on earth's surface, it is called lava.

World distribution of Volcano :

World distribution of volcanoes is presented in form of belts :

1. Circum Pacific Belt : More than 2/3rd of

world's volcanic eruptions are found in this belt. This belt is extended all around in Pacific Ocean in coastal regions. The extension of this belt starts from Erebus of Antarctica including Rockies Andes mountains, turns from Alaska towards south eastern coastal regions and merges with Continental Plate. This belt include Fujiyama of Japan. Mt. Taal of Philippines, Mt. Shasta of Mt. Rainier USA.

2. Mid-Continental Belt : This belt is extended in Alps and Himalayan ranges. Mediterranean volcanic eruptions come under this belt. Mt. Varnon, Mt. Elbruz, Mt. Etna, Mt. Vesuvius, Stromboli are all included in this belt.

3. Mid Atlantic Ridge Belt : This belt is extended in Atlantic Ocean is form of English Alphabet 's'. This belt extends from Iceland in the north including Mid Atlantic Ridge to Antarctic in the south. Hekla, Katla, Ascension St. Helena, volcanoes are included in this belt.

4. East African Belt : This belt extends from Israel in the north. Red Sea in the south and from Rift valley in the east till Madagascar. Volcanoes of Elgon and Kilimanjaro are included in this belt.

5. Other Volcanoes : Besides these belts, some volcanoes are also extended in singular form, it includes the volcanoes on Hawaii Islands in Pacific Ocean. Mauritius, Comoro, Reunion Islands in Indian ocean.

Effects of Volcanoes

Positive or Constructive Effects- The volcanic eruption after scattering of lava, gives birth to highly fertile soil. The black soil of Indian Peninsula is an example of the beneficial side of volcanic eruption. The volcanic process has an important role in the development of various types of mineral belts.

Destructive Effects- The erupted lava along with other substances like gases, ashes result in loss of human lives as well as cultural landscape. There is mass destruction of life due to volcanic eruption, flooding of coastal areas and there is loss of marine acquatic plants and animals.

Important Points

1. Sudden vibrations on the earth's surface caused due to endogenetic forces of the earth's

- interior is called earthquake.
- Faults, Volcanoes, Construction of earth's crust, water load causes of earthquake.
 - Seismic waves are of three types- P-waves, S-waves and L-waves.
 - Volcanoe is a sudden activity caused due to endogenetic forces of the earth's interior, during which gases, rock materials and magma erupts out.,
 - Active, Dormant, Extinct, Central Erupting and Eruption from Fractures are some of the types of Volcanoes.

Exercises

Multiple type questions-

- The Etna volcano of Italy is which type of volcano from the following types?
(a) Active (b) Silent
(c) Extinct (d) Dormant
- The Vesuvius volcano, falls under which category of volcano?
(a) Active (b) Silent
(c) Extinct (d) Dormant
- Mt. Popo of Myanmar is which category of volcanoes?
(a) Active (b) Silent
(c) Extinct (d) Dormant
- The volcanoes which have a vent is kept under which category of volcanic types?
(a) Fissure Volcano (b) Central Eruption
(c) Extinct (d) Dormant
- The 'Deccan Trap Region' of India is made up of which volcanic type eruption?
(a) Fissure Eruption (b) Central Eruption
(c) Extinct (d) Dormant

Very Short Type :

- Define Earthquake.
- Name the materials emitted during volcanic eruptions.
- What are Secondary Waves?
- Give the names of two active volcanoes.
- Give the names of two extinct volcanoes.

Short Type :

- Explain Elastic Rebound Theory.
- Vulcanism causes earthquakes. Explain.
- Explain waterlod.
- Give the types of volcanoes.
- Give the examples of active volcanoes.

Essay Type :

- Describe the major causes of origin of the earthquakes and different types of seismic waves.
- Classify earthquakes and give their world distribution.
- Describe the causes of volcano and explain its classification.

Answer Key

1.A 2.D 3.D 4.B 5.A

Lesson - 8

Major Landforms

There is sufficient difference between various landforms visible on the earth's surface like continents, oceans, mountains, plateaus and lakes. Major landforms are divided into three different categories:-

1. Relief of First order - continents and oceans
2. Relief of Second order - mountains plateaus and plains
3. Relief of Third Order - Valleys and deltas etc. (Fig.8.1)

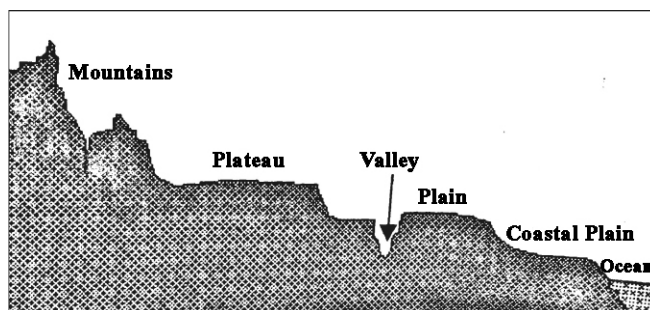


Fig. 8.1 : Major Landforms

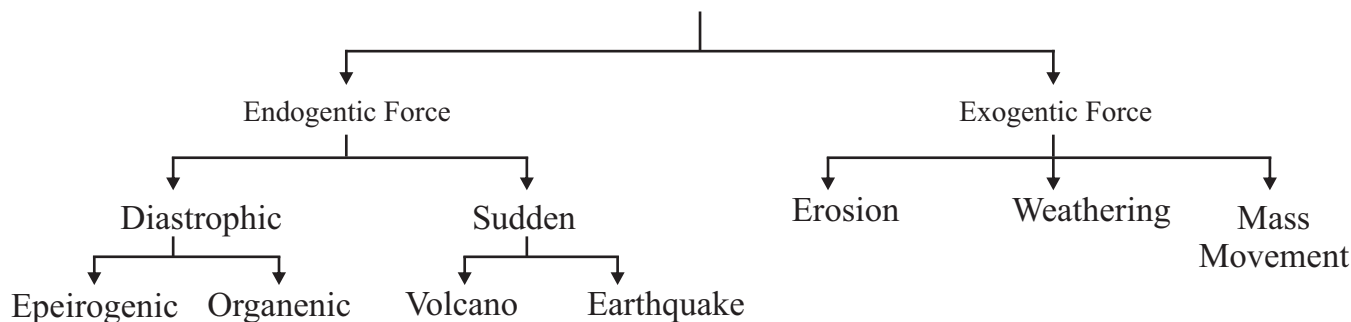
The formation of different landforms on the earth's surface is because of the interaction of endogenetic and exogenetic forces. These forces are classified into different categories as follows :-

Mountain

The landform which is elevated from its surrounding area , and has a pointed peak with steep slopes is called mountain.

According to Finch Mountains are 600m or

Table 8.1
Forces responsible for formatin of different landforms



600 metres above mean sea level and its slope varies from 260 to 350 degrees.

Types of mountains and their classification

1. Fold mountains

Due to the contractional forces of the earth's interior, folds appear on the earth's crust, these are called fold mountains. The uplifted area in form of fold, formed due to the contractional forces is called anticline and the down folded portion is called syncline. Intense geological activities uplift these anticlines and synclines and gradually the fold mountains are uplifted. Himalayas, Andes and Ural Mountains are the examples of fold mountains. These Mountains are the youngest mountains of the world, fossils are not found in these type of mountains. (Fig.8.2)

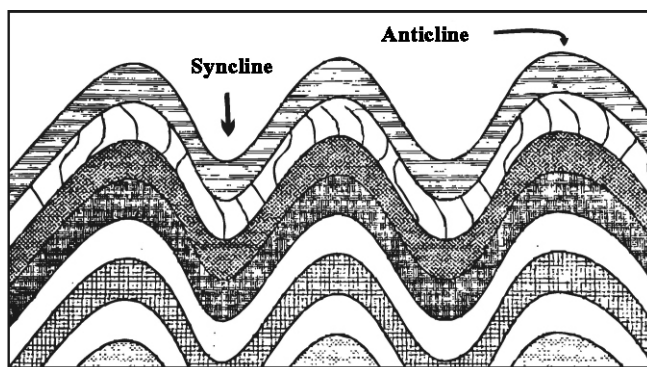


Fig. 8.2 : Folded Mountain

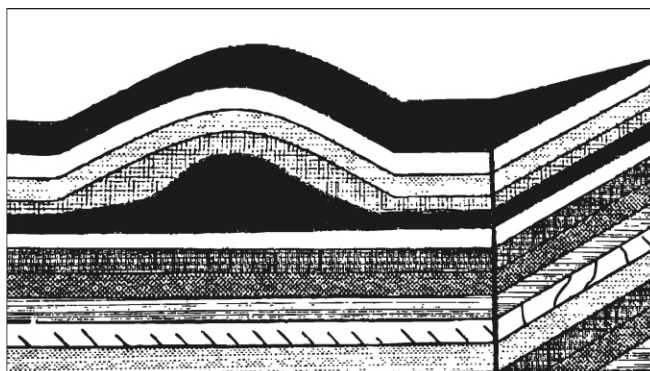


Fig. 8.3 : Dome Shaped Mountain

2. Dome shaped mountain

The hot molten magma attempts to move out to the surface of the earth, when this magma is not able to erupt, it uplifts the crustal rocks in form of a dome. Henry and Yunta ,of Utah Province of North America are examples of this types of mountain. (Fig. 8.3)

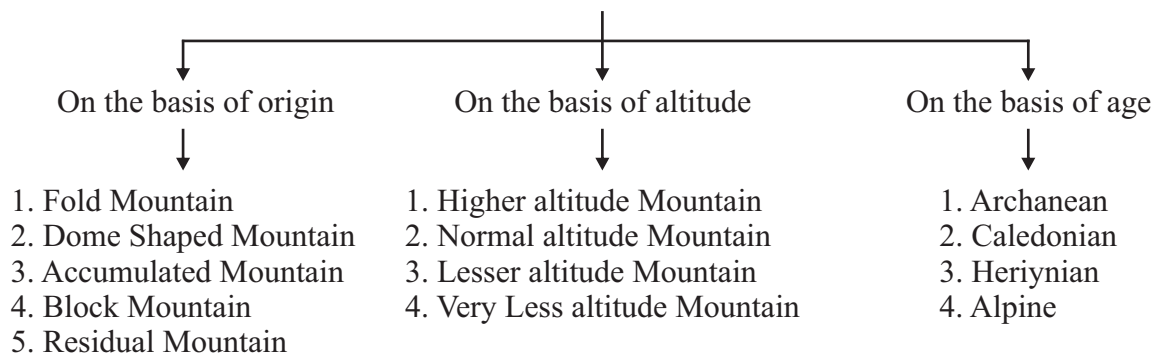
3. Accumulated mountain

These Mountains are formed of the huge heap of accumulated material and its deposition by wind, river, glaciers, waves and volcanoes. Fujiyama of Japan, Mt. Vesuvius of Italy, Kilimanjaro volcano of Africa are the examples of accumulated mountain. (Fig. 8.4)



Fig. 8.4 : Accumulated Mountain

Table 8.2
Classification of Mountain



4. Faulted or block mountain

When the central portion between the two parallel faults or fracture gets uplifted or the sides of the central region gets subsided down , it results into the formation of Block mountains. As it is formed of fault it is also called fault mountains.

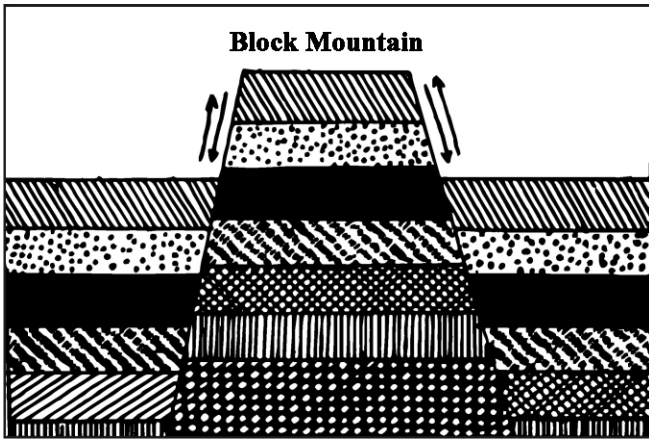


Fig. 8.5 : Block Mountain

5. Residual mountains

These are hard portions of the rocks which remains uplifted from its surrounding areas and is not affected by the agents of denudation like river, wind, sea waves, glaciers. When the river erodes the terrain and plateau is converted into flat plain but harder rocks are not eroded by the river , these left over raised portions take the form of residual mountains. (Fig.8.6)

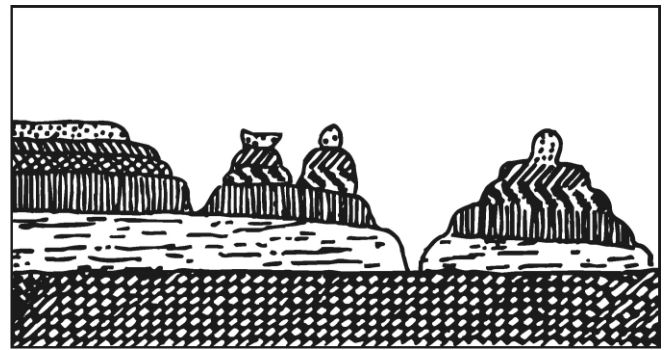


Fig. 8.6 : Residual mountains

of absolute no activity in between these activities . During this period, contractional force kept accumulating. due to which the following mountain building activities happened.

1. Archaean Mountain

Archaean mountain building activities occurred around 40 million years ago , during the pre-cambrian period. During this period Feno-Scandia of Europe and Aravalli mountains of India were formed.

2. Caledonian Mountains

Around 32 million years ago, during the previous mountain building activities, the appalachian mountains of America, Scandinavian uplands of Europe and mountains of Ireland were formed.

3. Hercynian mountains

Mountain building activities that occurred almost 22 million years ago are also referred as Altai, Variscan and Armenian activities.

Classification on the basis of age of mountains

So far four major mountain building movements have taken place. There has been period

**Table 8.3
Classification of Plateaus**

Basis			
Origin	Location	Development	Climate
1. Formed by Lava	1. Intermountane	1. Young	1. Humid
2. Formed by Glacier	2. Pedimont	2. Mature	2. Arid
3. Formed by Wind	3. Continental	3. Old	3. Snow covered
4. Formed by Water		4. Rejuvenated	

Tein Shan , Khingan and Altai mountains of Asia, Eastern cordillera of Australia, the Pennines of Europe are the mountains formed during this period.

4. Alpine mountains

Around 3 million years ago, the formation of fold mountains began. mountains included in this category are Himalayas Karakoram, Kunlun, Elburg, Hindukush, Rockies, Andes, Balkans , Pyrenees etc.

Classification of mountains on the basis of height

French has proposed these divisions-

1. High mountains

The height of these mountains varies from 6000 to 2000 m

2. Rugged mountain

These Mountains are mostly between 4500 to 6000 feet or 1500 to 2000m high.

3. Rough mountain

These are the with lesser height. Their height varies between 3000 to 4500 feet or from 1000 to 1500m.

4. Low mountain

Mostly these mountains are 2000 to 3000 feet on 700 to 1000 m high.

Effect of mountains on human beings

Mountains have been an important tourist destination. Mountains play an important role in entertainment, health benefits and adventurous mountaineering. Mountains have strategic and political importance. Mountains are the source of origin of many rivers which provides drinking water, irrigation, fishing and generation of hydroelectricity. mountains also affect the climate of the area and controls the rainfall. Mountain dwellers are mostly brave, healthy and simple.

Mountains have their own importance in reference to religion and mythology. Peaceful and isolated caves are centres of meditation and dwelling places of saints. Many pilgrimage sites are the gift of mountains. Badrinath, Vaishno Devi which are important pilgrimage sites are being

visited by thousands of devotees every year.

Plateau

Areas which are uplifted from their surroundings, having a flat and a broad top, having more than one, steep slopes are called plateau.

Classification of Plateau on the basis of origin.

1. Lava plateau

Lava from the interior of the earth when overflows over an area, forms Lava plateau. Columbia and Deccan Plateau of India are its example.

2. Glaciated plateau

These plateaus are located in higher latitudes like Labrador, Alaska and Scandinavia etc.

3. Aeolian plateau

These plateaus are formed because of the excess deposition of soil accumulated erosional work of the Wind. Potwar in Pakistan and Loess plateau in China are its best examples.

4. Acqueous plateau

The sediments which have been constantly being deposited in the oceanic regions or geosynclines, causing upliftment in sea beds due to endogenetic forces, resulting into formation of acqueous plateau.

Classification of plateaus on the basis of their location -

1. Intermontane plateau

As these plateaus are located between mountains they are called intermontane plateau. Tibet plateau is located between Himalaya and Kunlun mountains. (Fig.8.7)

2. Pedimont plateau

These plateaus are formed on the foothills of the mountains, having mountain on one side and sea or plain on the other. Petagonian plateau of Argentina is situated at the foothills of Andes mountain. (Fig.8.8)

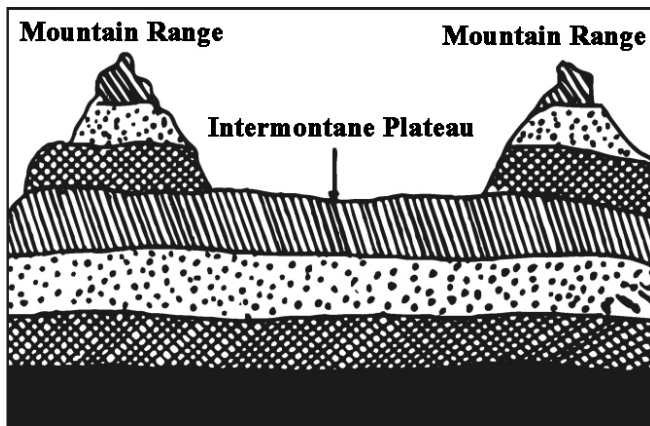


Fig. 8.7 : Intermontane Plateau

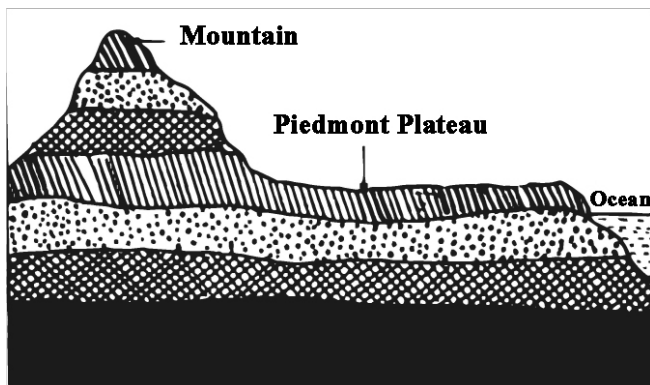


Fig. 8.8 : Piedmont Plateau

3. Continental plateau

These types of Plateaus are extended in the entire area of a country or a continent. for example Deccan Plateau , plateau of Greenland and plateau of Antarctica.

Classification of Plateau on the basis of climate-

1. Humid plateau

These plateaus mostly have 50% of humidity and good rainfall. For example plateaus of Meghalaya and Malagasy are included under this category.

2. Dry or Arid plateau

The amount of evaporation exceeds the amount of rainfall received thus dryness prevails on these plateaus example Tarim, Gobi and Potwar Plateau.

3. Iced plateau

Higher regions and higher latitudes are mostly covered with perpetual snow because of lower temperatures example Greenland and Antarctic plateaus.

Classification of plateaus on the basis of its stages of development -

1. Young plateau

These types of plateaus are separated from its nearby region with a steep edge. The rivers flowing on these plateaus creates deep valleys. Kolu plateau, which is on a river creates deep canyon.

2. Mature plateau

These plateaus have caves and ridges with highly uneven surface. the margins of these plateaus appear to be terrace form like Appalacian plateau.

3. Old plateau

The relief features of these plateaus are converted into flat Plains example plateau of Ranchi.

4. Rejuvenated plateau

Due to the endogenetic forces the old plateaus sometimes get uplifted and erosion begins again.

Importance of Plateau -

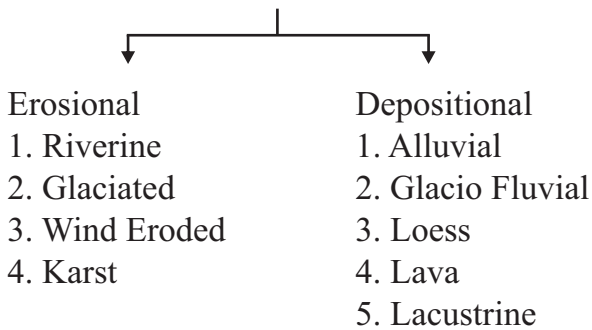
In reference to economy, plateaus are more crowded than mountains . intensive agriculture can be practiced on its fertile soil the store houses of minerals. Rivers creates waterfalls on its steep slopes. Reservoir can also be created on its hard surface. Means of transport are more developed in comparison to mountains. Plateaus are comparatively less developed than plains.

Plain

The part of earth's surface which is comparatively more flat, successive and gentler slope and have lower elevation is called plain. Plains have dissimilarities in refrence height above sea level. Like Polder plain of Holland is lower than sea level whereas the plains of the lakes in Kashmir are situated at the height of 1700 m. On the other

hand the northern plain of India extends from 8 metre high delta region to 200m high plain in Punjab.

Classification of Plain



Erosional plains

At the end of the cycle of erosion all the topographic features are turned into a plain.

1. Riverine plains

The rivers transform the undulating surface with their erosional work into flat plains. In these plains, hard rocks which are resistant to erosion are visible as small ridges and are called Monadnocks. The basins of Paris and London are the examples of these type of plains.

2. Glaciated plain

Higher mountain ranges and latitudes are mostly covered with snow. The surface beneath the snow undergoes attrition and abrasion, which turns the surfaces into flat plains. Glaciated plains are found in Canada, Sweden and Finland.

3. Wind eroded plain

Wind blows away the loose and broken rock pieces with mechanical erosion. The rocks lying in the direction of the winds get eroded through the process of abrasion by the wind. This abrasion results in the formation of Pediplain.

4. Karst plain

In the areas of limestone rocks, by the end of

the erosional cycle of the underground water, the topographical features are transformed into a Karst plain. The Karst plains of Nainital and Almora in India, Yugoslavia and France are its examples.

(B) Depositional plains

1. Alluvial plains

These plains are formed by the deposition of debris brought down by the rivers from higher elevations to the lower regions. These plains are called Piedmont plain or Deltaic plain on the basis of their locations. The Deltaic plains of Ganga Brahmaputra and Nile rivers are very fertile and thickly populated.

2. Glacial fluvial plain

These plains are formed by the deposition of glaciers. Till plains are formed by the deposition of boulders, rock pieces and sand brought down by the glaciers whereas Outwash plains are formed during the ablation of the glaciers when fine sand is deposited in form of plains.

3. Loess plain

These plains are formed in desert areas, due to the deposition of sand particles by the wind. Loess plains found in China, Argentina and near Caspian Sea are its remarkable examples.

4. Lava plains

These plains are formed with during volcanic eruptions when Lava, ashes and fine particles of rocks are deposited extensively. Lava plains are found in Southern parts of India.

5. Lacustrine plains

When the lakes get completely filled with sediments brought by the rivers, the deposited sediments, take the form of fertile lacustrine plains. Sometimes due to endogenetic forces when the bottom of the lakes are uplifted and the water spreads in the nearby surroundings, the bottom of the lake is transformed into a plain.

Importance of plains

80% of the world population, resides in plains. Major civilizations of the world like Indus Valley Civilization, Nile civilization, Babylon Civilization of Mesopotamia flourished in plains. This is the reason why plains are called cradle of civilizations. Plains are most suitable for transport communication, pastures and human habitat. As plains are flat the construction of railway lines, roadways and airports are much easier. Plains are best for all the different types of human activities. The densest places of the world are situated in plains.

Valleys

Valleys are mostly referred as 'Negative Topography' of rivers, but all the valleys are not necessarily formed by rivers. Diastrophism is also responsible for formation of valleys. Glaciers and underground water also form valleys. Valleys are actually underdeveloped or eroded trenches between the two slopes, formed by the tectonic movement or exogenetic forces.

Classification of valleys -

Valley is formed of tectonic movements. The valleys which are formed because of the movement due to endogenetic forces are included under this category. its following types are as follows-

1. Synclinal Valley

Due to tectonic activities, contractional forces causes folding of the rocks. This results in the formation of synclinal valley in the syncline of the folds.

2. Rift Valley

When the land between two parallel faults subsides down, Rift valley is formed. Valley formed by river Narmada is an example of Rift valley.

Valleys formed of exogenetic forces are as follows-

1. River valley

Rainwater erodes the surface of the earth

horizontally and vertically, which leads to the formation of River valley. The depth, width and the length of the valley develops it.

2. Glacial valley

The sliding snow from higher peaks of the mountain forms 'U' shape valley which is broad and has steep sides. Another Glacier joining the main Glacial valley, forms the hanging valley.

3. Blind valley

Due to the solution of the limestone rocks with river water, sinkholes are formed. The rivers often disappears in these sinkholes. The dry valley left after disappearance of the river into the sinkholes is called Blind valley.

Genetic classification -

1. Consequent valley

The valleys that corresponds to the slope of the surface are called consequent valley.

2. Subsequent valley

After the formation of consequent valley, this valley is formed along the strike dip of the slope. It is also called longitudinal valley.

3. Obsequent valley

This valley is formed by the tributaries of the rivers of the subsequent valleys. In these valleys the water in the streams flow opposite to the rivers of consequent valleys.

4. Resequent valley

These valleys are formed by the streams that flows in the direction as that of the consequent valleys.

5. Insequent valley

The valleys which remain unaffected by the structure and slope are called insequent valley.

Stages of valleys

1. Youth valley

During the youth stage Valley has a steep slope. The rivers erodes vertically due to which the depth of the valley increases.

2. Mature valley

In the Mature stage, the slope of the valley is reduced and it becomes more gentler, lateral erosion increases and the valleys start broadening.

3. Old valley

This may be called the last stage of the valley. In this stage the slope of the valley is negligible and the valley starts becoming flat.

Classification of valleys on the basis of structural trends-

1. Antecedent valley

Antecedent valleys are formed when part of the earth's surface on which river was flowing undergoes upliftment, the river does not change its course and continues flowing in the previous valley.

2. Superimposed valley

The valley built on the upper layers of the ground when it progresses in the same direction on rigid rocks is called a superimposed valley.

Classification on the basis of change in base level

1. Drowned valley

With the rise in sea levels, the opening of the valleys gets submerged, which is called a Drowned valley.

2. Rejuvenated valley

When the rivers flow below sea level, they erode the valley downward, due to which these valleys are rejuvenated.

Concept of development of landforms

Continents and oceans are the largest landforms on the earth's surface. Mountains, Plateaus and Plains are the landforms of the second order. The third order landforms are formed when the endogenetic forces work on these first order and second order landforms and none of these landforms formed on earth's surface is permanent. Whenever a new landform is formed because of the work of endogenetic forces, its degradation starts along with its development. Tethys sea existed at the place of the present day Himalayas. Mountains are eroded and take the form of plateau, Plateaus are eroded and take the form of plains, Plains get submerged and get transformed into sea. The cycle

of erosion continues. Many complexities are found in the development of landforms. All the continents and the oceans are formed by 20 major and minor tectonic plates. As the tectonic plates shift due to tectonic activities, many different types of landforms are formed on the plate margins. The concept of plate tectonics resolves many questions related to the formation of mountains, earthquakes, volcanoes and continental drift. In the same way Geomorphic cycle and cycle of erosion resolves many problems related to the development of the third order landforms.

Important points

1. Many landforms on the earth's surface are formed due to the work of endogenetic and exogenetic forces.
2. Range of fold mountains are the youngest mountains in the world. These mountains are formed of geosynclines.
3. Himalayas, Urals and Andes are the examples of young fold mountains.
4. A landform which is extensively high from its surrounding areas, has a steep slope and a conical top is termed as a mountain.
5. A landform which is of higher elevation from its surrounding areas, with a broader flat top and steep slopes, is called a Plateau.
6. A comparatively flatter area with a gentler slope, with negligible relief features is called a plain.

Exercise

Multi Choice Questions

1. Identify the first order landforms-
 - A. Deltas and valleys
 - B. Continents and Oceans
 - C. Mountains and Plateaus
 - D. Plains and Coasts
2. Which of the following forces is not an endogenetic force-
 - A. Volcano
 - B. Earthquake
 - C. Mountain building
 - D. Erosion

3. Which of the following is an example intermontane plateau-
 - A. Plateau of Patagonia
 - B. Plateau of Tibet
 - C. Plateau of Loess
 - D. Plateau of Malagasy

4. Which of the following is the example of accumulated mountain-
 - A. Himalaya
 - B. Fuji Yama of Japan
 - C. Ural
 - D. Andes

5. Which of the following is an example of humid plateau-
 - A. Plateau of Potwar
 - B. Plateau of Gobi
 - C. Plateau of Cherrapunji
 - D. Plateau of Tarim

Very short type questions-

6. Which are the youngest fold mountains of the world?
7. Which Mountains are called accumulated mountains?
8. Which type of valley is formed by river Narmada?
9. What are residual mountains?
10. What are pediment plateau?

Short type questions -

11. Write the names of Hersynian mountains.
12. Describe briefly about glaciated plateau.
13. What is intermontane plateau?
14. What is antecedent valley?
15. What is Mature plateau? Give examples.

Essay type questions-

16. Classify mountains
17. Classify plateaus on the basis of its origin.
18. Classify plains and highlight its importance.

Answer key -

1. B. 2. D. 3 B. 4. B. 5. C

Lesson - 9

Denudation

Landforms on the earth surface changes constantly. The endogenetic forces forms the asymmetrical landforms (mountains, plateaus, plains etc.) and the Exogenetic forces work constantly on these landforms to erode them to flat surfaces. The process through which the lowest rocks on the earth's surface are exposed is called denudation. There are different processes involved in denudation which are as follows-

1. Weathering-

It is a static process in which the rocks broken down through disintegration and decomposition.

2. Erosion-

It is dynamic process , in which the rocks are moved through the processes of attrition, abrasion and are shifted or transported to other places.

3. Mass movement-

The movement of the eroded material under the impact of gravity along the slope is called mass movement.

Weathering

The breakdown of rocks because of mechanical and chemical activities through the processes of disintegration and decomposition is called weathering.

The factors affecting weathering -

1. Structure and composition of the rocks

The Rocks which are porous and are composed

of soluble minerals are affected more by chemical weathering. The rocks with vertical layers undergo mechanical weathering and the rocks with horizontal layers undergo chemical weathering.

2. Slope of the land

Weathering is comparatively lesser in the areas of gentler or negligible slope than in the areas of steeper slopes.

3. Difference in climate

Tropical and humid areas undergo more of chemical weathering whereas tropical and dry areas undergo more of mechanical weathering.

4. Effect of vegetation

Vegetation marginally act as a factor that causes weathering as well as it marginally also inhibits weathering. The areas which are not covered with vegetation undergoes more of weathering.

Types of weathering

On the basis of the factors that contribute in the disintegration and decomposition the rocks are classified under the following different categories-

1. Physical weathering

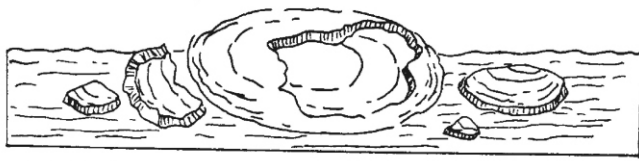
The process of the disintegration of rocks due to solar radiation, water and frost is called physical weathering.

A) Block disintegration

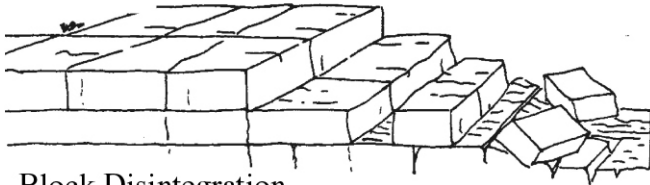
In the desert areas, when the rocks undergoes disintegrated into large pieces due to high daily range of temperature it is called block disintegration. (Fig No 9.1)

B) Exfoliation

When the outer layers of the rocks are peeled



Exfoliation



Block Disintegration

Fig 9.1 : Physical weathering

off because of constant heating and cooling, it is called exfoliation.

C) Frost weathering

The repetitive freezing and melting of the water in the cracks of the rocks exerts tremendous pressure and physically breaks the rocks, this type of weathering is called Frost weathering.

D) Pressure release

Whenever the excess pressure is released by the upper layers of the rocks, the lower rocks cracks due to this release of pressure.

2. Chemical weathering

The disintegration, solution decomposition and formation of new compounds due to the action of chemical processes of water and gases on the rocks is called chemical weathering.

A) Oxidation

The atmospheric oxygen dissolves in water and convert the minerals present in the rocks into oxides, this process is called oxidation. Oxidation increases the rate of weathering. The minerals that contain iron are more affected.

B) Carbonation

The atmospheric carbon dioxide mixes with the oxygen in water and forms carbonic acid. This carbonic acid is a strong solvent for limestone rocks.

C) Desilication

The removal of silica from the rocks is called Desilication process. In humid areas, due to the work of water, silica is separated from igneous rocks and the rocks further undergoes weathering.

D) Hydration

When the minerals of the rocks absorbs

water it is called hydration. Rocks like Bauxite, Feldspar etc absorbs water, as a result it becomes heavier and later the rocks are further broken down.

E) Solution

When the rainwater dissolves many acids and carbonic elements it becomes a chemical mixture. This process is called hydrolysis.

3. Biological Weathering

Many Plants and animals contribute in biological weathering on the earth surface.

A) Weathering caused by vegetation

The roots of many trees enters the rocks and loosen the rocks particles, further causing the breakdown of rocks.

B) Weathering by animals

The rodents like rats or other creatures like Termites, Earthworms disintegrates the rocks.

C) Weathering by humans

Human activities like agriculture, mining and construction also causes weathering.

Erosion

Erosion is derived from the Latin word 'Erodere' meaning wearing or tearing. Erosion is a continuous process in which, the rocks are worn off, eroded and transported by the work of agents of erosion like glaciers, underground water, waves, winds and rivers. The rivers, glaciers, wind, waves erodes the rocks in following ways:-

1. Abrasion

When the agents of denudation (Rivers, Glaciers, Wind, Waves) carries the rock boulders, pebbles cobbles, along with them, the valley floors are eroded. This process is called Abrasion.

2. Attrition

Attrition is the process of collision of the boulders, cobbles and pebbles against each other resulting in their fragmentation in the course of action of Wind, River and Waves.

3. Hydraulic Action

The erosion of the rocks due to excess of water pressure exerted by the river is called hydraulic action.

4. Corrosion or Solution

Due to the chemical action of the water, rocks get dissolved in water, this process called

solution or corrosion.

5. Deflation

The process of the lifting and blowing away of sand particles from the rocks by the action of wind is termed as deflation.

6. Cavitation

The waves generated in the river whirls, often drill deep holes in the floor of the river valleys. Riverine caves and pools are examples of this type of erosional work.

7. Plucking

The process in which the debris along the course of glacier is extracted from the valley floor and is transported along with the glacier is called plucking.

The eroded material is transported in 3 ways-

1) Solution

The materials are dissolved and transported along the water.

2) Suspension

The eroded material remains floating in the water and is transported along with the course of water.

3) Traction

The gravels, pebbles, cobbles and boulders travel along with the water by leaping and jumping along the valley floors, this is called traction.

Deposition

As the speed and slope gradient reduces, the capacity to carry the debris by the agents of denudation also reduces. The deposition of the eroded material results in formation of sedimentary rocks.

Mass translocation

The transportation of rock material in huge quantities under the impact of gravitational force along the slope gradient is called mass translocation. Rock wastes get accumulated along the bottom, after being slid from the slopes. This accumulated rock waste is called Talus. When

the rock waste is accumulated in form of a cone it is called Talus cone. Mass translocation is classified under three different categories on the basis of speed and quantity of loosened rock material.

1) Slow speed mass translocation

Due to the lesser moisture content disintegrated rock waste slides slowly.

The process of slow drifting is more frequent in subpolar areas. This slow drift also includes processes like Solifluction, Rock creep, Talus creep, Soil creep.

2) High speed mass translocation

Due to abundance of water the drift of rock waste is at very high speed. High speed drift includes Earthflow, Mudflow and Sheet Wash. The sliding mudflow can easily be visible on the slopes of the valleys.

3) Very high speed mass translocation

In this type of drift availability of moisture is not important. Huge boulders suddenly fall down under the impact of gravity. It includes landslides, rockslide, rockfall, debris slide, debris fall and slump processes.

Cycle of Erosion

American geologist William Morris Davis proposed the theory of cycle of erosion in 1899. He described

"The cycle of erosion is a period of time during which an uplifted landmark undergoes its transformation by the process of land sculpture ending into a low featureless plain"

David further described that

"Landscape is a function of structure process and stage"

(i) Structure - On any part of the earth's surface, the structure of the rocks are first to be formed, formation of other landforms occurs later.

(ii) Process- The Process refers to the formation or lowering or erosion of landforms through agents of denudation (like river, winds, waves, glaciers,

underground water etc.) One of these processes somehow plays an important part in the transformation of landforms.

(iii) Stage- Similar to the life span of human beings, the cycle of erosion involves three stages like stage of youth, stage of maturity and stage of old age. The duration of these three stages depends on the mobility of the processes and the composition of rocks.(Fig. No. 9.2)

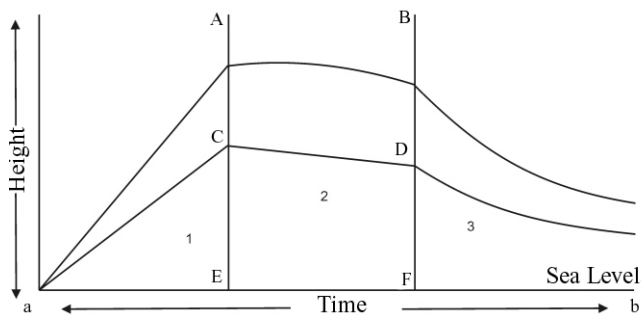


Fig. 9.2 : Cycle of Erosion of Davis

1. Youthful stage

During this stage the rivers deepens the valleys with vertical erosion

2. Mature stage

In this stage the rivers broadens the valleys through lateral erosion.

3. Old age stage

In this stage the topographic regularities are reduced and the entire region is turned into a Peneplain.

Penck's cycle of erosion

A German geographer, Walter Penck, has proposed the cycle of erosion as sum total of interactions between the phases of development, rate of a upliftment and the degradation of landforms.(Fig No.9.3)

1. First Phase

According to Penck, upliftment and erosional processes occurs at the same time. There is more of upliftment in comparison to erosion.

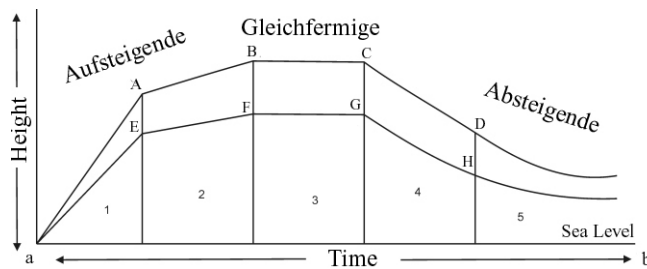


Fig. 9.3 : Cycle of Erosion of Penck

2. Second Phase

During this phase, the processes of upliftment and erosion occurs simultaneously, as a result the valleys get broader and more deeper.

3. Third Phase

In this phase, due to the competitive state between the processes of upliftment and erosion, the difference between the upper and the lower curves remains same, from the base level.

4. Fourth Phase

In this phase the rate of upliftment is reduced whereas erosion is progressive with the same rate as it was in the previous phase. This results into the deepening of the valleys and lowering of Doabs.

5. Fifth Phase

The rate of upliftment as well as erosion becomes slower and weaker. The difference of both the curves from base level is also reduced.

Difference between the view points of Davis and Penck

1. According to Davis the erosion starts after the upliftment of the landform but according to Penck the upliftment and erosion of landforms starts simultaneously.
2. Davis believes that the upliftment takes place in very short period of time where as Penck believes that the upliftment takes longer period of time.
3. The cycle of erosion as proposed by David involves youth stage, mature stage and old stage whereas the Penck cycle of erosion describes Aufsteigende pertaining to increase in rate, Gleichförmige meaning

uniform rate, and Absteigende meaning reduced rate.

4. According to Davis, the cycle of erosion describes landform as the work of structure, process and time. Penck proposes formation of landforms as the result of rate of upliftment and degradation.
5. The cycle of erosion as proposed by Davis completes in three stages where as the cycle of erosion proposed by Penck undergoes through 5 phases.

Important points

1. Denudation is the sum total of activities of erosion, weathering and mass movement.
2. The disintegration and decomposition of rocks at their own place is called weathering.
3. The word erosion is derived from latin word Erodere meaning wearing or tearing.
4. The process of collision of boulders, pebbles, and rock particles against each other which are being transported by rivers or waves is called Attrition.
5. The process of removing or blowing of loose particles of sand or dust by the action of the wind is termed as deflation.
6. According to William Morris Davis landscape is a function of structure, process and stage.
7. According to Penck the process of upliftment and erosion start simultaneously.

Exercise

Multiple choice questions

1. The disintegration and decomposition of rocks is called
 - A) Denudation
 - B) Erosion
 - C) Weathering
 - D) Solution
2. What is Denudation?
 - A) erosion and transportation
 - B) erosion and deposition
 - C) erosion weathering and mass transportation
 - D) erosion and solution

3. The process of exfoliation is mostly found in these regions in which -
 - A) Higher annual range of temperature
 - B) Higher temperature
 - C) Lower temperature
 - D) Higher daily range of temperature
4. Which place undergoes accelerated rate of chemical weathering?
 - A) Tropical and dry
 - B) Polar regions
 - C) Tropical and humid
 - D) Cold and humid
5. The transportation of huge rock debris under the impact of gravitation, along the slope is called...
 - A) erosion
 - B) weathering
 - C) mass translocation
 - D) transportation

Very short type questions-

6. Which kind of weathering is oxidation?
7. What do you mean by erosion?
8. Attrition takes place in erosion or in weathering?
9. Which kind of weathering is block disintegration?
10. Which kind of weathering is carbonation?

Short type questions-

11. Describe briefly the meaning of denudation.
12. Write the types of weathering.
13. What is plucking?
14. What do you mean by solution?
15. Explain physical weathering.

Essay type questions

16. Clarify the meaning of weathering and describe its different types.
17. Explain denudation and describe its different types in detail.
18. Explain the concept of cycle of erosion.

Answer Key -

1.C. 2.C. 3.D. 4.C. 5.C

Lesson - 10

Agents of Erosion

Indogenetic and exogenetic forces form different landforms on the earth surface. The exogenetic forces (weathering, erosion and mass translocation) transforms the outer layers of the rocks. The structure of landforms constantly undergoes changes due to these exogenetic forces and new landforms are also formed.

Erosion is a static process. The forces which contribute in erosion like rivers ,sea waves, winds ,glaciers and underground water are called the agents of erosion. It is not always necessary that these agents of erosion work in the same way and at the same speed, the other factors like climate and composition of rocks and their structure also affects erosion.

The factors which play an important role in the erosional and depositional work of different landforms, on the earth's surface are as follows:-

1. River - Fluvial topographies
2. Sea Waves - Coastal topographies
3. Wind - Arid Topographies
4. Glacier -Glaciated tomographies
5. Underground water - Karst topographies

River -Fluvial topographies

The flowing water in the valley, erodes the valley bottom and its sides and carries the eroded material along with it and deposit it at some other places. This process of erosion and deposition gives birth to many landforms.

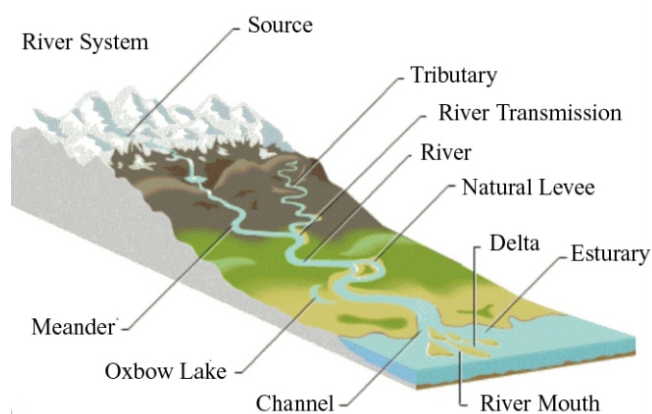


Fig 10.1 : Fluvial Topographies

A) Erosional topographies

1. **Gorge** - It is a narrow deep valley with almost vertical sides.
2. **Canyon**- These are comparatively more narrower and more deeper valleys than Gorges.
3. **Waterfalls** - When the river water plunges almost vertically from a higher level to lower level it forms water fall. (Fig 10.2)
4. **Rapids** - The river appears to be jumping over the hard rocks which leads to the formation of rapids. (Fig 10.3)
5. **Pot Holes** - The holes created in the bottom of the valleys as the result of the drilling action of water are called pot holes.
6. **Structural benches**- When the hard and the soft rocks are arranged horizontally in the course of the river differential erosion results in the formation of structural benches.

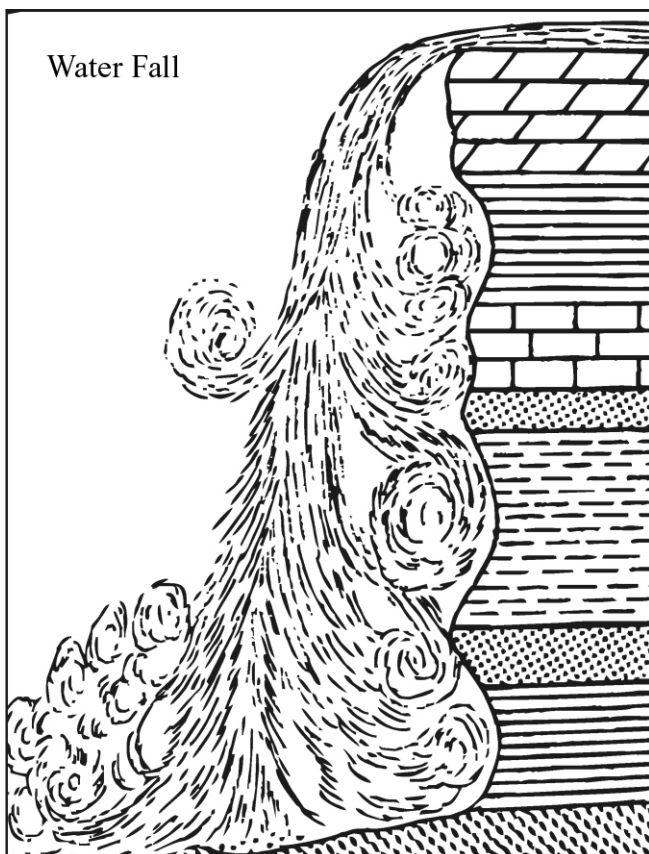


Fig 10.2 : Waterfall

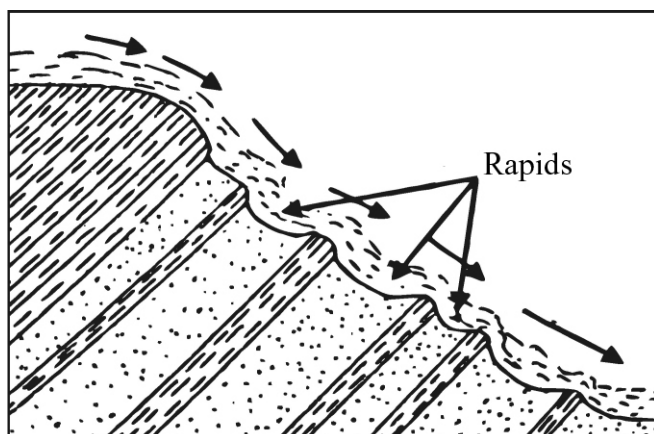


Fig 10.3 : Rapids

7. **River meanders** - The river bends in the latter stages of fluvial erosion in a serpentine manner, which are called meanders.
8. **Peneplain** - This is a featureless plain formed by the river with a very gentle slope.

B) Depositional topographies

1. **Alluvial cone** - When the rivers progress from the mountain slopes towards the valley floors, the deposition of eroded material in form of cone is called Alluvial cone. (Fig 10.4)
2. **Alluvial fan** - The deposition of sediments brought by the river on the foothills of the mountains in the form of fans, are called Alluvial fans. (Fig 10.4)
3. **Delta** - The triangular shape deposition of sediments at the mouth of the river is called delta. (Fig 10.1)
4. **Natural Levees**- The sand materials deposited at the banks of the river on both of its sides are called natural levees.
5. **Flood plain**- The part of the river where it deposits all the sediments during the floods leads to the formation of floodplain.
6. **Oxbow lake**- When the rivers follow a straight course leaving behind its meanders, these meanders are filled with water, these are called oxbow lakes. (Fig 10.1)

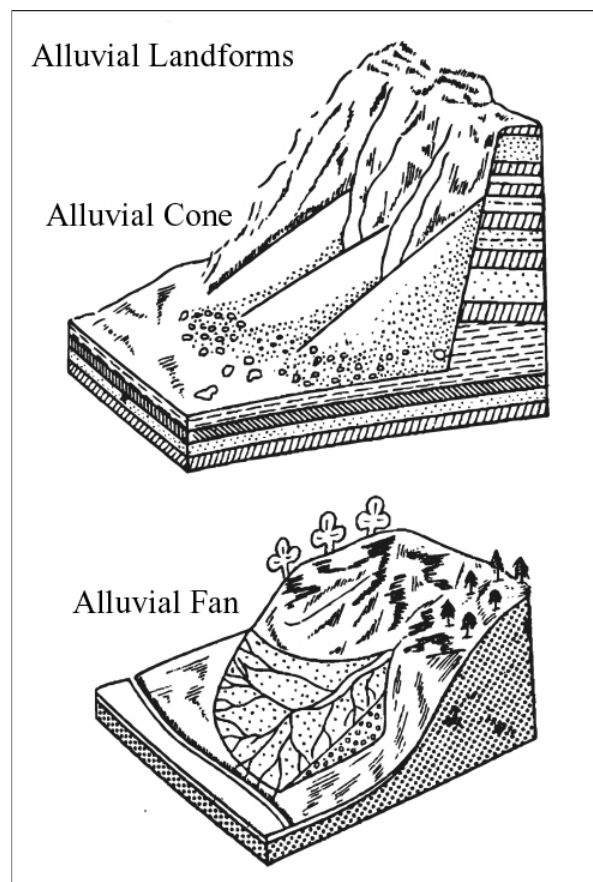


Fig 10.4 : Alluvial Cone and Fans

Sea waves- Coastal topographies

The movement of the water under the impact of the wind is termed as a wave. The sea waves forms many erosional and depositional landforms in the coastal regions through the erosion and deposition of sediments, resulting from the processes of abrasion, attrition and hydraulic action.

A) Erosional topographies

1. **Cliff**- The formation of vertical coast due to the hydraulic action of the sea waves are called Cliffs.
2. **Caves**- The formation of oval shaped cavities parallel to the coast due to the erosion of hard and soft rocks are termed as Caves.
3. **Sea Caves**- In the coastal areas when the grooves are constantly eroded by the sea waves, it results into formation of sea caves.
4. **Blowout**- When the sea waves forms a hole on the roof of the sea caves, it is called as blowout.(Fig.10.5)
5. **Arches** - In the coastal regions, when the two caves are formed adjacent to each other, arches are formed.(Fig. 10.5)
6. **Stack**- Due to the collapse of arches stacks are formed. (Fig. 10.5)
7. **Wave cut platform** - These platforms are formed as the Cliffs and they constantly recedes backward from the coast.

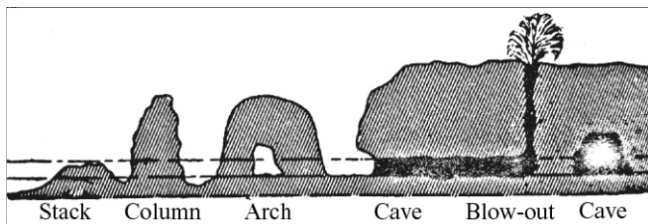


Fig. 10.5 : Coastal Topography

B) Depositional topographies

1. **Beach** - The deposition of the marine sediments on the sea coast forms the sea coast.
2. **Cusp beach**- A triangular beach which is formed of cobbels, boulders and sand and that extends seaward is called cusp beach.
3. **Spit**- The formation of an embankment due to deposition along the coast line towards the sea

is called spit.

4. **Bars**- The elongated depositions of shingles much parallel to the coastline are called bars.
5. **Offshore bars**- When the bars are formed away from the coastline but parallel to it, its called Offshore bars.
6. **Hook** - The semi circular depositional spits are called hooks.
7. **Loop**- The land along the growth of the hook are called loop.
8. **Connecting bars**- When the spits joins or connects two headlands or islands it is termed as connecting bars.
9. **Lagoon and Bay Bars**- When the two edges of a bay are connected by a wall or a barrier formed of deposits, it is called Bay bars and the closed bay is called Lagoon.
10. **Tombolo**- The bar that connects the islands with the mainland is called Tombolo.

Wind - Arid Topographies

The erosional and depositional work of the wind forms many landforms in the desert regions. Wind through the process of attrition, ablation and abrasion erodes the rocks and then transport the eroded material extensively in the desert region this results in formation of many erosional and depositional landforms.

A) Erosional Topographies

1. **Blow out** - The troughs or trenches which are formed due to the ablation of the wind are called blowout.
2. **Inselbergs** - These are steep sided hills of hard Rocks rising from a plain region in the vast deserts. They often resemble like an island or a mountain.(Fig. 10.6)
3. **Mushroom rock** - These are actually residual of the hard rocks which takes the shape of a mushroom. (Fig. 10.6)
4. **Demoisells**- These are earth pillars which are protected by hard rocks as a outer cover. (Fig. 10.6).
5. **Dreikanter**- A rock piece which is braided and polished by wind blown sands in the deserts is called Dreikanter.
6. **Stone lattice**- The pitted and fluted rock

surfaces which contains lots of holes formed by the powerful winds in the deserts are called stone lattice.

7. **Zeugen** - They are in form to deep cuts in the layers of the rocks of varying hardness due to the erosional work of winds. (Fig. 10.6)
8. **Yardang**- These are the steep sided over hanging ridges parallel to the direction of the winds in the deserts. (Fig 10.6)

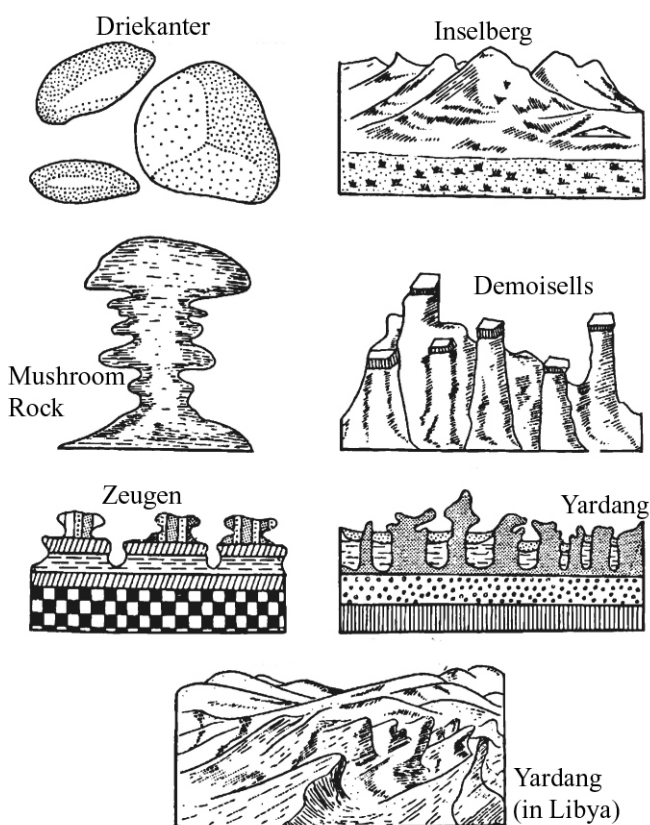


Fig. 10.6 : Arid Topography

B) Depositional topographies

1. **Sand dunes**- These are heaps or mounds of sands that move continuously along with the wind in the deserts.
2. **Ripples**- These are marks produced on the sand dunes perpendicular to the wind direction.
3. **Sand drift**- These are longitudinal accumulation of sands around the obstacles and moves along with the wind in the deserts.
4. **Sand Levees**- These are sand ridges having a broad and longitudinal peak.

5. **Loess** - The deposition of the fine sand particles by the deflation process of the winds is called Loess.

Glaciers- Glaciated Topographies

Glaciers are the mass of ice that drift slowly on the earth's surface, from the place of their accumulation. The glaciers in the higher latitudes erodes the rocks in through the process of plucking and abrasion, the eroded material is then deposited in form of moraines. This erosional and depositional work of the glaciers forms many different landforms.

A) Erosional topographies

1. **"U" shaped Valley** - Glaciers transforms the pre existing river valleys into 'U' shape valleys. These valleys have steep slopes, broad and flat valley floor. (Fig. 10.7)
2. **Hanging valley** - These valleys are formed by the tributary Glacier which joins the main glacier valley and appears to be hanging in the main glacier valley. (Fig. 10.7)

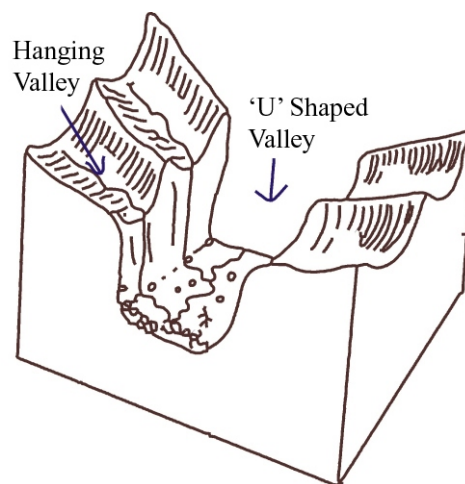


Fig. 10.7 : "U" shaped and Hanging Valley

3. **Cirque**- The armchair shaped depression formed in a glacial valley is called cirque. (Fig. 10.8)
4. **Tarn** - A basin formed at the floor of the cirque due to the glacial erosion is called tarn.
5. **Nunatak** - The higher peaks of the ridges that

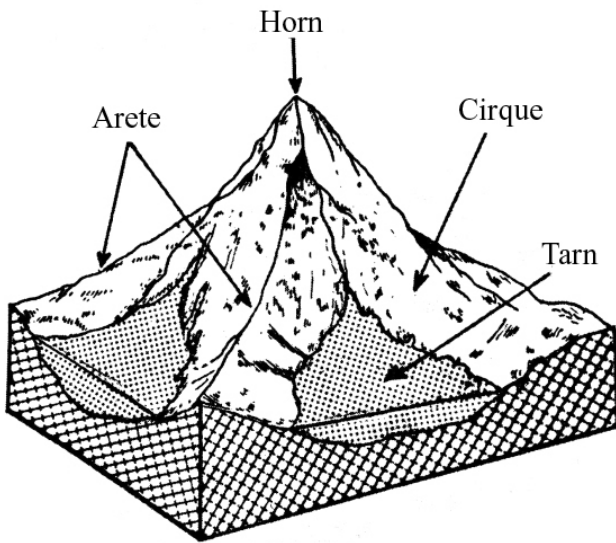


Fig. 10.8 : Glaciated Topography

projects from the ice sheets are called Nunatak.

6. **Col-** It is a pass or a gap formed when two adjacent cirques combine.
7. **Craig and tail-** This landform is characterized by vertical eroded steep sides and a tail like appearance on its other side which is lower.
8. **Sheep rock-** These are hillocks eroded by

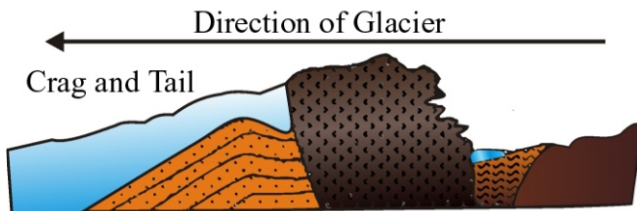


Fig. 10.9 : Craig and Tail

glacier and resembles a sheep's back.

9. **Fjords-** These are highly distorted coasts of the submerged glaciated valleys.

B) Depositional topographies.

1. **Moraines-** These are formed by the deposition of glacier debris which includes pebbles, boulders and cobbles. Moraines are deposited at sides of the glaciers, and its floor or at the end of the glaciers.
2. **Esker -** These are long, narrow and wavy low ridges formed by the deposition of glacial

debris.

3. **Kame -** It is a steep sided ridge or a conical hill formed by glacial moraines.
4. **Kettle-** These are depressions formed due to the melting of glacial blocks.
5. **Drumlin-** These landforms are formed of boulder clay and often resemble a basket of eggs.
6. **Outwash Plain-** The fan shaped extensive deposition of glacial debris in larger region by glacial meltwater is called Outwash plain.

Ground water - Karst topographies

The water present in holes and cracks beneath the earth surface is termed as groundwater. Many different landforms are formed by the ground water through the process of solution in the regions of Limestone rocks. The region of limestone rocks are called Karst region. The origin of the word 'Karst' is from 'Krass' word meaning 'region of limestone' in Yugoslav language. The word Karst region has been taken from Karst region of Yugoslavia. The limestone topography in the entire world having the similar characteristic of Karst region of Yugoslavia is called Karst topography, where many erosional and depositional landforms are formed.

A) Erosional topographies.

1. **Terra- Rossa -** Red and brown soils is formed due to solution are called Terra-Rosa.
2. **Lapies-** It is highly rugged and rough surface of limestone region with pinnacles. (Fig. 10.10)

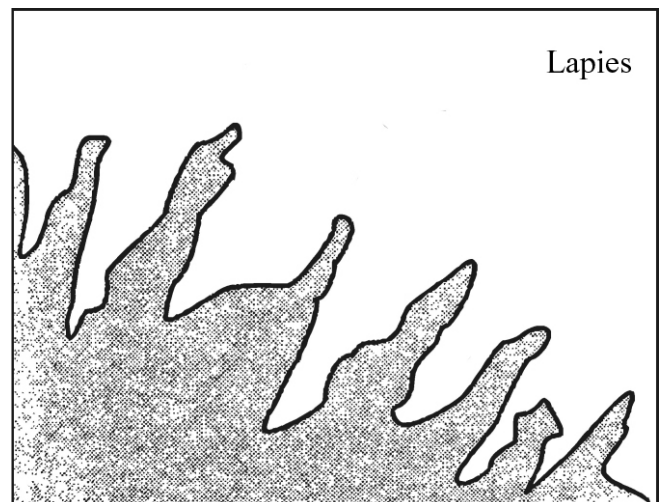


Fig. 10.10 : Lapies

- Sink Hole** - These are sinkholes formed due to solution process of carbonated water. Swallow hole and Doline are sinkholes of same kind which are larger in size respectively. (Fig. 10.11)

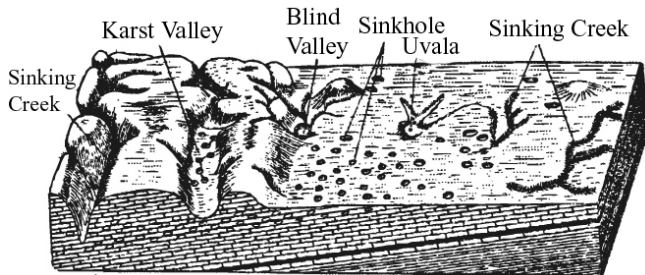


Fig. 10.11 : Karst Erosional Topography

- Swallow Hole** - These are larger depressions than the sinkholes.
- Doline** - These are larger size of swallow holes.
- Uvala**- When many dolines merge together, it leads to the formation of Uvala.
- Polije**- These are formed when many Uvalas merge together.
- Sinking Creek**- Due to the presence of many sink holes on the surface of limestone, water disappears through them and the topography resembles 'a sieve', this type of landform is called Sinking Creek.
- Blind valley**- The river goes underground through sinkholes or dolines in limestone topography, the valley seems to be dry, this

type of valley is called Blind Valley.

B) Depositional topographies

- Stalactite**- The hard, solid and sharp depositional features hanging downwards from the ceiling of caves, formed due to the evaporation of carbonated water are called stalactite.
- Stalagmite**- The pillar shaped depositional features that are formed due to dripping of carbonated water on the cave floors are called stalagmite.
- Cave Pillar** - When stalagmite and stalactite merge together cave pillars are formed.
- Drip Stone** - Smaller pillars on the floor of the caves that resembles a curtain is called drip stones.
- Nodules** - The deposition of a type of a mineral solution in the holes of the rocks are called Nodules.

Important Points

- Rivers, Sea waves, Winds, Glaciers and Underground water are major agents of Erosion.
- When rivers follows a straight course instead of meandering, the left off curved portion filled with water is called Oxbow Lake.
- Gorges, Waterfalls, Rapids, Alluvial cones, Natural levees and Deltas are some of the major landforms formed by the rivers.
- Cliff, Caves, Beach, Cusp beach, Spit, Bars Lagoon, Bay bars etc are major landforms formed by of sea waves.
- Blow out, Inselberg, Mushroom rock, Driekanter, Zuegens, Yardang, Loess etc. are major features formed by the work of winds.
- Tarn, Hanging valley, Nunatak, Craig and Tail, Kame etc are major landforms formed by the work of glaciers.
- Terra Rosa, Lapies, Sink holes, Dolines, Stalactites, Stalagmites etc are landforms formed by the work of underground water.

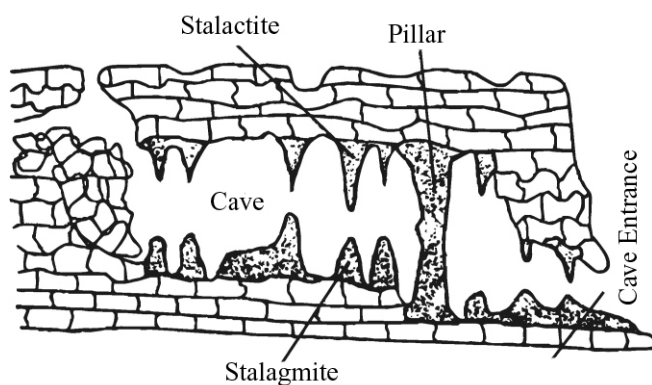


Fig. 10.12 : Karst Depositional Topography

Exercise
Multiple choice questions

1. The landscape formed by the deposition of river is-
A) Gorge
B) Alluvial Fan
C) Pot Holes
D) Waterfall
2. Landscape which is formed by waves is-
A) Cliff
B) Delta
C) Mushroom rock
D) Doline
3. Which of the following landforms is not formed by erosional work of the wind-
A) Sandune
B) Mushroom rock
C) Inselberg
D) Zuegen
4. Which landform of the following is not formed by the work of Glacier-
A) Fiords
B) Glacial Stairways
C) Craig and tail
D) Esker
5. The wavy formations in the deserts perpendicular to wind direction are called-
A) Sand Levees
B) Ripples
C) Barchans
D) Loess

Very short type questions-

6. What are Alluvial fans?
7. What are gorges?
8. What do we call the basins of cirques when filled with water?
9. Name the landform which is also called "the basket of eggs topography" .
10. What are Yardangs?

Short type

11. How are oxbow lakes formed?
12. How are lagoons formed?
13. How are mushroom rocks formed?
14. What is Blind Valley?
15. What are Cirques?

Essay type

16. Describe the landforms formed by the river.
17. Describe the landforms formed by the Glacier.
18. Explain erosion and describe the different landforms formed by its agents.

Answer key

1. B. 2. A. 3. A. 4. D. 5. B

Lesson - 11

Atmosphere: Composition and Structure

The atmosphere is the enclosure of the air which extensively surrounds our Earth. This enclosure of air is in a form of an envelope which has become an integral part of the our earth due to earth's gravity. This air is colourless, tasteless and odourless. We can feel wind because of the movement of air.

The gaseous cover around the earth is called atmosphere which is thousands of kilometres in height. The atmosphere can not be separated from the Earth like the lithosphere and the hydrosphere. No human being or organism can live without the air. Air is the basis of all living creatures on earth.

Importance of atmosphere

The gases like oxygen, nitrogen, carbon dioxide, hydrogen and many other useful gases are found in atmosphere. Atmosphere as our cover protects us against harmful effects of ultraviolet rays.

This may be the reason why the atmosphere has been a matter of curiosity for all of us, since the beginning of mankind. The temperature and humidity present in the atmosphere influences human life. Atmosphere presents us with its natural scenes and its composition keeps us alive.

Composition of Atmosphere

Atmosphere is the mixture of gases. Apart from gases, water vapour and dust particles are also found in atmosphere. There are 9 different types of gases in our atmosphere, of which Oxygen,

Nitrogen, Argon, Carbon dioxide, Hydrogen, Helium Neon, Krypton and Ozone are the major gases.

The most important gas for all the living organisms is Oxygen in our atmosphere. No one on the earth can survive without oxygen. The highest amount of gas in our atmosphere is Nitrogen, which contributes about 78.8% of the total atmosphere. Oxygen is next that contributes about 20.95%. In this way both these gases contribute about 99% of the total volume of the entire atmosphere.

Important characteristics of some gases

1. Nitrogen -

This gas is maximum in our atmosphere. We are aware of air pressure, force of wind and the reflection of light due to presence of Nitrogen in our atmosphere. This gas is colourless, odourless and tasteless. This gas controls combustion. This gas helps the plants to prepare proteins which is an important part of food. If Nitrogen gas would have not been there in the atmosphere, it would have been very difficult to control fire. This entire process is called Nitrogen cycle. (Table & Fig 11.1)

2. Oxygen -

It is considered vital for life on the earth. Oxygen gas easily combines with other chemical elements and creates different types of compounds. This gas is important for combustion. Therefore it is an important source of energy. It also plays an important role in the formation of carbohydrates.

Table - 11.1
Percentage of Gases in the Atmosphere

Sr. No.	Name of Gas	Formula	Percentage
1	Nitrogen	N ₂	78.8
2	Oxygen	O ₂	20.95
3	Argon	Ar	0.93
4	Carbon dioxide	CO ₂	0.03
5	Neon	Ne	0.0018
6	Helium	He	0.0005
7	Ozone	O ₃	0.00006
8	Hydrogen	H ₂	0.00005

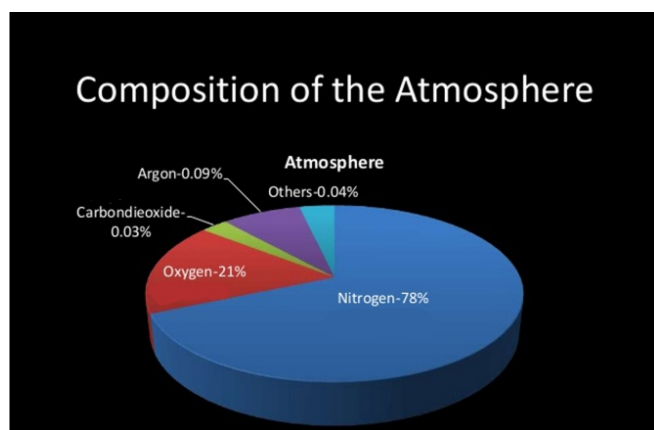


Fig. 11.1 : Composition of the Atmosphere

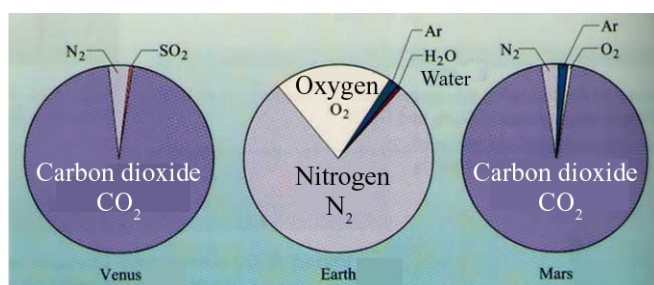


Fig. 11.2 : Status of Carbon dioxide on Venus, Earth and Mars

3. Carbon dioxide

It is a heavy gas. It is emitted during combustion. All type of vegetation dioxide during the process of photosynthesis. According to scientist, it is believed that the increase in the amount of carbon dioxide, causes increase in the temperature in the lower layers of the atmosphere. Global temperatures are rising and climate is also changing.

4. Ozone-

It is another important gas of the atmosphere .It is formed from three atoms of oxygen.This gas has special significance in terms of climate.It absorbs some part of the harmful ultraviolet radiation coming from the sun.Thus, only that proportion of solar radiation is allowed to reach the earth's surface that is necessary and useful.

5. Water vapour-

Water vapour is mostly concentrated near the lower layers of the atmosphere. With the increase in height there is decrease in the amount of water vapour in the atmosphere.90% of the entire water vapour in the atmosphere is found up to the height of 8 kilometres. Beyond this height , the amount of water vapour is very less in the higher layers of the atmosphere. The average amount of water vapour in the atmosphere is 2%.

Water vapour absorbs some percentage of solar radiation coming to the earth and retains the heat which is being reflected back into the atmosphere. Thus water vapour works as a blanket ,as it does not allow our earth to get extremely warm or to get extremely cold. Condensation of water vapours results in rainfall.

6. Dust particles -

The dust particles which are minute, also moves along with the movement of winds. There are many different sources of these dust particles. This include minute particles of dust, sand, sea salt, volcanic ash, meteoric dust. These dust particles mostly remain in the lower layers of the atmosphere.

Apart from gas and water vapour, whatever

is there in the atmosphere in a solid form, will be called as dust particle. Due to the presence of dust particles in the atmosphere, sky appears to be blue in colour.

In comparison to humid regions, relatively more dust particles are found in the industrial cities and in arid regions.

Structure of Atmosphere

Atmosphere is divided into many layers. Generally, on the basis of the vertical distribution of temperature in the atmosphere, it is divided into the following five major divisions-

1. Troposphere
2. Stratosphere
3. Mesosphere
4. Ionosphere
5. Exosphere

1. Troposphere

This is the lowest layer of the atmosphere, 75% of the total atmospheric volume is concentrated in this layer. The average height of this layer above the Earth's surface is 13 km, at equator it is 18 km and at poles it varies from 8 to 10 km. It is considered to be the most important layer of the atmosphere as most of the weather conditions occurs in this layer.

The decrease in temperature with the increase in height is the most important feature of this layer. There is a decrease of 6.5 degree Celsius per 1 km which is also called as 'Normal lapse rate of temperature.' Changes in the weather and climatic conditions that influence human beings occur in this layer. In this layer dust particles and water vapours are more in quantity, which when condenses, causes rainfall and other weather and climatic conditions. This layer is the area of intensive study for climatologists.

The uppermost layer of troposphere is called tropopause. It has a thickness of about 1.5 kms. Atmosphere is more stable above the layer. It is also called "Roof of the weather changes". The temperature does not decrease beyond 20 km from this layer.

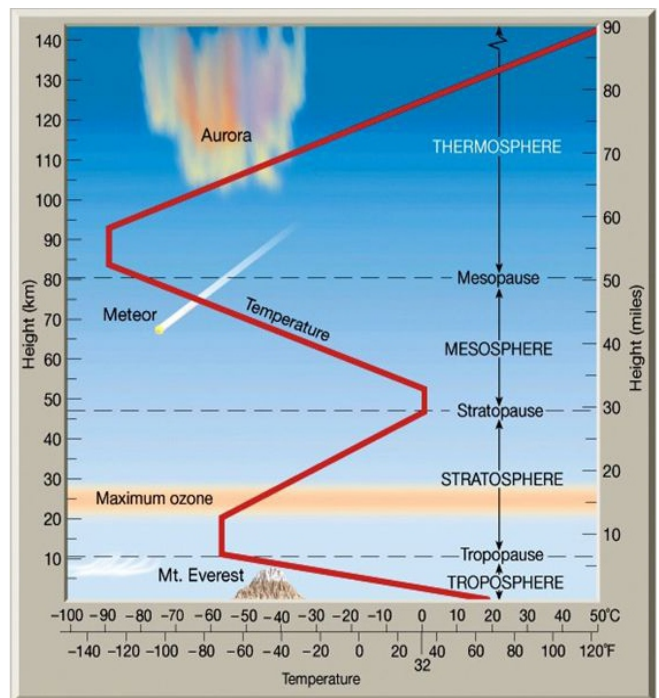


Fig. 11.3 : Structure of the Atmosphere

2. Stratosphere

The average height of this layer is approximately 50 kms from the earth's surface. This layer is thinner at the equator and thicker at the poles. Many scientists have considered Ozone Layer to be a part of stratosphere and because of this its estimated thickness of this layer ranges from 50 to 55 kms. Ozone Layer is found in this layer. It absorbs the harmful ultraviolet rays from the incoming solar radiation.

3. Mesosphere

This layer extends about 80 km beyond stratosphere. In this layer there is a gradual decrease in temperature with increase in height and decreases upto -80°C . The temperature again starts increasing beyond this. In this layer the pressure is extremely low. The upper most part of the mesosphere is called Mesopause Sphere.

4. Ionosphere

This layer extends from 80 to 400 km of height from Mesopause Sphere. The existence of

this layer was known because of the radio waves. The dust particles present in this layer are electrically charged. The electrically charged particles are called as ions. Thus this layer is called Ionosphere. The temperature of the upper limit of this layer is 1100 °C. Aurora is also visible in this region. This layer is also called as Thermosphere.

5. Exosphere

This is the outermost layer of the atmosphere. The availability of wind is rare in this layer and the outer margins of this layer merges with the space. There is no upper limit of this layer, but many scientist are of opinion that its height is up to 1000 kms.

Elements of Weather and climate

The atmospheric conditions of a particular place at a particular period of time is termed as weather. Therefore the atmospheric conditions are understood clearly with the help of weather.

The factors like temperature, pressure, rainfall, humidity helps to know more about weather. These factors are called elements of weather. The weather conditions keeps on changing. Therefore the weather of a place also keeps on changing. This change of weather from one day to the other, from one place to the other place are caused due to the differences in quantities, activity, and distribution of elements of weather. The factors that control this change of weather elements are called "Controls of weather". These include, latitude, uneven distribution of land and sea, pressure, height above sea level, mountains as barrier, nature of the earth surface, wind disturbances.

Important points

1. Atmosphere surrounds the earth from all sides.
2. Atmosphere works as a huge house made up of glass.
3. About 99% of atmosphere is made up of nitrogen and oxygen gases. Rest 1% is contributed by other gases like argon, carbon dioxide, hydrogen, helium, ozone, neon and xenon.

4. The other components of atmosphere also include water vapour, dust particles smoke and salt particles.
5. There are five layers of atmosphere- Troposphere, Stratosphere, Mesosphere Ionosphere, Exosphere.
6. The elements of the weather include temperature, pressure, rainfall and humidity etc.

Exercise Multiple choice-

1. The gas which is maximum in atmosphere is.....
A) Carbon dioxide
B) Nitrogen
C) Oxygen
D) Argon
2. The weather conditions occurs in which layer of the atmosphere?
A) Stratosphere
B) Troposphere
C) Ionosphere
D) Mesosphere
3. Which layer is called the "Roof of weather conditions"?
A) Troposphere
B) Ionosphere
C) Stratosphere
D) Mesosphere
4. The average amount of vapour present in atmosphere is...
A) 1 percent
B) 2 percent
C) 3 percent
D) 4 percent
5. The most extensive layer of atmosphere is..
A) Stratosphere
B) Troposphere
C) Ionosphere
D) Mesosphere

Very short type

6. How many types of gases are found in atmosphere?
7. What are dust particles?
8. What is stratosphere?
9. Where do we find ozone layer?
10. Which layer of the atmosphere has maximum concentration of helium gas?

Short type

11. What is atmosphere?
12. Which are the major gases that are found in atmosphere?
13. What is the importance of water vapour and dust particles in our atmosphere?
14. What are the major characteristics of troposphere?
15. Write the importance of atmosphere and describe its layers.

Essay type

16. Describe the concentration of atmosphere in detail.
17. Describe the layers of atmosphere in detail.
18. "The atmosphere is the core of life on the earth". Analyse scientifically.

Answer Key

- 1B. 2B. 3A. 4B. 5D.

Lesson - 12

Insolation and Heat Budget

The atmospheric cover which is thousands of kilometres thick protects our earth from scorching solar radiation and extensive heat from the Sun. During night, the atmosphere does not allow the heat generated by Terrestrial radiation to be lost in space, thus keeping the environment warm. The earth is situated 15 million kms away from the Sun. The other sources of heat energy except for sun are negligible. The sun is a glowing gaseous body that radiates energy constantly. It takes 8 minutes 20 seconds for the sunrays to reach the earth's surface.

Insolation

The radiation which reaches the earth's surface from the sun is called Insolation, and the radiation emitted from all around the sun is termed as Solar radiation. The absorption of solar radiation by the earth is called Insolation. According to Critchfeild " Radiant energy from the sun that strikes the earth, is called insolation"

The solar radiation which is received by the earth is called insolation but the entire solar radiation does not reach to the earth's surface, some portion of this solar radiation, gets absorbed by the atmosphere. The energy from the solar radiation reaches the earth's surface in form of short waves. According to Trewartha 'the amount of energy received by entire earth from the sun every minute is equal to the energy mankind uses for its various activities for the entire year.' Thus this solar energy received by the earth is responsible for all the

physical and biological phenomenon. In this way the portion of solar radiation received by a particular place, for a particular period of time is called as insolation and its not uniform at every place. The Solar radiation is measured by " Pyranometer".

Distribution of temperature

The distribution of temperature is not uniform at all the places on the earth's surface. In comparison to the other factors which affect the distribution of temperature, latitudes play the most dominant role. The ancient Greeks had the knowledge of the fact that the temperatures are higher at the equator and it tends to decrease towards the polar regions. On this basis, our earth is divided into 5 heat zones by them. We hardly differentiate between solar radiation and temperature but both are different and still they are interrelated, as temperature depends on solar radiation. Here temperature is referred to heat in the

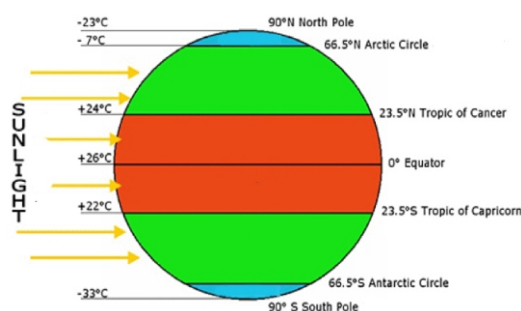


Fig. 12.1 : Temperature zones and horizontal distribution

atmosphere, which has its source from the Sun.

Horizontal distribution of temperature

Central distribution of temperature means latitudinal distribution of temperature. Changes in the temperature is observed as we move from equator towards the poles. Isotherms are imaginary lines joining the areas of similar temperature on the map.

The minimum and maximum temperatures are recorded in the months of January and July, respectively in the entire world. Therefore the months of January and July are chosen for the analysis of the temperature.

Isotherms of January

As the sun rays shines vertically in the southern hemisphere on Tropic of Capricorn, Summer season prevails in Southern hemisphere and Winter season prevails in Northern hemisphere. Therefore during this time period, the temperatures are more in Southern hemisphere in comparison to Northern hemisphere. The most coldest areas during this period lies in Siberia and Greenland. Isotherm of 25° C is drawn on Siberia. Isotherms of 30°C are drawn on the southern continents and the 10°C isotherm is parallel to the latitude in Southern hemisphere whereas 20°C isotherm is bent according to the distribution of continents and oceans. Isotherms are mostly curved due to uneven distribution of water and land in the northern hemisphere

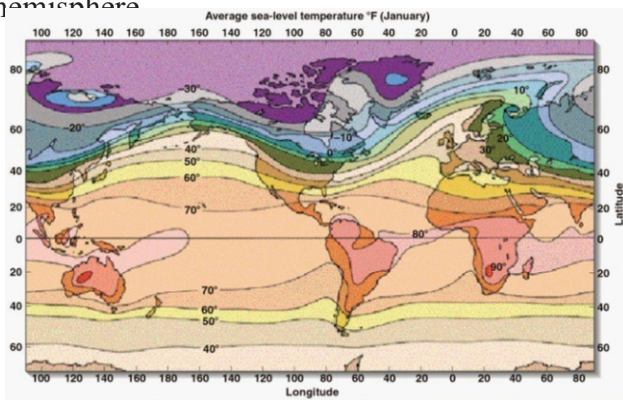


Fig. 12.2 : Isotherms in January

Isotherms of July

The sun shines vertically over the Tropic of

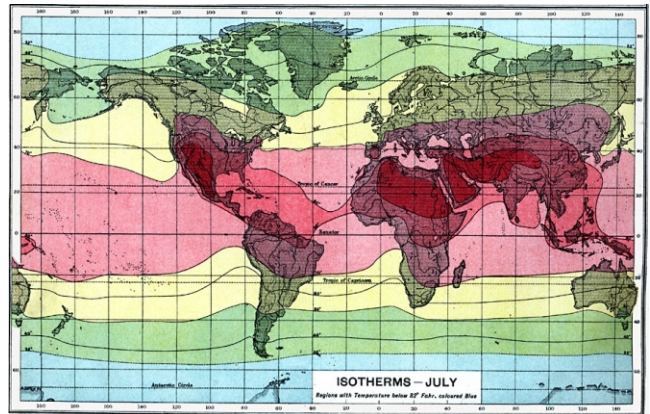


Fig. 12.3 : Isotherms in July

Cancer in the month of July in Northern hemisphere. Therefore it is summer season in the Northern hemisphere and winter season in the southern hemisphere. The isotherm of 30°C passes over North Africa, South-West and Central Asia and from Columbian plateau in North America.

When we compare the isotherms of January with that of July, it is clear that the effect of summers is more extensive in the month of July. Antarctica observes negligible temperatures during this period. The isotherms are drawn almost parallel to the latitudes in the southern hemisphere.

Vertical distribution of temperature

By Vertical distribution of temperature we mean the distribution of temperature above the Earth's surface in different layers of atmosphere in terms of height. The scientist have proved the fact that with the increase in height there is a decrease in temperature. This is the main reason why the hilly regions are much cooler than the plains. There is a decrease of 1°C for every 165 m. This is called Normal lapse rate of temperature. This rate of decrease of temperature is not uniform everywhere, it tends to change with seasons, location and local irregularities. Normally the temperature decreases at the rate of 6.5°C per km. This rate of decrease in temperature continues till Troposphere. Beyond this the temperature changes with the change in atmospheric layers.

Temperature Anomalies

During temperature anomalies the

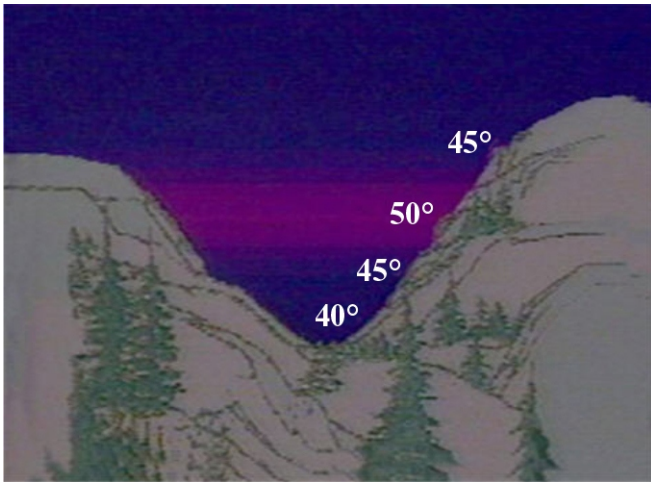


Fig. 12.4 : Temperature inversion in the valley

atmospheric conditions are stable. In normal conditions the temperature decreases with the increase in height but in some conditions with the increase in height, the temperature also increases. The condition in which the temperature increases with the increase in height is called temperature anomaly. The geographical conditions like long nights, clear sky, calm wind, dry wind and snowfall are the major factors of temperature anomaly. Under such conditions the heat radiation from the lower layers of the ground and wind occurs faster. As a result the lower layer of the air becomes denser and heavier as it cools down. The upper layers where radiation of heat is at a lower base is comparatively warmer. Under these conditions the temperature increases with the increase in height. This condition mostly prevails during winter season in intermontane valleys. This is the reason why the settlements and orchards are preferred in the upper slopes of the valley instead of lower. Apple plantation in Himachal Pradesh are situated in the upper regions of the valleys.

Factors affecting the distribution of temperature

1. Distance from the Equator

The equatorial regions receives maximum insolation as the sun shines vertically over the equator for the entire year. The sunrays starts getting more slant as we move away from the equator towards the pole. Therefore the amount of insolation received is also less. The temperature decreases below freezing point in the polar regions

and it is mostly covered with snow.

2. Height above sea level.

The temperature decreases with the increase in height. Normally there is a decrease of 1°C for every 165 m or 6.5°C decrease for every 1 km. The temperature of Shimla is comparatively lower than Delhi because Shimla is situated at a higher altitude than Delhi. Therefore the mountainous regions are much colder than the plains.

3. Distance from the Sea

The land gets warmer and cooler faster than water. Therefore the areas which are closer to the sea have moderate temperatures. Whereas the areas which are further away from the sea have variations in temperature.

4. Ocean Currents

The temperature conditions of the coastal areas are greatly affected by the ocean currents. The coastal margins that experiences hot ocean currents observes rise in temperature, on the other hand cold ocean currents causes decrease in temperature. The warmer Gulfstream maintains the warmer temperature conditions on the coastal regions of Europe. Thus in this way the nature of ocean currents controls the temperature of the coastal margins.

5. Prevailing Winds

The temperature increases in the areas where warm winds prevails and the temperature decreases where colder winds blow. The temperature increases by the warm winds named 'Sirocco' prevailing in Italy from Sahara desert and 'Chinook' that prevails in the plains of North America. Similarly the northern parts of India experience increase in temperature of about 45°C due to warm wind called 'Loo' during summer season.

6. Slope of the Land

The slopes of land that receives more solar radiation also causes increase in temperature. Where as the slopes which are on the opposite side of sunshine receives lesser solar radiation and have lesser temperatures. The temperatures are

comparatively higher on the southern slopes of Himalaya and Alps than the northern slopes.

7. Nature of the earth's surface

The vegetation and the snow cover on the earth's surface reflects back the maximum part of solar radiation. The temperature do not rise in these regions. On the contrary, areas which are covered with sand and are formed of Black soil observes maximum solar radiation, which causes increase in temperature. The process of reflection of the solar radiation from the earth's surface is called Albedo.

8. Clouds and Rainfall

The areas which are mostly cloudy and receives maximum rainfall does not witness increase in temperature as most of the sun rays are reflected back by the clouds. For example the Equatorial Regions are comparatively less warmer than the cloudless tropical deserts, despite the fact that the sun shines vertically over the equator for the whole year.

Heat Budget

The balance between the heat observed and its loss by the earth and its atmosphere is called heat budget. The temperature of the earth remains almost constant, because the amount of the radiation received by the earth and the heat lost through Terrestrial radiation is almost the same. The Earth receives 2 billionth part of the solar radiation, only one part of it reaches the earth's surface, the rest is

absorbed by atmosphere and lost in reflection, refraction and other processes.

If we consider that the total amount of heat received by the atmosphere is 100 units, then the heat budget it will be as follows:- 35% of the heat received by the earth is reflected back into the space before it reaches the Earth surface, which is as follows-

In this way out of 100 units, only 51 units are received by the earth. 51% of the solar radiation absorbed by the earth is returned in the space in form of longwave radiation. From these 51%, 17% is reflected back to the space from the Earth and the 34% is absorbed by the atmosphere. From this 34% about 6% is observed by the atmosphere itself, 9% is observed in convection and 19% as latent heat of condensation. The 48% of the atmosphere, 14% from the sun and 34% by terrestrial radiation, thus (17+ 48= 65) is radiated to space by the atmosphere. Thus the total 65 units which is received by the earth is equal to the amount of heat which is radiated by the earth. This is the estimated heat budget of the earth, which undergoes changes sometimes.

Important points

1. The source of energy for earth and its atmosphere is Sun.
2. There are three zones of latitudinal distribution (belts) of annual insolation on the earth's surface- Lower latitude, Mid latitude and Poles.
3. There are number of factors that affect the insolation on the earth surface like slanting rays of the sun, duration of the day, effect of land and sea, sun spots, atmosphere, height above sea level, structure of the slope, ocean currents etc.
4. The distribution of temperature according to latitudes is called horizontal distribution of temperature. The temperature distribution according to the height from the earth's surface is called vertical distribution of temperature.
5. Normally temperature decreases with the increase in height in troposphere but sometimes in special conditions temperature increases with the increase in height, this is

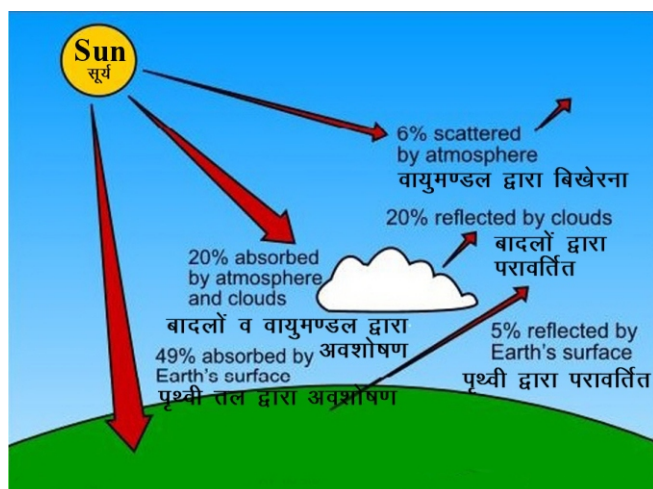


Fig. 12.5 : Heat Budget of the Earth

called inversion of temperature.

Exercise
Multiple choice questions

1. Solar radiation is measured by-
A) Pyranometer
B) Thermometer
C) Barometer
D) Centimetre
2. How long it takes for the sun rays to reach the earth?
A) 5 mins
B) 6 mins
C) 7 mins
D) 8 mins
3. The Solar Energy which is received by the earth is called-
A) Terrestrial radiation
B) Radiation
C) Insolation
D) Heat budget
4. By temperature inversion, we mean-
A) Increase in temperature on earth surface
B) Decrease in temperature in the sky
C) Increase in temperature with the increase in height
D) Decrease in the temperature with increase in height.
5. What is the total amount of solar radiation that reaches the earth?
A) 51%
B) 48%
C) 35%
D) 17%

Very short type questions

6. What is solar radiation?
7. What are isotherms?
8. What is the total distance between sun and the earth?
9. What are heat belts?
10. What is the major source of atmospheric heat?

Short type questions

11. What is albedo of the earth?
12. What is temperature inversion?
13. What is insolation?
14. What are the factors that affect solar insolation?
15. What is the difference between vertical and horizontal distribution of temperature?

Essay type questions

16. What is insolation? Explain the factors that affect the distribution of temperature.
17. Explain the heat budget of the earth.
18. Explain the distribution of temperature specially in reference to its horizontal and vertical distribution.

Answer key

1.A. 2.D. 3C. 4C. 5A

Lesson - 13

Air Pressure Belts and Winds

The atmosphere that extends thousands of kilometers above the earth's surface, exerts enormous pressure on it. This pressure is maximum near the earth surface. It is reduced, as we move higher in the atmosphere. Pressure and wind, are those major elements of climate that affect the other factors to a great extent.

The atmosphere which envelopes the Earth from all the sides, is composed of many gases. This gaseous cover exerts enormous pressure on the earth surface which is called air pressure. In short the meaning of the air pressure is the weight of column of air at any given place and time. The air pressure was first discovered by Guericke in 1651. The air pressure is not uniform at all the places and at all the times but it is controlled by solar radiation. The air expands at higher temperature due to which its density reduces, this results in decrease in Pressure.

The air is much denser near the earth surface than the upper atmosphere due to the impact of gravitational force. Air becomes relatively thinner at higher altitudes. Therefore, on the mountains and plateaus, man has to breathe more often to get the required amount of oxygen. This is the reason why it is necessary for the mountaineers to carry oxygen cylinders along with them.

The vertical distribution of pressure is comparatively more important than its horizontal distribution. The weather department studies pressure as one of the controlling factors of climate or weather.

The slightest change in pressure conditions affect weather. The other elements of weather like clouds, rainfall, thunder, dust storms are actually controlled by pressure. The air pressure plays an important role in weather forecast. The most popular unit to measure pressure is millibar (mb). One Milli bar means Force of 1 gram of weight exerted on 1 square centimeter. The other factors that affect air pressure are temperature, water vapour, height above sea level.

Air pressure and Winds

There is a deep relationship between air pressure and the prevailing winds. The difference in pressure conditions is the main cause of origin of winds. The difference of pressure also affects the rainfall and temperature. The winds transfer the heat between the lower and higher latitudes which helps to maintain the latitudinal heat balance. The winds create the possibility of rainfall as they transfer the humidity from the oceans towards the continents.

Air Pressure Belts

The main basis for determining these pressure belts, is the temperature. As these pressure belts are determined it is also assumed that the earth is having a uniform surface (land or sea). Therefore these pressure belts are very generalized. Due to the variation of the factors of air pressure on earth, it is obvious to have an uneven distribution of air pressure. The air pressure is represented in 7 pressure belts. The following air pressure belts are

found in each hemisphere on the surface of the earth. (Fig. 13.3)

1. Equatorial Low Pressure Belt(Doldrums)
2. Subtropical High Pressure Belt
3. Subpolar Low Pressure Belt
4. Polar High Pressure Belt

1. Equatorial Low Pressure Belt

This belt extends upto 5° north and 5° South latitudes of equator. High temperatures and low pressure are observed in this belt, as the sun shines vertically over the equator for the whole year. This region is also characterized by high humidity and lower density of air. The rotation of the Earth is maximum at the equator and this results in the maximum development of centrifugal force.

The surface winds are absent in this belt whereas high temperature causes expansion in wind and it rises up, this gives birth to conventional currents. This is the reason that this belt is also called 'Doldrums' or equatorial calm belt.

2. Subtropical High Pressure Belt

This belt extends 30° to 35° north and South of the equator. Mostly this belt is characterized by high temperature, high pressure and clear sky.

The most important feature of this belt is that all the tropical deserts are found on the Western margins of the continents. Due to absence of friction in the upper layers of the atmosphere, these winds turn towards right and left in the northern and Southern hemispheres respectively. These belts of higher pressure are also called horse latitudes.

3. Subpolar Low Pressure Belts.

The subpolar low pressure belts extend between 60° to 65° north and South latitudes. The temperature is lower in these latitudes but instead of high pressure, lower pressure exists. This low pressure is observed due to rotation of the earth. Flowing of warm ocean currents also cause increase in temperature resulting in the low pressure in the region.

4. Polar High Pressure Belts

As the temperature is lower at the polar

regions, higher pressure always prevails near the poles. Both the belts located in both hemispheres are thermally generated. Due to lower temperatures, the surface of the poles and nearby regions remain always covered with snow. Therefore the air near the surface is cooler and more dense. This is the main reason for non-availability of the data related to the surface pressure of this region, in abundance.

Distribution of Air Pressure

The air pressure is depicted through isobars on the maps. Similar to temperature, two months (January and July) are selected for air pressure recording.

Pressure distribution in January

Figure 13.1 presents the pressure conditions of January. At this time the sun shines vertically over Tropic of Capricorn in the southern hemisphere. Due to this the temperature is higher and the density of air is lower. The areas of Low pressure are found in South America, South Africa and interior parts of Australia. The well-developed subtropical high pressure areas are found in the continents of Northern hemisphere.

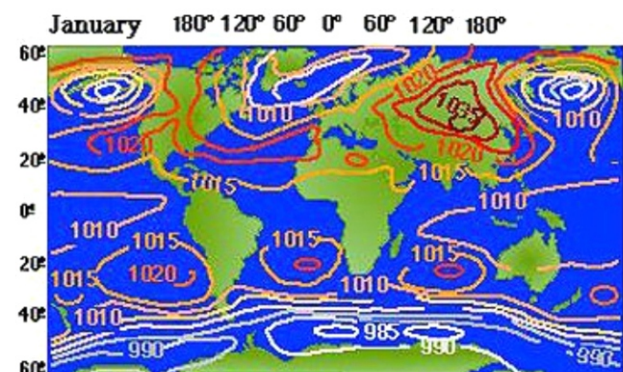


Fig. 13.1 : Air Pressure in January

Pressure conditions in July

The sun shines vertically over Tropic of Cancer in the month of July in the northern hemisphere. This shift is observed maximum in Asia. The land masses of the northern hemisphere get extremely hot and result in the development of low pressure areas and a high pressure belt is developed in the southern hemisphere. (Fig 13.2)

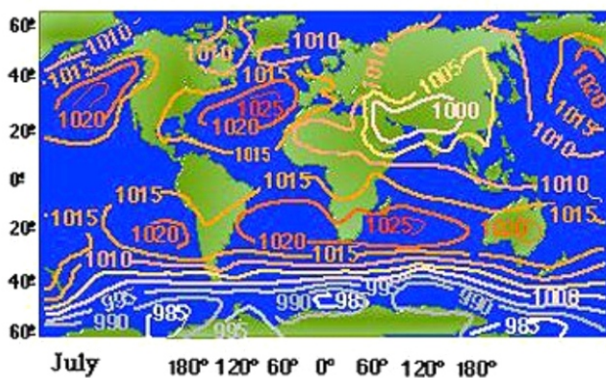


Fig. 13.2 : Air Pressure in July

Seasonal Changes of the Air pressure belts

The distribution pattern of the pressure belts does not remain the same as described above. Daily and annual changes occur in pressure, due to many factors like winter and summer solstice, effect of land and sea etc. During summer when the sun shines vertically in northern hemisphere, these pressure belts shift 5° north from their mean position and when the sun shines vertically in the Southern hemisphere, these pressure belts shift 5° towards the south from their mean position. The most ideal position of these pressure belts, is on 21st March and 23rd September when the sun shines vertically over the equator. During the shifting of the air pressure belts, the equatorial low pressure belt, instead of being located at 5° latitude, it shifts between 0° -10° latitude in northern and southern hemisphere depending upon the season. Similarly subtropical high pressure belt shifts from 30°-35° degree latitude to mid of 30° to 40° degree latitude, Whereas the Sub Polar Belts instead of being located on at 60° to 65° latitude shifts to mid of 60° to 70° latitudes. Due to the continental expansion in polar regions, especially in the Northern Polar region, it has a greater effect as the pressure belt becomes very narrow in summer. As the expansion of landmass is lesser in comparison to oceanic expansion in Southern polar regions, There is no specific difference in the shifting of air pressure belts.(Fig. 13.3)

Vertical distribution of atmospheric pressure

Pascal in 1643 proposed for the first time that there is a decrease of pressure with the increase

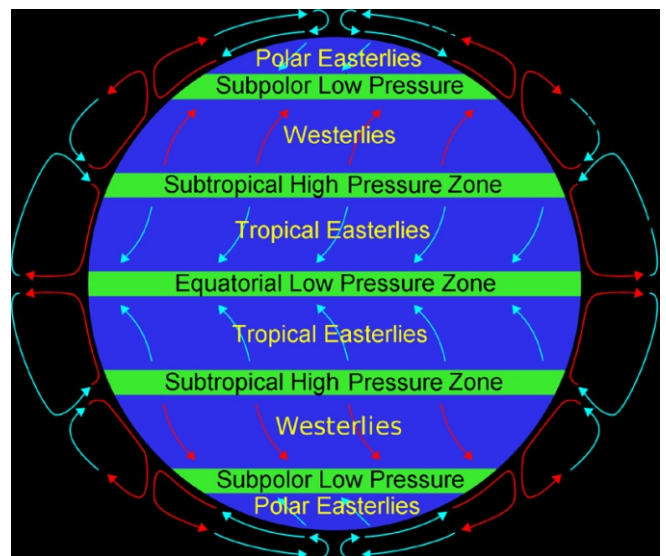


Fig. 13.3 : Air Pressure and Winds' Belts

in height in atmosphere.

The density of the lower layers of atmosphere is comparatively more as the upper layers exert more pressure. This results in high density and high pressure of the lower layers of atmosphere. Due to this, the air pressure always decreases with the increase in the height in atmosphere but this rate of decrease is not always uniform.

This depends on density, temperature and amount of water vapour and gravitational force of the earth. As these factors are constantly changing there is no direct proportional relationship between height and air pressure. But still the rate of decrease of air pressure in Troposphere is mostly 34 mb for every 300m of height. The gases become very thin and light in higher altitude. This results in decrease in air pressure. This is the main reason that mountaineers carry oxygen cylinders and special suits along with them while climbing higher peaks of mountains.

Winds

The horizontally moving air is called Wind. The winds always blow from high pressure areas to low pressure areas. It is the effort of nature to balance the variations of air pressure. If the earth would have been fixed and surface would have been plain, the winds would have blown straight and,

perpendicular to the isobars, from high pressure to low pressure areas. But in reality this does not happen, because many factors affect the direction and speed of the wind. These factors are as follows-

1. Pressure Gradient

The difference of air pressure between any two places is called pressure gradient. This pressure gradient is in horizontal direction. Pressure Gradient is also called Barometric Slope. When the pressure gradient between the two places is high, the speed of the winds will also be higher contrary to this when the pressure gradient is low the speed of the wind will also be lower.

2. Rotation of the Earth

The winds are deflected because of the rotation of the earth. This is called Coriolis Force and the effect of this force is called Coriolis effect. Due to this force, the winds deflect towards right in northern hemisphere and towards left hand side in the southern hemisphere. This effect was proved by scientist named 'Ferrel' and it is also called Ferrel's law.

3. Landforms.

The irregularities of the Earth's surface serve as a obstruction in the path of wind, which in term affect the direction and speed of the winds. when the surface is plain it does not cause more friction and the winds blows in higher speed. On the other hand the irregularities of Earth's surface causes friction and obstruction that reduces the speed of the wind. This is the main reason that, the Westerlies follow a fixed direction and blows in high speed in southern hemisphere, as it has extensive oceans. Whereas in Northern hemisphere, the speed of the westerlies is comparatively slow as this hemisphere has more of land mass.

Nomenclature of Winds

The winds are named after the direction in which they blow. The winds which are blowing from the Western direction are called Westerly and the winds blowing from Eastern direction are called Easterly. (Fig 13.3)

Classification of Winds

Winds are classified under three categories on the basis of their area of influence and duration.

- (i) Permanent winds
- (ii) Periodical winds
- (iii) Local winds

i) Permanent winds

The winds that blow through out the year in a particular direction and in a constant course are called permanent winds. These winds are popularly known with other names like also planetary winds, prevailing winds or invariable winds. These winds are related to air pressure belts. The major ones are Trade Winds, Westerlies and Polar Winds.

Trade Winds

The winds blowing in both the hemispheres, from subtropical high pressure areas towards the equatorial low pressure areas are called trade winds. Instead of blowing in the straight direction these winds follow the ferrel's law and deflect towards right in the Northern hemisphere and towards the left in the southern hemisphere. Thus according to the direction these winds are called 'North East Trade Winds' in the northern hemisphere and 'South East Trade Winds' in the southern hemisphere. These winds helped in sailing of the ships in the ancient period, hence are called trade winds.

These winds have different characteristics in different regions. The winds are dry and calm, due to descending of the winds near subtropical high pressure. As these winds proceeds further in their direction, they pick up moisture as they blow over the water bodies. These winds become almost saturated as they reach the equator, being unstable, they causes rainfall. The trade winds of both the hemispheres, clasp together near the equator, and on the line of convergence by rising in the form of conventional current these winds cause heavy rainfall.

Westerlies

The winds that blow in both the hemispheres, from subtropical high pressure belt

towards subpolar low pressure belts are called Westerlies. The direction of these winds in the Northern hemisphere is from south-west to north-east in the Northern hemisphere. The wind system of westerlies disturbed in the Northern hemisphere due to dominance of land mass, and seasonal changes. These winds are more regular and constant in the southern hemisphere due to the large extension of oceans. The velocity of the winds in the southern hemisphere remains high. These winds are called 'Roaring Forties' between 40° to 50° latitude, called 'Furious Fifties' near 50° south latitude, 'Shrieking or Screaming Sixties' near 60° south latitude because of its intensity.

The margins of these winds become unstable near the poles and these winds cause disturbance in the weather conditions.

Polar winds

The winds blowing from the polar high pressure belt towards the subpolar low pressure belts in both the hemispheres are called polar winds. These winds blow from North East to south west direction in the Northern hemisphere and from South East to North West direction in the southern hemisphere. As these winds blow from the polar regions, they are very cold and dry. These winds have lesser capacity to hold moisture as their temperature is low. The polar winds are called Nor'easter in the Northern hemisphere as they blow with very high intensity. These winds affect North Eastern Canada and USA.

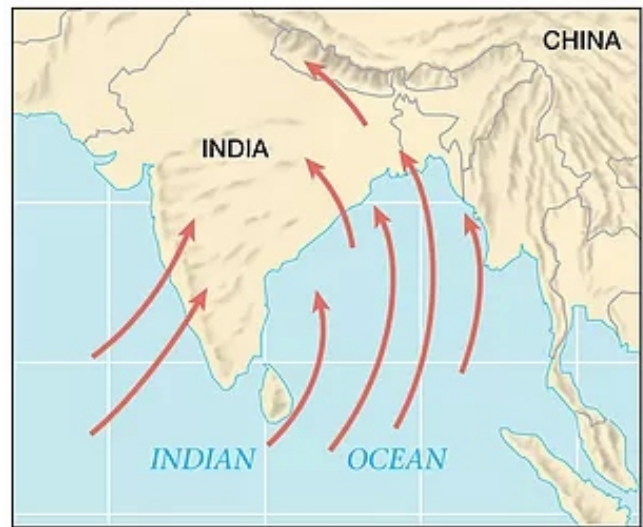
Periodical winds

The winds that change their course according to season or time are called periodical winds. They are as follows-

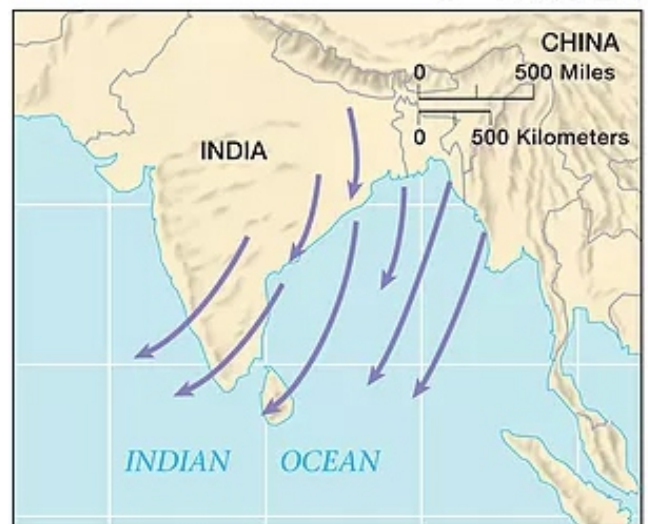
- A) Monsoon Winds
- B) Land Breeze and Sea Breeze
- C) Mountain Breeze and Valley Breeze

A) Monsoon Winds

The term monsoon has been derived from the Arabic word 'mausin' meaning 'season'. Thus the monsoon winds are those winds that change their direction according to the change of season. The theories regarding the origin of monsoon winds are



Summer



Winter

Fig. 13.4 : Monsoon winds

as follows-

Thermal concept

According to this theory the origin of monsoon is due to uneven distribution of land and sea and their contrary nature of heating and cooling. During summers due to excessive solar radiation, the land becomes much hotter than the seas this causes development of low pressure areas. Due to this, the wind blows from sea towards land. This situation is reversed during the winters land becomes the centre of high pressure and sea

becomes the centre of low pressure. This results in the winds blowing from land towards sea and is called winter monsoon. It is also called North East monsoon. (Fig 13.4)

Dynamic concept of Flohn

Flohn rejected the thermal concept of origin of monsoon and proposed his Dynamic concept of origin of monsoons.

According to him the origin of monsoon winds is due to the shifting of winds and air pressure belts. As the two trade winds clasp near the equator, it develops Convergence. It is called Inter-Tropical Convergence ITC. Its northern margin is called NITC and its southern margin is called as SITC. The Doldrum belt exists between these ITC in which equatorial westerlies winds blow. During the summer solstice ITC shifts and extends till 30° north latitude, which covers south east Asia. Therefore, the doldrums equatorial westerly winds blow in these regions, during summers these become south west monsoon winds. In the same way, during Winter Solstice, the NITC shifts away from south east Asia, and north east trade winds re-establishes. These are called North East monsoon winds.

Modern concept

It's also called 'Jet Stream' theory. Jet stream is a stream of fast moving air from west to east usually found in South Asia in the upper troposphere at a height of about 12 km. It is also called Sub tropical West Jet Stream here. The height of Jet Stream is about 9 to 10 km at 60° north latitude and its height gradually decreases towards the pole. Due to mechanical barrier of the Himalayas and Tibetan plateau, the upper westerly jet stream is divided during winters in northern hemisphere.

Its northern branch blows from west to east in north of Tibetan plateau, and its main branch blows in South of Tibet plateau and Himalaya from west to east direction. The main branch follows a cyclonic pattern over Afghanistan and Pakistan. This causes the origin of winter monsoon. After 21st of March during summers when the sun is in summer solstice, due to which the polar surface high air pressure weakens.

As the higher level Polar vortex shifts towards north, the high level Westerly Jet stream also shifts towards north. This Jet stream disappears completely from India by mid of June. The Jet stream now blow in opposite direction of winter path over the north of Tibetan plateau. The path of high-level crystal jet stream over the northern part of Afghanistan and Iran is in cyclic form (in anticlock direction), which develops low pressure and cyclonic conditions in troposphere. This low pressure extends over North Western India and Pakistan. Thermal low already exists below this on the surface.

During these conditions the winds rise from lower pressure area and upper strata low pressure attracts them to higher parts, due to which there is sudden burst of Southwest monsoon.

(B) Land and Sea Breeze

These winds are miniature form of monsoon winds which change their direction twice during 24 hours. The main cause of land and sea breeze is the differential heating and cooling of land and water bodies. These winds are experienced daily on the coastal regions or the margins of the lakes.

Land Breeze

During night the heat loss is rapid due to terrestrial radiation on land in comparison to the water bodies, due to this land becomes cooler than

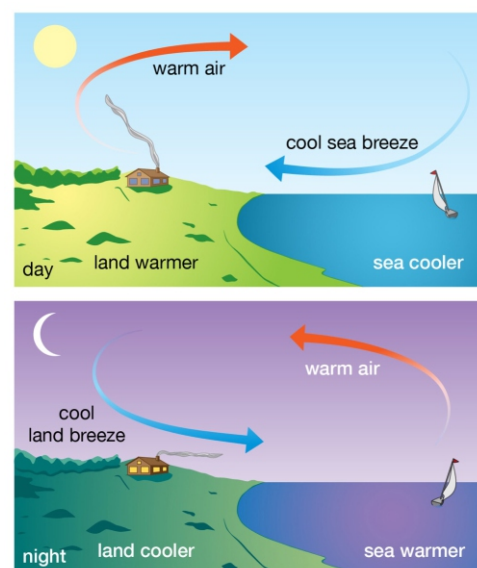


Fig. 13.5 : Land and sea breeze

water bodies.

This causes development of high pressure over land and low pressure over sea. Due to this, the winds blow from land towards the sea and are called land breeze. These are dry winds. The coastal margins are similarly affected by these winds. This is the main reason why the climate of Kolkata, Mumbai, Chennai and other coastal cities in India experiences moderate type of climate which is neither too hot nor too cold.

Sea Breeze

During daytime, land mass gets more heated in comparison to the water bodies, resulting in the development of low pressure over land and high pressure over sea. This results in the blowing of the winds from sea towards land which is called sea breeze. These winds begin by 10:00 am to 11:00 am in the morning and reach their maximum velocity around 1:00 pm to 2:00 pm and almost diminish by 8:00 pm in night. These winds cause a decrease in the temperature of about 5° to 7° degree Celsius in just 15 to 20 minutes in the coastal margins of tropical regions.

This causes weather to be pleasant and healthy. These winds also cause rainfall in the coastal regions. These winds prevail only during the day in summer season.

(C) Mountain and Valley breeze

During the day, the slopes of the mountain become much warmer than the lower region of the valley, due to this low pressure develops on mountain slopes and higher pressure develops in valley floor. Due to this difference in pressure conditions the winds blow from valley floor towards the mountain slopes. These winds are called valley breeze. The conditions are reversed after the sunset. During night the slope of the mountains loses its heat due to terrestrial radiation. Due to this high pressure area develops over mountain slopes and lower pressure in the valley floors. The cold and heavier wind blows towards low pressure areas of the valley bottom. These winds are called mountain breeze. These winds create the position of inversion of temperature, this causes frost during night in the valley floors whereas the upper parts are free from the frost. Similar conditions exist in Himachal Pradesh in India.

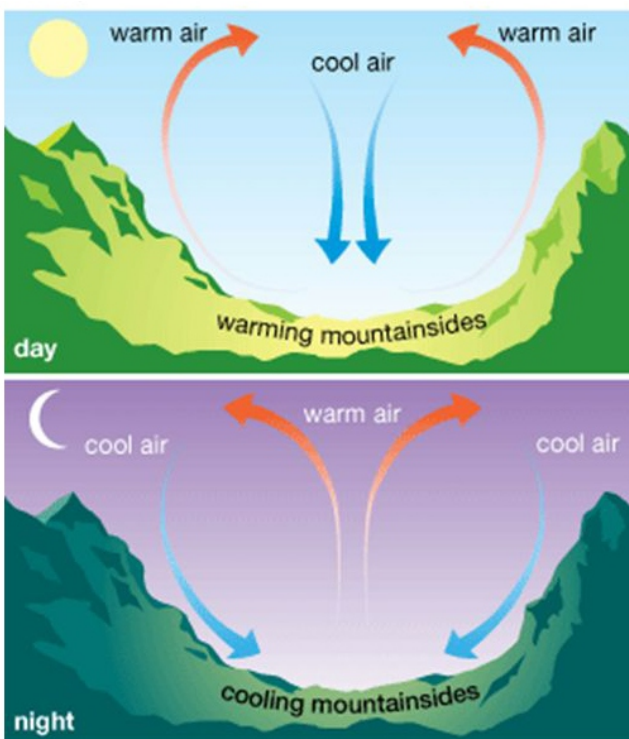


Fig. 13.6 : Valley and Mountain breeze

Local winds

The winds which develop as a result of local differences in temperature and pressure conditions are called local winds. These winds are of opposite nature to the prevailing winds in the region. The characteristics of these winds varies according to the local regions, they may be warm, cold, dusty, snowy and many other different types. These winds have favourable as well as unfavourable effects on the regions where they prevail. The major winds are Chinook, Foehn, Bora, Sirroco, Harmattan, Mistral, Brickfielder Willy-willy etc.

Chinook and Foehn

The dry and warm winds which blow down the mountain slopes are called 'Chinook' in USA and Foehn in Europe. The effect of these winds can easily be observed on the Prairie region of USA. These winds mostly blow in winter season. During this season, when these dry and warm winds cross over extensive Rockies mountains and enter eastern

Prairie grasslands, they melt the snow. It is the reason that they are also called as Snow Eaters.

Foehn have characteristics similar to Chinook. It ascends over southern slopes of Alps mountain and descends on from the northern side. These winds causes sudden increase in temperature of about 8° to 10° Celsius. Due to increase in temperature the snow melts and pasture lands are created, and cultivation is started. Its maximum impact is on Switzerland, where these winds blow mostly in Spring and Autumn season.

Sirocco

These are dry, warm and dust laden winds which blow from Sahara desert to north of Mediterranean sea and affect Italy, Spain etc. These winds carry red sand in ample quantity. These winds pick up moisture as they cross over Mediterranean sea. They causes rain as these winds with red sand descends down in southern Italy. This type of rain is also called "Blood Rain". As these winds descend down along atmosphere slopes of Atlas Mountains they become more dry and warm. These winds are known by different names in different places. Sirocco in Italy, Simmom in Sahara, Gibli in Libya,

Chili in Tunisia, Leveche in Spain. The dry and hot wind that prevails in Arabian desert is called Simoom. These winds have devastating effects on vegetation, agriculture and orchards.

Harmattan

These winds which are dry, hot and blow in the eastern part of Sahara desert of Africa from North-East to west are called Harmattan. These are high velocity winds. The Western coastal regions of Africa is hot and humid due to which the weather remains unhealth. The weather becomes dry and pleasant with the arrival of Harmattan winds. Therefore these winds are also called 'Doctor winds' in the Guinea coastal area of Western Africa .

Similarly dry and hot winds blow in the Victoria region of Australia, which are called Brickfielder.

Mistral

These are cold dry and high velocity winds, which blow in north-west direction of mediterranean sea, and affect Spain and France. These winds blow with an average speed of 56 to 64 km per hour but some times it becomes 128 km per



Fig. 13.7 : Local winds of the world

hour. This high speed adversely affects the air flights. In order to reduce the impact of these winds, orchards and shrubs are planted at right angles of their flow direction. With the arrival of these winds there is a sudden drop in the temperature below freezing point.

Bora

These winds are cold and dry which blow along the eastern margins of Adriatic sea.

The northern part of Italy is specially affected by these winds. The high velocity of these winds uproots the trees and blows off the roofs of many houses. Sometimes these winds blow continuously for several days. These winds also causes rainfall as they carry moisture.

Blizzard

These winds are also called thunderstorm. These winds are prevalent in USA, Canada & Siberia. The average velocity of these winds varies from 80-96 km per hour. These winds have snow particles which hampers the visibility. The arrival of these winds causes sudden decrease in temperature and the entire region is covered with snow. These winds reach USA and affect the extensive plains of the Southern states of USA, as there is absence of any east-west, mountain barrier in USA. These are called Northern in southern USA and 'Buran' in Siberia.

Loo

These hot and dry winds blow during summer season specially after noon in the plains of Northern India and Pakistan from western direction. These winds are called Loo. The temperature of these winds varies from 40° to 50° Celsius. These winds causes heat stroke. The regions which are affected by these winds observe troublesome weather conditions.

Important points

1. The pressure exerted by the layers of the atmosphere on the earth's surface is measured by Barometer. The factors that affect the air pressure include temperature, height above sea

level, rotation and revolution of the earth and water vapours etc.

2. The air pressure belts changes according to the change in seasons. The air pressure decreases with the increase in height.
3. The factors that affect the direction and speed of the winds are temperature, rotation and revolution of the earth, relief features.
4. The winds like Westerlies, Trade winds and Polar winds are Permanent winds and seasonal winds are monsoon land, sea breeze and Valley - mountain breeze. The theories regarding origin of monsoon include thermal theory dynamic, theory of Flohn and modern hypothesis.
5. Chinook, Foehn, Siricco, Mistral, Harmattan, Mistral, Bora, Blizzards, Loo are examples of Local Winds

Exercise

Multiple choice questions

1. Who discovered air pressure?
(A) Twewartha
(B) Ferrel
(C) Guerick
(D) Finch
2. What is the extension of equatorial low pressure belt?
(A) 5° North to 5° South latitudes
(B) 30° to 35° North and South latitudes
(C) 60° to 65° North and south latitudes
(D) None of these
3. The hot and dry winds which blow in the plains of North India and Pakistan are called....
(A) Chinook
(B) Loo
(C) Mistral
(D) Bora
4. The winds that blow in a particular direction for the whole year are called....
(A) Uncertain winds
(B) Seasonal winds
(C) Prevailing winds

(D) Local winds

5. The belt of 'Doldrums' are found in ...
(A) Near equator
(B) Near Tropic of Cancer
(C) Near Tropic of Capricorn
(D) Near Arctic circle

Very short type questions

6. What is the most popular unit to measure air pressure?
7. Where does Mistral winds prevail?
8. Which winds blow in Alps mountains?
9. Give the extension of equatorial low pressure belt.
10. What is wind?

Short type questions

11. What is air pressure?
12. What are Doldrums?
13. What are Prevailing Winds?
14. What is Loo?
15. Name the factors that affect the air pressure.

Essay type questions

16. What is air pressure ? Describe the air pressure belts.
17. What is wind ? What are the different types of winds ? Explain
18. Examine critically the theories about the origin of monsoon winds.

Answer Key

1.C. 2.A. 3.B. 4.C. 5.A

Lesson - 14

Air masses, Front, Cyclone and Anticyclone

Air Masses

An extension and dense part of atmosphere in which physical properties specially temperature and humidity are relatively uniform horizontally, are called Air masses. Generally, the air masses are extended upto thousands of kms and consist of many layers. Each layer of the air mass has uniform properties. When the atmospheric conditions of an extensive area remains stable for a longer period of time, the air above it attains the temperature and moisture conditions of the ground surface, this leads to the formation of an air mass. After the formation of air mass, it seldom remains stationary over the source region. It moves ahead and affects the regions where it prevails. During this, its properties undergo changes but due to its extensive size these changes are very slow.

Source Regions of its origin

The regions where the air masses originate are called source regions. An ideal source region of an air mass should have the following essential conditions:-

- (i) There should be an extensive and homogeneous surface of the earth so that it may have uniform temperature and moisture conditions. The source region may be entirely a landmass or an entirely an Oceanic surface.

- (ii) The speed of the wind should be slow and should have divergence, so that The air of other region may not enter.
- (iii) The atmospheric conditions should remain constant for considerable longer period of time, the air mass may possess the characteristics of the ground surface.

There are 6 ideal source regions of air masses on earth:-

- (i) Polar Oceanic regions (Northern parts of Atlantic and Pacific Ocean-during winter season)
- (ii) Sub-polar Continental regions (Snow covered Eurasia and North America - during winter season)
- (iii) Monsoon region (South-east Asia)
- (iv) Tropical Oceanic Regions (anticyclone regions- summer and winter)
- (v) Tropical Continental regions (North Africa, Asia and Mississippi Valley region of USA)
- (vi) Equatorial Region (throughout the year)

Classification of Air Masses

The air masses are classified on two basis:-

- (i) Nature of the surface of source region
- (ii) Transformation of air masses

These are two types of air masses based on the nature of the source region- Tropical and

Polar. As the source of origin of air masses maybe land mass or ocean, each is divided into two subtypes- Maritime tropical air mass, continental tropical airmass, Maritime polar air mass, Continental polar air mass. As more moisture content is present in Maritime air masses, it causes more rainfall, contrary to this

Continental air masses are dry and causes lesser rainfall.

As the masses move further away from the source region, they are transformed according to the region through which they are pass. This transformation is of two types Thermo-dynamic and Mechanical. As the air

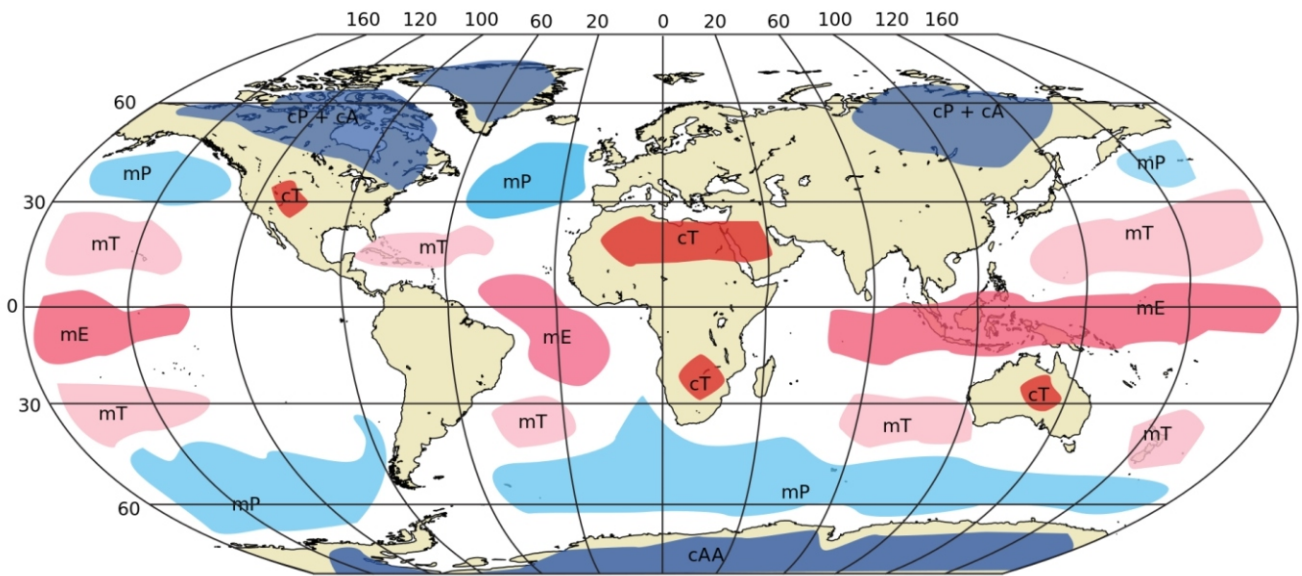
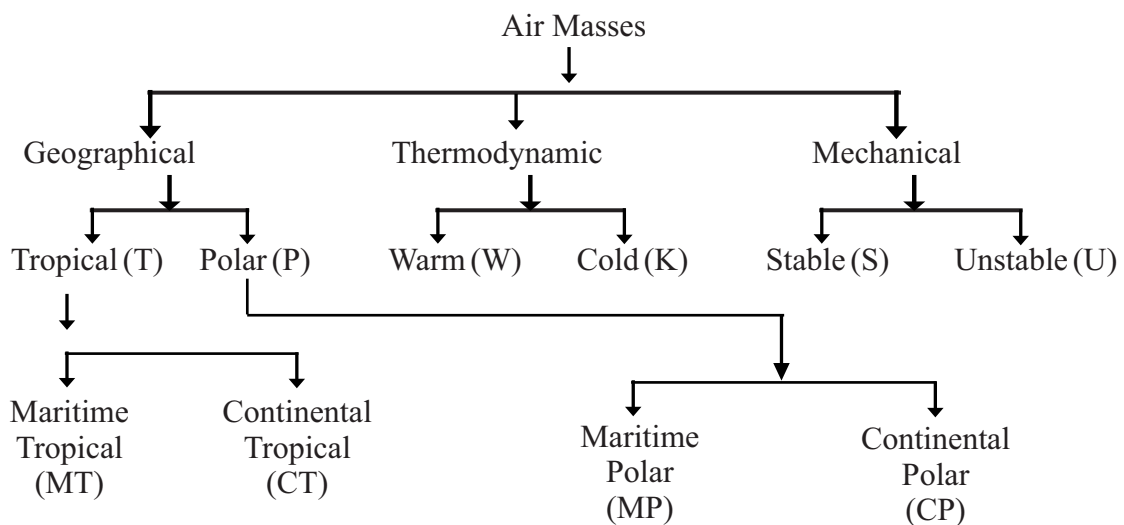


Fig. 14.1 : Air masses of the world

Table 14.1 : Classification of Air Masses



masses pass through a surface, the temperature differences occur, which causes increase or decrease in temperature of the lower layers of the moving air mass, this is called Thermodynamic Modification. The modifications of the air masses which are not affected by the warmth or coldness of the surface area are called Mechanical Modifications. For example-Modifications occurring by Cyclones and Anticyclones and Vertical movement of air. When the air mass is moving, it is called Unstable- U and when it's not moving, it is called Stable- S.

Front

The term 'Front' was used first of all during the World War. When two air masses of different nature (warm and cold) connect, they try constantly to maintain their temperature and moisture conditions. An inclined boundary is formed during this process which is called front. When two air masses of different character come in contact with each other, they do not merge, but try to maintain their differences for long period of time. According to Blair "The surface or line, along which air masses remain separated, is called front.

Fronts are important in climatology as they give birth to many specific atmospheric conditions like cyclones and anticyclones. This is the reason why fronts are also called "Cradles of cyclones and anticyclones."

Origin of Front

The following conditions are necessary for the origin of front:-

- (i) Air Masses having different properties means warm and Cold Air Masses
- (ii) Variation in humidity
- (iii) Atmospheric Circulation

Types of Fronts

Petterson has divided Fronts in four different types, which develop in the mid-latitudinal cyclones.

(1) Warm Front

Front in which the warm air becomes active and rises slowly over cold and dense air is called warm front.

(2) Cold Front

The Cold front is formed when the cold and dense air uplifts the hot and lighter air.

(3) Stationary Front

The front in which the two contrasting air masses converge in such a manner that they are parallel to each other and there is no movement of air, it is called Stationary Front.

(4) Occluded Front

This type of front is formed when a cold air mass overtakes the warm front and lifts the

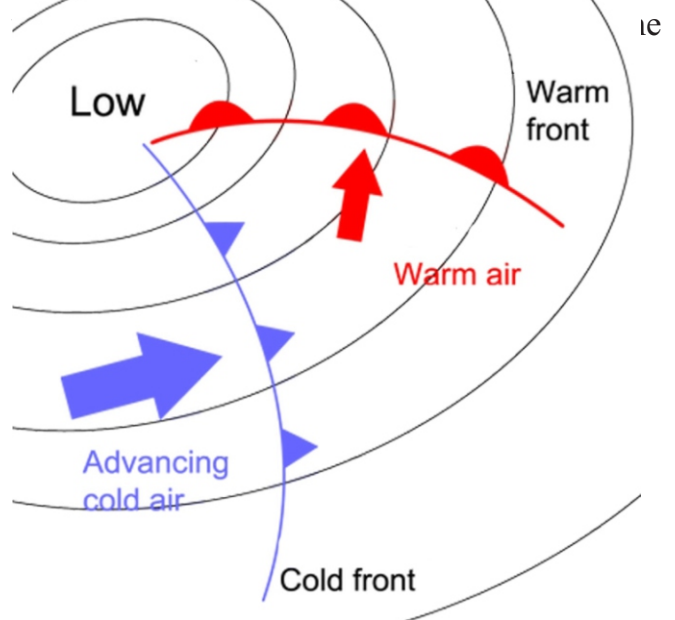


Fig.14.2 : Front and Cyclone

Cyclone

Cyclone is generally the centre of low pressure, in which the air pressure increases outwards, due to this the winds blow towards the centre. According to Ferrel's law, these winds will move anticlockwise in the Northern hemisphere and clockwise in the southern hemisphere fully. It means that the winds will

turn towards right in the northern hemisphere and towards left in the southern hemisphere. According to Twewartha, 'Cyclones are those centres of low pressure which are surrounded by circular and adjoining isobars. The shape of the cyclones are mostly circular, elliptical or 'V' shaped.

Major characteristics of cyclones

- (i) Cyclones are areas of low pressure, in which the pressure increases outwards from the centre.
- (ii) The winds move towards the centre.
- (iii) The shape of the cyclones is mostly circular, elliptical or 'V' alphabet shape.
- (iv) Cyclones affect the weather conditions, which causes decrease in pressure, formation of halo around Sun and Moon, and heavy rainfall etc.
- (v) The winds blow anticlockwise in Northern hemisphere and clockwise in the southern hemisphere.

Types of cyclones

1. Temperate cyclone
2. Tropical cyclone

(1) Temperate Cyclone

The weather conditions are not uniform in mid-latitudes. Mostly the weather keeps on changing here, resulting in the origin of cyclone in mid latitudes, having low pressure in its centre and is surrounded by high pressure. They are of circular, elliptical or v-shaped, which are called lows or depressions or trough. They are formed due to the convergence of warm and cold air. They are mostly found in the regions extended between 35° to 65° latitude in both the hemispheres, where they blow from west to east under the influence of Westerlies. The sequential movement of these cyclones are similar to up and down movement of the whirls in a flowing stream. The cyclones cause formation of clouds in the atmosphere which causes rainfall or snowfall when the conditions

are appropriate. These cyclones cause changes in the air pressure and temperature. The velocity of these cyclones is comparatively higher during winters than summers.

Origin of temperate cyclones

The temperate cyclones are produced mainly by polar fronts but out of temperate zone they can develop the origin of temperate cyclones is mostly at polar regions anywhere. Their origin and development is mostly during the winter season. The major centres of these cyclones where they originate are North Pacific Ocean to West of Aleutian low pressure region and western coastal margins of North Atlantic Ocean to Iceland low pressure region, the area of cyclones further extends to China, Philippines, Siberia. The origin of these cyclones in the southern hemisphere during winter and summer seasons, is in the similar pattern. In this hemisphere the cyclones are very frequent near 60° South latitude.

Types of temperate cyclones

These cyclones are divided into three different categories:-

- (i) Thermal Cyclone
- (ii) Dynamic Cyclone
- (iii) Secondary cyclones

The weather conditions tend to change before the arrival of cyclone. When the sky is covered with thin white layer of clouds and there is sudden decrease in pressure in barometer, there is change in the direction of winds, the sun and the moon are encircled by halo, circulation of winds almost stops, it indicates the arrival of a cyclone.

(2) Tropical Cyclones

Tropical cyclones are formed between the Tropic of Cancer and Tropic of Capricorn on both sides of the equator. There are numerous forms of tropical cyclones. The cyclones become more vigorous and cause havoc in the

affected area. No uniformity is found in these cyclones as that of temperate cyclones.

The major characteristics of the cyclones are as follows-

- (i) The centre of the cyclone is characterized by low pressure and the isobars are circular.
- (ii) The velocity of these cyclones varies, somewhere their speed is 32 km per hr and somewhere it is 200 kilometre per hour.
- (iii) Their size also varies. Mostly their diameter is between 80 to 300 kms.
- (iv) These cyclones are permanent in nature. They can cause heavy rainfall for many days at the same place.
- (v) The cyclones are more devastating.
- (vi) The speed of these cyclones is more on oceans but it reduces as they reach land mass.

Origin

The cyclones are originated between 8° to 15° north latitudes over oceans. They are more common during summer season. Their birth place of origin and development are mostly oceanic areas. They usually fade away as they reach the land mass. The cyclones are called hurricane near Western Islands, China and Philippines, in Japan they are called Typhoon and Cyclone in Indian Ocean. The major centres of the origin of these cyclones are North Atlantic Ocean, Gulf of Mexico, Western Island group, South China Sea and most of the regions of Pacific Ocean.

The tropical cyclones are categorised into the following parts:-

- (1) Tropical depressions, (2) Tropical Storms
- (3) Hurricane or Typhoons (4) Tornado

Hurricane is the name given to tropical cyclones of USA.

Typhoon is similar to Hurricane which is frequently found in eastern coastal regions of

China.

Tornado is comparatively smaller in size but most vigorous and devastating tropical cyclone which is frequent in the Mississippi Valley of USA and some regions of Australia.

Theories about the origin of cyclone

There are three major theories about the origin of cyclones:-

- (1) Local Thermal Theory
- (2) Dynamic Theory (Lambert and Shaw)
- (3) Polar Front Theory (Berknes 1918)

Anticyclone

The anticyclone wind system, which are surrounded by circular isobars having high pressure at the centre and lowest at the outer margins. The winds blow from the centre towards the outer margins. Anticyclones are totally opposite to cyclones in nature, characteristics, wind system and weather conditions. They are much larger in size comparatively more than the cyclones. The winds blow gently and the sky remains clear. The term anticyclone was first used by Galton in 1861. Anticyclones of permanent nature are mostly found between 30° latitude in both the hemispheres over in the oceans. They usually fade away in the higher layers of the atmosphere.

There is high pressure area at the centre

Characteristics:-

- (i) Anticyclones are high pressure areas, and the pressure decreases outwards from the centre.
- (ii) The winds blow clockwise in the Northern hemisphere and anticlockwise in the southern hemisphere.
- (iii) Anticyclones are comparatively larger in size than cyclones and circular in shape.
- (iv) With the arrival of anticyclones the weather becomes pleasant; the sky becomes clear and winds blow gently.
- (v) They are more frequent in temperate

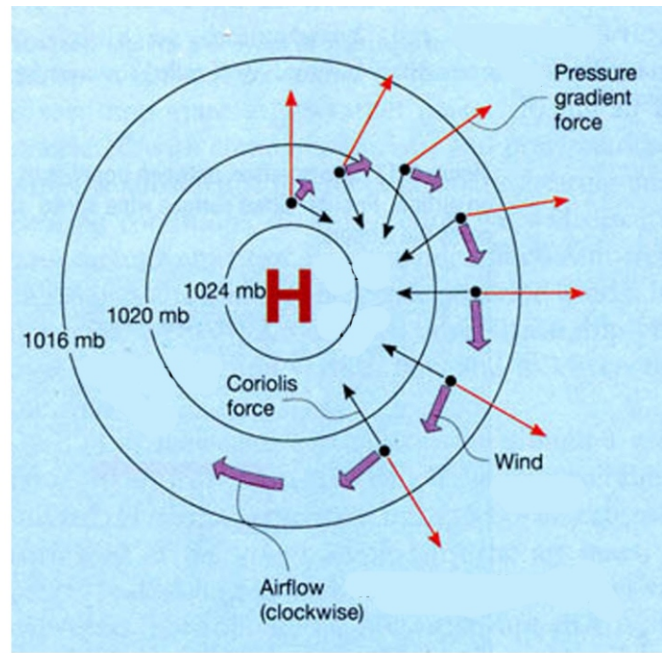
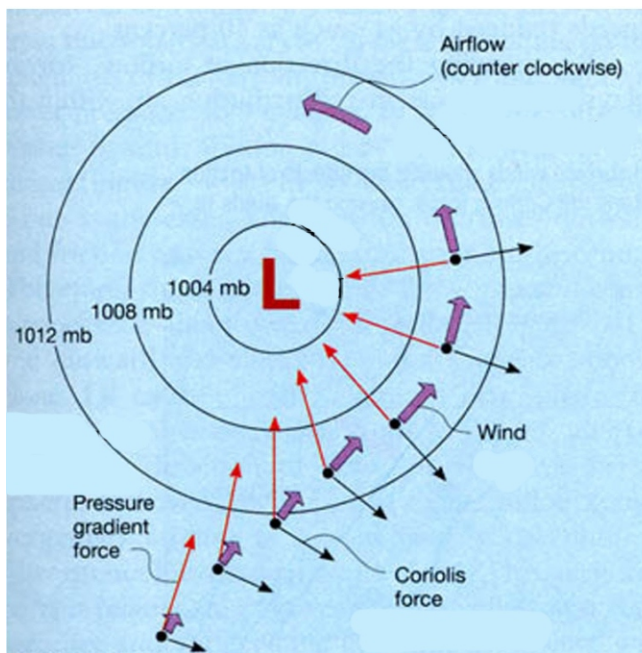


Fig. 14.3 : Cyclone and Anticyclone in Northern hemisphere

high pressure areas.

Types of Anticyclones

The famous meteorologists, Hanzilk in 1909 categorised anticyclones into two different categories:-

- (1) Cold anticyclone
- (2) Warm anticyclone

On the basis of new discovery of meteorologist (3) Blocking anticyclone was also categorized.

So now there are three types of anticyclones.

(1) Cold Anticyclone

These cyclones basically originate in the polar regions specially in Arctics, from where they advance in easterly and south easterly direction. (Fig. 14.3)

They are comparatively smaller than tropical anticyclones but they move rapidly than the latter. Their thickness is also lesser and the height is not more than 3000 m. These are of two types:-

- (i) Temporary Anticyclones usually fade away as they move forward. There are very few anticyclones that reach the

tropical regions.

- (ii) Semi Permanent Anticyclones these anticyclones are more active and travel longer distances.

The origin of cold cyclones are mostly thermally induced. These Anticyclones are developed because of high pressure developed due to decrease of temperature by radiation and receiving less insolation during winter season in the Arctic regions. Basically cold anticyclones follow two important tracks:-

- (1) North of Canada and (2) North of Siberia

(2) Warm anticyclone

These anticyclones originate in the belt of temperate high pressure areas. The winds diverge in this belt. They are larger in size but are less active. However they are more active in south east USA and West European countries. In this type of anticyclone, the wind blows gently and sky remains cloudless and mostly clear.

(3) Blocking Anticyclone

This type of cyclones have been categorised on the basis of new discoveries made by meteorologists. They are developed

due to obstruction in the air movement in the upper layers of troposphere. They have similar characteristics of wind system, air pressure and weather conditions of warm anticyclones. They are smaller in size and mostly move slowly. They originate in North-West Europe and Western regions of Atlantic Ocean and Pacific Ocean.

Jet stream

The fast moving air in the upper layers of troposphere, near the boundary of troposphere is called jet stream. These are narrow belt of, spiral and high speed wind currents. They continuously encircle the earth. They are 40 to 160 km wide and 2 to 3 km thick.

Their speed is more than 120 kilometres per hour. Their speed is more during winter season. The circulation pattern changes according to the season. Their circulation shifts towards the poles during summer season and towards the equator during winter season. The discovery of these winds was made during Second World War. Since then they were extensively studied. However there is no unanimous approach of meteorologist regarding the origin and other aspects of Jet stream but still the information collected is utilised to facilitate the aircrafts. Jet streams are divided into two parts:-

- (i) Subtropical Jet Stream
- (ii) Mid Latitudinal or Polar Front Jet Stream

(i) Subtropical Jet Stream

The location of this Jet stream is found between 30° to 35° latitudes in both the hemispheres. They prevail throughout the year. They are believed to be formed due to rotation of the earth. The rotation of the earth creates maximum velocity in the atmosphere near the equator. This results, in rising of air currents above the equatorial region, that extends in north and south and blows in high velocity. These air currents, under the impact of Coriolis force diverge towards right in Northern

hemisphere and towards left in Southern hemisphere. These air currents take the form of subtropical jet stream at 30° latitude.

Mid Latitudinal or Polar Front Jet Stream.

These Jet streams are formed due to the variation in temperature and keep deep reaction with polar front. They are located between 40° to 60° latitudes in both the hemispheres. Their location tends to change more frequently than subtropical jet stream. They shift towards Polar Regions during summers and towards equator during winters.

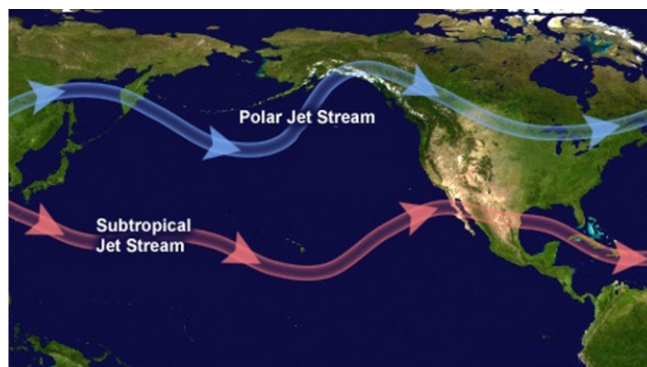


Fig. 14.4 : Direction of Jet Stream

Although the jet streams are not yet fully understood but they still create a huge impact on weather conditions. Many atmospheric conditions are affected and made vigorous by Jet streams like cyclones and anticyclones, monsoon winds, high velocity winds and many other atmospheric conditions.

Important points

1. The high velocity winds blowing in the upper layers of troposphere in mid-latitudes is called jet stream.
2. The line along which two different air masses converge is called Front. There are two types of front, warm front and cold front.
3. Cyclones are low pressure centres surrounded by high pressure from all

sides. The winds in cyclone, blow in anticlockwise direction in the Northern hemisphere and clockwise in the southern hemisphere. They cause rainfall with thunderstorm.

4. In an anticyclone pressure conditions and direction of winds is totally opposite to cyclone. The weather remains dry and clear.

Exercise

Multiple choice questions

- Which of the following is called Cradle of cyclones and anticyclones?
 - Fronts
 - Air Masses
 - Disturbances
 - Hurricane
- The direction of winds in the Northern hemisphere in cyclones is:-
 - Anticlockwise
 - Vertical
 - Clockwise
 - Diagonal
- A Hurricane is a:-
 - Temperate cyclone
 - Tropical cyclone
 - Anticyclone
 - Front
- Who propounded the dynamic concept of origin of cyclones?
 - Bjerknes
 - Lampert and Shaw
 - Wegner
 - Davis
- Which of the following is not a type of front?
 - Warm Front
 - Cold Front

- Stationary Front
- Non-stationary Front

Very short type questions

- Classify air masses on the basis of its place of origin.
- What is a Warm Front?
- What is a Stationary Front?
- Where do the tropical cyclone origin?
- What is a Cyclone?

Short type questions

- What is a front? What are its different types?
- What are the necessary conditions for the formation of Fronts?
- Differentiate between cyclone and anticyclone.
- What is a Hurricane?
- What are the major theories about the origin of cyclones?

Essay type questions

- What are Fronts? What are the conditions necessary for the formation of fronts and describe its major types.
- What is a Cyclone? Describe the origin of Temperate cyclones and their different types.
- What are cyclones and anticyclones? Describe their characteristics and different types.

Answer key

- 1.A. 2.A. 3.B. 4.B. 5.D

Lesson - 15

Condensation and Rainfall

The water vapour present in the atmosphere is called humidity. On average there is 2% of humidity in the atmosphere. Water is present in the air in the form of water vapour or steam. Like every substance water is found in three states as solid, liquid and gas. Water vapour comes in the atmosphere through evaporation. Under favourable conditions this water vapour condenses, descends on the earth's surface in the form of rainfall, hail or snow. This surface water, flows back to sea or directly enters into the atmosphere. Some percentage of water is absorbed by plants and the rest is left in the atmosphere for evaporation. This mutual exchange of water between oceans, atmosphere and continents occurs continuously through transpiration, evaporation, condensation and precipitation.

The actual amount of water vapour present in the atmosphere is called absolute humidity. Or the total amount of moisture content actually present in a given volume of the air is called absolute humidity. Absolute humidity is different at different places on the earth's surface. The rainfall depends on the amount of absolute humidity. Absolute humidity is expressed in gram/sq metre. In the same way the proportion between the capacity of the air to hold moisture and the actual moisture present in the air at a given temperature is called relative humidity. It is expressed in percentage.

$$\text{Relative Humidity} = \frac{\text{Absolute Humidity} \times 100}{\text{Humidity Capacity}}$$

The atmospheric humidity is measured by Hygrometer.

The air with moisture content, which is equal to its capacity to hold moisture, is called saturated air. In the same way the temperature at which the air gets saturated is called 'Dew Point'.

Evaporation

The process through which water in the form of liquid or solid, changes in to gas or water vapour, is called evaporation. The atmosphere receives humidity through evaporation. Therefore the process through which the water turns into vapour is called evaporation. The amount and the intensity of evaporation depend upon speed of the wind, temperature and dryness. Evaporation is more prominent in the oceans in comparison to land mass. Generally, it requires 79 calories for one gram of ice to change into water and one gram of water requires 607 calories to change into vapour.

The maximum evaporation takes place on continents between 10° north to 10° South latitudes and in oceans between 10° to 20° latitudes in both the hemispheres. The amount of evaporation reduces towards the higher altitudes. Evaporation is not uniform at all the places. The amount of evaporation depends on (1) Temperature (2) Dryness air, (3) Extent of water in the region, (4) Clouds, (5) Velocity of the Wind.

Condensation

The process of converting water in the form of liquid or solid is called condensation. The process of condensation in the atmosphere depends on the availability of amount of the absolute humidity. The

temperature at which the air gets saturated is called Dew Point. The process of condensation begins either when the temperature drops below Dew Point or when the amount of water vapour increases. This happens under two conditions:-

- (1) Decrease in the temperature
- (2) Increase in humidity

The decrease of temperature is most favourable for the process of condensation.

Forms of condensation

The major forms of condensation are Dew, Frost, Clouds and Fog.

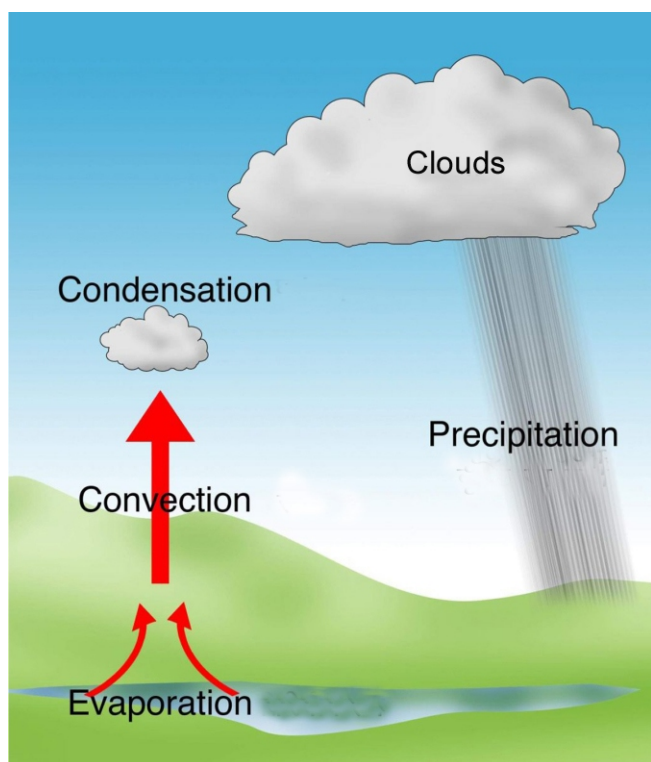


Fig.15.1 : Evaporation, Condensation, Convection and Precipitation

(1) Dew

Mostly the earth's surface gets heated during the day and cools down during the night, sometimes the temperature of the air touching surface of the earth decreases below the Dew Point. The water vapour present in the air gets condensed and is deposited in form of droplets on plant leaves and other objects. This is called Dew. The formation of the Dew depends on (1) presence of water vapour in the air (2) the temperature of the earth's surface should decrease to an extent that, it condenses the

water vapour present in the air.

(2) Frost

During the condensation of water vapour in the air, when the temperature is 0°C or below it, the water vapour, instead of getting condensed into water droplets, transforms into. It is important for the formation of the Frost that the temperature of the air decreases rapidly and for a longer period of time. The sky should be clear and water vapour should be present in the air and the temperature should remain below Dew Point.

(3) Fog

Fog forms due to the condensation of water vapour near the earth's surface. The Fog reduces the transparency of the atmosphere. When the visibility on the earth's surface or in atmosphere is reduced to less than 1 km, the condensed water vapour is called Fog. The decrease in temperature below Dew point and gentle movement of wind are important for the formation of Fog. On the basis of visibility, fog is of following types- Light, Moderate, Thick and Very Dense. The visibility in the fog is measured by an instrument called Transmissometer. When the visibility is extremely low it is called Mist.

(4) Clouds

The mass of particles or ice crystals, that are formed due to condensation of water vapour at the greater heights of the atmosphere, is termed as clouds. Clouds are mostly found at the height of 12000 meters. As the formation of the clouds occurs at some height from the earth's surface, its shapes varies.

Thus on the basis of their height, density, extension and transparency, clouds are classified into following types-

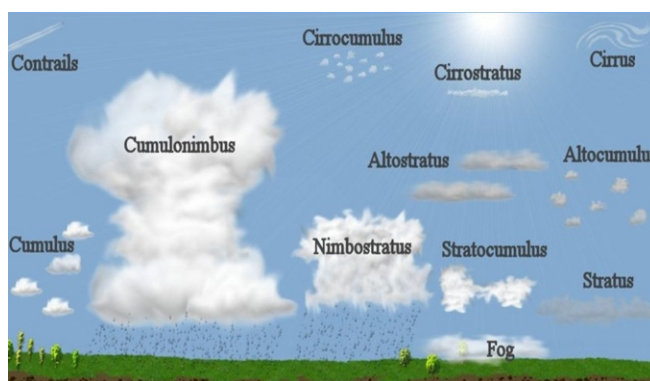


Fig. 15.2 : Types of Clouds

(i) Cirrus Clouds, (ii) Cumulus Clouds, (iii) Stratus clouds, (iv) Nimbus clouds

(i) Cirrus Clouds

They are found at the maximum height. (8000 to 12000 m). The weather remains calm and sky is clear and these clouds do not cause rainfall. They extend in the whole sky like a sheet. Due to these clouds, a halo is formed near the sun and the moon; which indicates the arrival of the cyclone.

(ii) Cumulus Clouds

These extensive and dark coloured clouds, dense and heavy. These clouds cause heavy rainfall and thunderstorms. They appear similar to a mass of cotton. Their height varies from 4000 to 7000m. Their shape resembles to a cauliflower.

(iii) Stratus clouds

These clouds are similar to Fog and are found near the earth's surface. They are in form of many layers. These clouds are formed due to convergence of two air masses of different nature in winter season in temperate zone.

(iv) Nimbus clouds

Clouds are very dense and dark. As these clouds are very dense they cause darkness and heavy rainfall. They are found nearest to the earth's surface.

Precipitation

A total amount of rainfall including drops received from snow, hail and clouds, measured by Rain gauge at a fixed place during fixed duration of time is called precipitation. The water vapour which is present in the air gets condensed and changes its form to liquid or solid state and falls on the ground, is termed as precipitation. It can be in both liquid and solid form. When the precipitation is in liquid form it is called rainfall. When the temperature is below 0°, the precipitation is in form of ice particles it is called as snowfall. Hail, snow and water, all three are included in precipitation. Generally, precipitation is understood to be as rainfall. There are two conditions important for precipitation:-

- (i) Sufficient amount of water vapour in the air
- (ii) The presence of such a means so that vapour laden wind may be condensed by getting cool

that leads to decrease of temperature of the air and it becomes cold

Types of rainfall

On the basis of the origin of the rainfall it is classified into following types:-

1. Convectional Rainfall
2. Orographic Rainfall
3. Cyclonic Rainfall

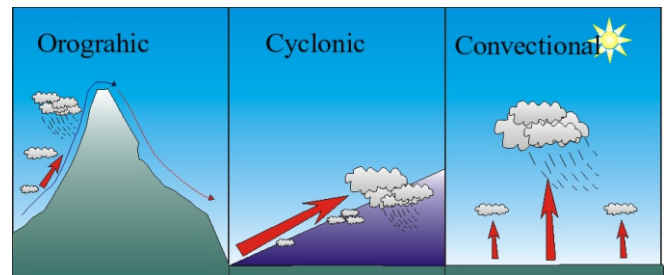


Fig. 15.3: Types of rainfall

1. Convectional Rainfall

This type of rainfall occurs almost daily in the afternoon in the equatorial regions. Due to excessive heat after getting heated. The air rises up as it becomes warm and light, the water of the oceans turns rapidly into water vapour and rises up and this process is called convectional process.

2. Orographic Rainfall

It is also called as surface rainfall. This is the most prevalent rainfall in the world in which the saturated air have to rise along the mountain to get cool. The colder air gets condensed and causes rainfall. Thus, this air rises up due to mountain barriers and causes rainfall as they cool down. The windward side of the mountain receives more rainfall than its other side. Thus this slope of the mountain that receives lesser rainfall is called as rain shadow area.

3. Cyclonic Rainfall

This type of rainfall is more common in colder regions. This type of rainfall is caused due to cyclones. The winds blow at high velocity towards the centre and rises up in a cyclone. These winds carry water vapour as they cross oceans. When these winds come in contact with the polar cold winds, it leads to the formation of fronts. The hot and humid air gets condensed and causes rainfall.

This type of rainfall is called cyclonic rainfall. This type of rainfall does not cause heavy rains but comes in the form of gentle showers throughout the year. This type of rainfall is more prominent in temperate regions. This type of rainfall occurs during winter season in North Western parts of India.

Isohytes

The lines which are drawn to connect the areas of equal rainfall on world's map are called Isohytes.

Rain Gauge

The instrument by which the rainfall is measured is called Rain gauge. The rainfall is measured in inches or millimetres.

Major Factors affecting rainfall

(i) Latitudes (ii) Height (iii) Prevailing winds (iv) Ocean Currents (v) Distance from the Sea (vi) Location of Land and Sea (vii) Direction of mountain ranges.

World Distribution of rainfall

The amount of rainfall received on earth's surface is different at different places. The distribution pattern of rainfall is highly uneven. At some places the amount of rainfall received is 200cms whereas at some places it is less than 20 cms. The factors that affect the distribution pattern of rainfall include, temperature, distribution of land and sea, direction of winds, direction of mountains etc. There are following six belts of rainfall on the earth,

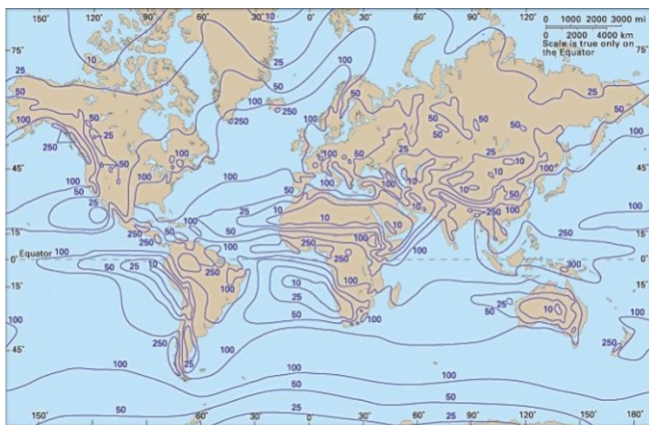


Fig. 15.4 : World Distribution of rainfall

1. Equatorial belt of maximum rainfall

It extends between 10° north and south of the equator, in both the hemispheres. It includes Amazon Valley of South America, Congo basin of Africa, coastal margins of Central America, New Guinea, eastern coastal regions of Madagascar and Philippines. This region receives rainfall between 175 cm to 200 cm. This type of rainfall is mostly convectional. The rainfall with thunder and lightning occurs in the afternoon on each day.

2. Trade wind rainfall belt

This belt extends between 10° to 20° latitudes from the equator in both the hemispheres. The rainfall occurs due to trade winds on the eastern margins. Monsoon rainfall also occurs in this zone.

3. Subtropical belt of minimum rainfall

This is zone extends between 20° to 30° latitudes in both the hemispheres. This is a high pressure belt, in which the winds descend from upper part to lower part.

Thus anticyclonic conditions prevail. The deserts of Egypt, Sahara and Thar are located in this belt. The average of yearly rainfall is about less than 25 cm.

4. Mediterranean rainfall Belt

This belt extends from 30° to 40° latitudes near the western coastal margins, in both the hemispheres. This includes California, Central Chile, south west region of South Africa, south west regions of West Australia. In this region, the rainfall occurs during winter season by Westerlies. Most of the rainfall is cyclonic. The average yearly rainfall is 100 cm. Dry summer season is the prominent characteristic of this belt, as it remains under the influence of dry trade winds during this season.

5. Mid Latitudinal belt of high rainfall

This belt extends between 40° to 50° latitude in both hemispheres. The Western margins receive more rainfall in this belt. The southern hemisphere receives more rainfall than northern hemisphere due to dominance of oceans. In this belt, the cyclonic rainfall occurs due to the convergence of westerlies and polar winds. The annual average rainfall is between 100 cms to 125 cms.

6. Polar belt of low rainfall

This belt extends from 60° latitudes to poles, in both the hemispheres. The amount of rainfall decreases towards the poles. Most of the rainfall occur in the form of snowfall. The annual average rainfall is about 25 cm.

Important points

1. Water vapour is present in atmosphere, due to which formation of clouds, rainfall, snowfall, dew, Frost, fog occurs.
2. The amount of water vapour present in the air is called humidity. It is of two types absolute and relative.
3. When the amount of water vapour present in the air is equal to the capacity it can hold, it is called saturated air. It is closely related to temperature.
4. When the water vapour changes into water or snow, it is called condensation. Dew, Frost, Fog, Mist are forms of condensation.
5. Convictional, Orographic and Cyclonic are different types of rainfall.

Exercise

Multiple choice questions

1. Which instrument is used to measure the humidity in the atmosphere?
(A) Hydrometer
(B) Hygrometer
(C) Isobar
(D) Barometer
2. Which of the following clouds are found at the maximum height in atmosphere?
(A) Cirrus clouds
(B) Stratus clouds
(C) Cumulous clouds
(D) Nimbus clouds
3. The visibility in the fog is measured by:-
(A) Hydrometer
(B) Transmissometer
(C) Cubic metre
(D) Millimetre
4. The rainfall occurring in the afternoon in

equatorial regions is called-

- (A) Orographic rainfall
- (B) Cyclonic rainfall
- (C) Convictional rainfall
- (D) None of the above

5. The actual amount of water vapour present in the atmosphere is called
(A) Evaporation
(B) Absolute humidity
(C) Relative humidity
(D) Condensation

Very short type questions

6. What is humidity?
7. What is relative humidity?
8. What is cyclonic rainfall?
9. What is precipitation?
10. What is fog?

Short type questions

11. What is humidity? Describe its different types.
12. Differentiate between absolute and relative humidity
13. What is evaporation?
14. What are the different types of clouds?
15. What are Isohyets?

Essay type questions

16. Describe the major factors that affect rainfall.
17. What is condensation? Describe its various forms.
18. Explain the concept of precipitation and describe various types of rainfall.

Answer Key

1. B. 2. A. 3. B. 4. C. 5. C

Lesson - 16

Classification of Climate

The temperature, pressure, humidity, clouds, rainfall and movement of winds of a place, are called elements of weather and climate. There is difference between weather and climate.

Weather-

The sum total of atmospheric conditions (like temperature, pressure, winds, humidity, precipitation and clouds) at a place and time is called weather. The weather always keeps on changing. In other words we may say that weather is a momentary state of atmosphere.

Climate-

The climate is the average summary of weather conditions of a particular place. It is the description of atmospheric conditions for a longer period of time of an extensive region. Therefore climate is much broader term than weather. According to Monkhouse- climate is basically, includes the description of atmospheric conditions for a longer period of time of a particular place.

Classification of climate

Different types of climate are found in different parts of the world. This is due to a number of factors that affect the climate out of which the major ones are location, distance from the sea, mountain barriers, ocean currents, direction of winds, height above sea level and atmospheric disturbances.

The first attempt of classification of climate was done by ancient Greeks. They divided the

world on the basis of temperature into three major zones-

1. Tropical Zone
2. Trade Zone
3. Frigid Zone.

Therefore, the description of climate after the collection and arrangement of data in sequential way and providing regional description on the basis of analysis of data collected, is called classification of climate. No climatic classification is complete in itself. Therefore the classification is done in a generalized way. Many scholars of the world have classified the climate out of them the major ones are Koppen, Miller, Thornwaite, Trewartha.

The climate greatly influences the physical and mental activities of human beings. The climate determines, the place of their dwelling and their development, occupation they will adopt to and the regions where they will cultivate crops. The climate effects the occupation, business, health, physical and mental capacities of human beings.

Classification of climate according to Koppen

The famous German climatologist Wladimir Koppen presented his classification of climate first of all in 1900, which was on the basis of the vegetation regions of the world. He modified his classification many times from 1900 to 1936. The basis of his classification was temperature, rainfall, and their relationships with the weather conditions. He tried to correlate these elements with the vegetation, as he believed that the climate as a whole, is well represented by natural vegetation. In this way, Koppen adopted such a quantitative method of classification of climates which could establish a deeper connection between climate and

vegetation. Koppen classified the climate of the world into 5 major types by using English alphabets A, B, C, D, E.

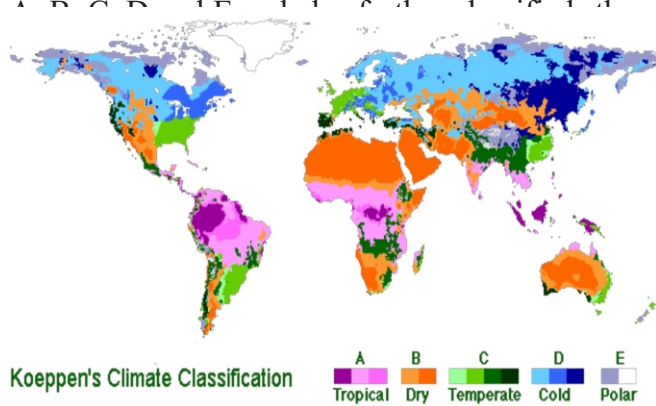


Fig.16.1 : Classification of Climate according to Koppen

	Classification of climate	Characteristics
A	Humid Tropical Climate	Mean temperature of all the months is above 18°C, winterless season, rainfall exceeds amount of evaporation
B	Dry Climate	Evaporation exceeds the amount of rainfall, scarcity of water
C	Mid-latitudes warm temperate climate	Both summers and winters are found here, the mean temperature of the coldest month is less than 18°C and more than 3°C
D	Cold Temperature Climate	Severe winters, Mean temperature during winters is less than 3°C but more than 10°C in summer
E	Polar Climate	Summerless season. The mean temperature of the warmest month is less than 10°C

Table 16.1

Classification of climate according to Koppen

The description of climatic classification by Koppen is as follows-

1. A Tropical Humid Climate

The average temperature here, is above 18°C of every month. Winter season is not found in this type of climate. The rainfall occurs throughout the year. The amount of rainfall exceeds the amount of evaporation. It is further classified into three sub divisions on the basis of temperature, rainfall and aridity.

(i) Af- Tropical humid Climate

The rainfall occurs throughout the year, there is no annual range of temperature, aridity is also deficient.

(ii) Am- Tropical Monsoon Climate

It is also called monsoon type of climate. Dense vegetation is found because of excessive rainfall. A short dry season is also found here.

(iii) Aw- Tropical Wet and Dry Climate

It is also called Tropical Savanna climate. The temperatures is higher throughout the year. The rainfall occurs during summer season and winters remain dry.

2. B Dry Climate

In this type of climate evaporation exceeds the amount of rainfall. There is often scarcity of extra water. It is further divided into two types on the basis of temperature and rainfall-

(i) BS - Steppe Region - The amount of rainfall, is sufficient for the growth of dry grass.

(ii) BW- Desert Region- The amount of rainfall in this region is insufficient for the growth of vegetation.

On the basis of temperature the steppe and desert climate, each region is further divided into two sub-divisions-

(i) BSh- Tropical Steppe Climate

(ii) BSk- Cold Steppe Climate

(iii) BWh- Warm Tropical Desert Climate

(iv) BWk- Cold Desert Climate

3. C Warm Temperate Humid Climate

It is also called mesothermal climate. The average temperatures of the coldest month is below

18°C and above -3°C. The summer and winter both type of seasons are found here. Winters are not extreme. On the basis of seasonal distribution of rainfall it is further divided into following three divisions:-

- (i) Cf- Precipitation throughout the year
- (ii) Cw- Heavy rainfall during summers
- (iii) Cs- Heavy rainfall during winters

Its other subdivisions are a- hot summer, b- cool summer, c- cool short summer.

4.D Cold Temperate Climate

The minimum temperature of coldest month is -3°C and the average temperature of the hottest month is more than 10°C. Coniferous Vegetation is found in this type of climate. It is further divided into two subdivisions-

- (i) Df- Rainfall throughout the year
- (ii) Dw- Rainfall during summers and dry winters.

5. E Polar Climate

- (i) ET - Tundra type of climate

The temperature during summer season varies between 0° to 10°C.

- (ii) EF - Perpetual Snow Climate

The temperature during summer season is less than 0°C. There is perpetual snow throughout the year.

In this way Koppen presented the classification of world climates by including, the secondary characteristics of rainfall and temperature.

Some scientist have considered the classification presented by Koppen to be incomplete. The climatologist like Thornwait, Jones, Ackermann have criticized the classification. They are of the opinion that this classification is suitable for plain regions but misleads for mountainous regions. It is not sufficient to divide the entire world into 5 climatic regions. But still koppen's classification is given importance in geographical studies, because it is very popular as it easy to understand.

The ease of teaching and learning of this classification is its most dominant characteristic.

Green House effect

In the colder regions, where the solar

radiation is almost negligible, green houses are used to cultivate fruits and vegetables. The incoming solar radiation reaches inside through the glass of these green houses but do not allow to go out the re-radiation in the form of long waves. Due to this the temperature inside the green house increases. The atmosphere of the earth works similar to green houses. It maintains the average temperature of 35°C on the earth.

The gases found in the atmosphere like carbon dioxide, methane, water vapour, nitrous oxide, chlorofluorocarbon are responsible for greenhouse effect. These gases allow the shortwave radiation to reach the earth but return the long wave radiation towards the earth, specially by absorbing red rays which keeps the surface of the earth warm continuously. This process is called greenhouse effect.

The water vapour present in the atmosphere keeps the earth warm but due to human activities, gases like carbon dioxide, Methane, nitrous oxide, chlorofluorocarbon are causing greenhouse effect. Carbon dioxide is the major Green house effecting gas. There is constant increase in the amount of carbon dioxide in the atmosphere.

The extensive industrial development and vehicular pollution causes increase in carbon dioxide. Due to the burning of coal, mineral oil, and fuel wood respiration of human beings, volcanic eruptions, decomposition of vegetation, the amount of carbon dioxide is constantly increasing. Methane gas is produced due to foodgrain cultivation, marshy lands, mining, termites and burning of fossil fuels. Nitrous oxide is basically produced due to use of Nitrogen based fertilizers and burning of fossil fuels. The production of Nylon also causes its increase. Chlorofluorocarbons are produced during chemical processes. According to studies done by scientist carbondioxide contributes 57%, Methane 18%, Nitrous oxide 6%, Chlorofluorocarbon 17% in the green house effect.

Harmful effects of greenhouse effect are as follows:-

1. Increase in Temperature

The global rise in temperature of the Earth is due to the greenhouse effect created by human beings. This is the major cause of rise in greenhouse

gases in nature. Due to increase in temperature the climate of the earth will change. The discrepancies in the weather conditions are the result of this.

2. Increase in Rainfall

Due to increase in temperature, there will be more evaporation from water bodies which would cause excessive rainfall.

3. Melting of Polar Ice

As the temperature of the earth will rise the ice on the mountain peaks and polar regions will melt.

4. Rise in the Sea Level

Due to the increase in average temperature of the world, the ice on the mountains and polar regions would melt which would cause rise in the sea level. This will cause the submergence of coastal margins.

5. Effect on Agriculture

As the pattern of rainfall will change the agriculture will also be affected.

6. Effect on living creatures and vegetation

The living creatures who will not be able to adapt themselves according to increasing temperature will get extinct. Due to the rise of sea level the vegetation near the coastal margins will be submerged under water. The biodiversity of the world will decline.

Measures to Control Green House Effect

Green house effect has caused danger to entire biosphere. To control this effect following measures are suggested:-

1. The drastic rise of carbon dioxide gas, which has the highest contribution in greenhouse effect, should be checked. The burning of fossil fuels should be reduced for this. Alternative fuels should be used more.
2. Deforestation on the large scale should be checked and afforestation should be done extensively.
3. Proper measure should be taken to check the increase in population.
4. Such devices should be used in vehicles and industries which may emit lesser polluted

gases and these gases should get disintegrated before they reach the atmosphere.

5. The use of chlorofluorocarbons should be very limited.
6. The chemical fertilizer should be used in restricted amount. Organic Fertilizers should be used more.

Global warming

The temperature of the earth is constantly rising due to increase in greenhouse gases. Excess amount of carbon dioxide is produced by industries and vehicles, which is comparatively higher than the proportion of carbon dioxide utilised by plants. This results in the increase of carbon dioxide in the atmosphere at the rate of 2% per year. As this gas is heavier it accumulates in the form of a layer near the surface of the earth. The Terrestrial radiation from the earth, is reflected back towards the earth which is the cause of increase in temperature of the earth. This increase of temperature of the earth is called Global warming.

The scientists after studying the Global temperature from 1400 till present, have found that 1990 1995 and 1997 have been the warmest years. It is estimated that there is rise of 1°C in the earth's temperature in the past 50 years. According to the scientist the amount of carbon dioxide will be double in the 21st century in comparison to the period before the industrialisation (1860). This will result into the increase in global temperature of 1.50 to 4.5°C by 2050.

Kirbati and many other island countries using "Migration with Dignity" policy are requesting many International platforms. The proportion of people going out of Kirbati island group may be more but due to rise in oceanic level, there will be no possibility of them to return home. Due to these climatological reasons there will be mass migration in the future. Therefore, it is the moral responsibility of all to establish sociological, cultural and economic harmony globally.

The National Academy of Sciences, US (2015) has studied the rise of sea level in 3000 years due to global warming. According to the

academy, if the Global Warming continues at the same rate, the sea level will rise by 1.5 m by the end of this century. This will affect 20 million people who are residing on the coastal margins in the world. It includes China, India, Japan, Indonesia, Vietnam, Bangladesh, Maldives and thousands of islands in Pacific Ocean. According to the report of USA, 16% of Bangladesh region and 15% of its population is directly related to this danger. The existence of many islands of Pacific Ocean like Tora, Solomon, Marshall and many other low lying island countries, which are formed of corals and volcanoes, are in danger.

Impact of Global Warming

The impact of global warming will be as follows:-

1. Due to the increase of temperature there will be large scale climatic changes. The presently observed climatic discrepancies is the result of global warming.
2. The rainfall patterns will be changed due to rise in temperature. Due to increase in temperature there will be more evaporation of water bodies. The increase in water vapour and temperature will cause more rainfall. This will result into change in the cycle of seasons. The summers will extend and winters will be shorter.
3. Global warming will increase the El Nino effect and the cyclones will be more frequent.
4. As the temperature of the earth will rise, the ice of the polar regions and mountain peaks will melt. This will cause rise in sea level and submergence of coastal margins. The islands in the oceans will also be submerged under water.
5. Increase in temperature the ice in the glaciers will also melt. Therefore the rivers originating from these glaciers will cause floods, as they will carry more amount of water in them.
6. The changes in the cycle of seasons, caused due to rise in temperature, will greatly affect the agriculture. This will cause change in agriculture pattern and its methods.
7. The existence of all plants, trees and all living creatures will be in danger.

Measures Preventing Global Warming Effects

Following measures can be taken to prevent the global warming:-

1. The burning of fossil fuels like coal, Mineral

oil and gases should be reduced. Instead alternative fuels should be used.

2. The forest should be extended by afforestation.
3. The growth in population should be controlled.
4. The industries and vehicles should use such devices that may cause lesser pollution.

Climatic Change

The average of weather conditions of a place is called climate. When there is a change in these average weather conditions (temperature, rainfall, humidity pressure etc), it is called as climate change. After the study of geological history of the earth, it had been proved that there had been climatic changes since the beginning of the earth. The places which are presently deserts, they were green fields long ago. In the same way which are presently in form of land mass, were water bodies earlier. There are evidences for these changes. These climatic changes are proved on the basis of evidences of changes in the structure, series of the shale, sediments found in lakes and other water bodies, fossils and radio isotopes. There are evidences that the magnetic poles of the earth have changed their positions. Ice ages, progresses in a sequential manner on the earth. The earth was totally covered with layers of snow during these ice ages.

After the discovery of Barometer in 1640 and Rain Gauge in 1676, systematic study of climate is being done. Thus the climatic changes are also being studied methodologically.

Presently, the earth is undergoing through following climatic changes:-

1. The temperature of the earth is constantly rising. This will result into the increase in global temperature of 1.50 to 4.5° C by 2050 according to scientists.
2. The amount of rainfall and its distribution pattern, cycle of seasons are constantly changing.
3. The snow of the glaciers are melting. Therefore they are shrinking backwards.
4. There is rise in sea level. This is resulting into submergence of coastal margins. Maldives and a number of islands of Pacific Ocean, are under this danger.

Important points

1. The sum total of atmospheric conditions of a place at a particular period of time is called weather. The average summary of weather conditions of a particular place for longer period of time is called climate.
2. The earliest attempt of classification of climate was done by Greeks. The German climatologist Koppen, classified climate on the basis of temperature and rainfall. Thornthwait classified climate on the basis of temperature, rainfall and evaporation.
3. Trewartha modified Koppen's classification and presented it comparatively in a simpler form. Trewartha classified the world climate into 6 major divisions.
4. The temperature of the Earth is constantly rising due to Green House Effect. The gases which are responsible for the greenhouse effect are Carbon dioxide, Methane, Nitrous oxide, Chlorofluorocarbon.
5. The entire biosphere is in danger due to Green House Effect. The average increase in temperature of the earth, is called global warming.

Exercise

Multiple choice questions

1. Koppen classified the climate into how many divisions?
(A) 4 (B) 5
(C) 7 (D) 9
2. According to Koppen, E type of climate is...
(A) Dry Climate
(B) Polar Climate
(C) Cold Temperate
(D) Humid Climate
3. In which type of climate, evaporation exceeds precipitation?
(A) Dry Climate
(B) Polar Climate
(C) Cold Temperate
(D) Mountain Climate
4. 'Am' climate is-
(A) Tropical Humid Climate

- (B) Tropical Monsoon Climate
(C) Steppe Climate
(D) Desert Climate

5. Koppen, presented his climatic classification for the first time in
(A) 1990 (B) 1901
(C) 1936 (D) 1952

Very short type questions.

6. What do you mean by 'A' type of climate according to Koppen?
7. What do you mean by 'BW' climate?
8. Excess of evaporation over precipitation is the characteristics of which type of climate?
9. Which type of climate does not have summer season?
10. In which climatic region rainfall occurs throughout the year?

Short type questions

11. In how many climatic region the world has been divided by Koppen? Describe briefly.
12. What is the difference between weather and climate?
13. What is climate?
14. What are the factors that affect climate?
15. Give the characteristics of Polar climate.

Essay type questions

16. Give the basis of classification of climate according to Koppen. Describe its types.
17. Differentiate between weather and climate and describe the major characteristics of Koppen's five types of climatic.
18. Give a comparative description of Dry Climate and Tropical humid Climate.

Answer key

1. B. 2. B. 3. A. 4. B. 5. A

Lesson - 17

Hydrological Cycle and Distribution of Water Bodies

Hydrological cycle

It is also called water cycle. This includes movement of water and its transformation into gas, liquid and solid state. The major process of this transformation is condensation, which causes rainfall. It includes accumulation and movement of water on and below the earth's surface, evaporation and transfer of humidity. Thus, the water cycle includes the cyclic form of water on hydrosphere atmosphere and lithosphere. We have already studied about condensation and evaporation in the previous chapters.

The water from oceans, lakes, rivers and plants reaches the atmosphere through evaporation and evapotranspiration and with changing weather conditions it takes the form of clouds through the process of condensation and it reaches back to the water bodies on lithosphere and hydrosphere in the form of rainfall.

The cyclic stages of water that occur in different forms of water are called Hydrological Cycle. The circulation of water in the hydrological cycle also happens freely in different spheres. In this the transfer of humidity from one place to the other, the circulation of water through ocean currents in hydrosphere and the water from rivers and glaciers moves towards the oceans. In the same way the water reaches in the ground through evaporation from the soil and evapotranspiration from plants. Every year 1% of the total water available, is circulated in hydrological cycle. The major portion of hydrological cycle consist of pure water. The rest of its proportion is permanently frozen in the form of glacier. The rivers play an

important part in hydrological cycle as they flow from land towards the sea and oceans. Therefore the water is retained longer in oceans, snow peaks and rocks of the earth, whereas the water is stored for a shorter period of time in rivers and atmosphere.

The process of Hydrological cycle

The transformation of water into water vapour, and its relaining in the atmosphere, is a very important process, as the changes of weather conditions depends on it. There are several agents that affect the mobility of water in the water cycle that is operating on the earth. The water of oceans enters atmosphere in the form of vapour created by energy received from the seen. The winds blowing from oceans towards land create movement in vapour and help in trasfer of vapour from one place to the other. Due to this, water vapour condenses and causes rainfall on the earth surface. Thus the water received from the rainfall flows in rivers and finally reaches the oceans. In this way some amount of rain water is reduced, as it is utilised in evapotranspiration by vegetation, and some of its portion is evaporated from rivers,lakes, ponds and the water reaches back to the atmosphere.

Major stages of Hydrological cycle

There are three major stages of hydrological cycle-

(i) Evaporation and Evapotranspiration

Through these processes the water from the surface reaches the atmosphere.

(ii) Rainfall

Through this, the water from the atmosphere

reaches the earth's surface.

(iii) Circulation of Wind

The mechanism of winds and weather are included in this, as they transfer and redistribute water from one place to the other.

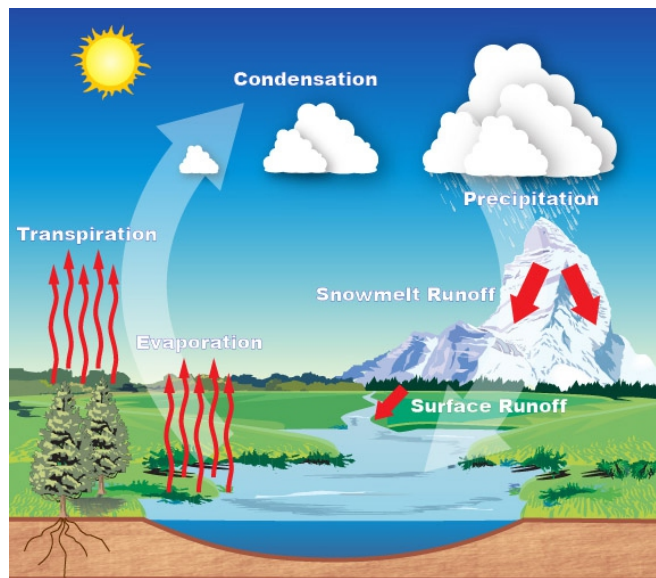


Fig.17.1 : Hydrological Cycle

Importance of hydrological cycle in nature

The transformation of water into water vapour and its retention in the atmosphere is an important process. Therefore hydrological cycle is very important for all types of activities of organism because without the circulation of water the water balance will be disturbed and life will not be possible. The hydrological cycle is the basis of life for human beings, vegetation, climate and for the entire organism of the world.

Waterbodies

The total area of the earth is 50.995 million sq km, out of which 36.10 million sq km area is covered by hydrosphere and 14.889 million sq km is of lithosphere. The ratio of lithosphere and hydrosphere was first presented by Dr. Long in 1942 which was 1: 2.81 i.e 26% of land and 74% of water, where as Wegner proposed 28.3% of land and 71.7% of water, of the entire earth.

According to many researches conducted, with the help of latest technology at the polar regions, the scientists have determined the proportion of land and water to be 1:2.43 that is 29.2

% of land and 70.8% of water . These researchers also highlighted that 43% of the entire hydrosphere is extended in northern hemisphere and 57% of it extends in southern hemisphere.

In order to clear the distribution of land and water, if we divide the entire earth into two imaginary hemispheres, the situation will be like this-

1. To depict the lithosphere, if an imaginary hemisphere is drawn, considering the mouth of river Loire, on the coast of the France as centre and the distance from this Centre to Singapore as radius, then 47.3% of this hemisphere will be land and 52.7% of this will be under water.
2. To depict the Hydrosphere, if an imaginary hemisphere is drawn from the south eastern part of New Zealand, considering as centre and the radius is taken from the north eastern coast of Sumatra to this centre, then the water will extend on 90% part of this hemisphere and land will extend upto 9.5%.

In this way, after studying the distribution pattern of land and sea, two major characteristics are highlighted:-

1. Land and Water areas are situated opposite to each other, for example African land mass opposite to Pacific Ocean, American Landmass opposite to Indian Ocean and Antarctic Landmass opposite to Arctic Ocean.
2. The shape of the continents and oceans are almost triangular. The base of the oceans is in Southern hemisphere and its head in the north whereas the base of the continents is in north and the head towards south.

**Table 17.1
The Area and Volume of water bodies**

S. No.	Waterbody	%age of area	%age of volume
1.	Oceans	88.91	96.46
2.	Enclosed Seas	0.63	0.03
3.	Fringing Bays	2.29	0.52
4.	Inland continental Seas & Lakes	8.17	2.99

The water bodies of the world apart from

extensive oceans (Pacific, Atlantic and Indian) also include enclosed seas like Mediterranean sea, Red Sea, fringing bays like Gulf of Mannar, Gulf of Baffin, inland continental seas and lakes like Caspian Sea, Dead Sea etc. The area and their volume is given in the table 17.1.

As the study of air masses is important in climatology in the same way the study of water bodies is also important in hydrology. The water bodies, in the central and lower latitude, extend extensively in a horizontal direction than vertical. The density of water increases with the increase in depth and in Polar Regions the water bodies extend in a horizontal direction than vertical.

On the basis of density, the difference in the nature of various water bodies can be well explained. According to Haylend Hassen, it is not necessary to have the same density in water of same temperature and salinity. In other words, the water bodies of varying temperature and salinity may have the same density.

The knowledge about the nature and the demarcations of water bodies, can be easily done by observing their temperature and salinity. As there are layers in the atmosphere in the same way there are layers in the oceans too. In the mid latitudes, near the equator, the surface of the oceans has a layer having lesser temperature, salinity and density, in which high velocity ocean currents flow. There is comparatively a denser layer below this. The bottom of the ocean consists of a layer of highest density.

The structure of water bodies are affected by the following factors:-

1. Latitudinal distance
2. The availability of fresh water from rain or Glacier
3. Direction of permanent winds
4. Divergence of water
5. Ocean currents
6. Oceanic cyclones

Distribution of Water Bodies

Most of the scientists have presented the classification of water bodies on the basis of temperature and salinity. It is important in a water body to possess the similarities of temperature and salinity extensively. The water bodies having same temperature and salinity are found in many seas

but many variations are found in Pacific and Atlantic Ocean. Equatorial water is not found in Atlantic Ocean. In the western parts of North and South America, the Equatorial Pacific water bodies are more. In the same way the central water bodies of Pacific ocean and North Atlantic Ocean are very different.

The world distribution of water bodies that progress in oceans, are as follows:-

1. Antarctic water body

This water body is found near Indian Ocean and south of Atlantic Ocean.

Near the continental margins due to high melting point the salinity is higher. The salinity of this place is 34.62 and the temperature is -1.9°C and the density is 27.89. After reaching the freezing point density of the water increases and it descends towards the bottom because the nearby water is comparatively warmer, which has the salinity of 34.68, temperature 0.5°C and the density is 27.84. This is a specific type of waterbody which expands in the bottom and through mixing, forms a specific type of water body.

2. North Atlantic Coastal Water Body

This water body is found between Oakland and Southern Greenland. The warm and saline water flow of North Atlantic gets cool down as it merges with East Greenland current and its density increases. Its divergence occurs at the depth of more than 1,000m. At that time its density is 27.88, salinity is 34.90 and temperature between 2.8°C to 3.3°C .

3. Antarctic Central Water body

It originates due to inclination of the



Fig.17.2 : Oceans of the world

Antarctic region. It originates all around Antarctica continent. The main cause of its origin is not known properly but it is definite that its salinity is 33.8, temperature 2.2°C and density is 27.0 which remains same at all the places. It is also affected by westerlies high velocity wind belt.

4. North Pacific Central Water body

It rises near the north east of North Pacific Ocean, near 40° north latitude. This water is deficient in oxygen levels. As it proceeds towards southern and western direction other types of water bodies also merges along with it. This is the reason why the properties of this water body after the convergence, are not always the same as it should be.

5. Central Water body

These water bodies are located centrally between 35° to 42° North and South latitudes. The amount of temperature and salinity is comparatively lower on the surface of these water bodies and keep decreasing towards higher latitudes but the density increases. These water bodies are not very deep. Its maximum depth of 900m is found in Saragossa Sea. These water bodies located in Pacific Indian and Atlantic Ocean do not have uniform relationship between temperature and salinity. The temperature of these water bodies is from -0.82°C to -1.2°C and the amount of salinity varies from 34.89 to 34.92%.

6. Equatorial Water body

This water body is located between Pacific and Indian Ocean along the equator. Due to the peculiar shape of Atlantic Ocean, equatorial water bodies are not found in them. The temperature of water is warmer. The thickness of this water body varies between 100 to 200 m. With the change of season, the temperature and salinity of this water body also changes.

Important points

1. The total area of hydrosphere is 36, 106 million square kilometre and the total area of lithosphere is 14,889 million square km which is 70.8% and 29.2% of the entire earth surface.
2. 43% of the entire hydrosphere is located in Northern hemisphere and 57% in Southern

hemisphere.

3. The distribution of land and water can be well defined in the form of two hemispheres.
4. Hydrological cycle is directly or indirectly related to the sun. Due to this fresh water is always available on the earth. Evaporation and condensation plays an important role in this.

Exercise

Multiple choice questions

1. The average amount of water present in the atmosphere is-
(A) 1 inch (B) 2 inch
(C) 3 inch (D) 4 inch
2. The cyclic stages which completes in different forms of water is called-
(A) Evaporation
(B) Condensation
(C) Hydrological cycle
(D) Rainfall
3. The difference in the nature of the water bodies can be expressed through-
(A) Salinity
(B) Density
(C) Temperature
(D) Depth
4. What is the total percentage of freshwater available in water?
(A) 1.6 (B) 2.6
(C) 3.6 (D) 4.6
5. The central water bodies are located between-
(A) 25° to 35°
(B) 35° to 45°
(C) 35° to 42°
(D) 32° to 45°

Very short type questions

6. What are the different parts of water bodies?
7. Which is the main process of hydrological cycle?
8. What percent of air water is circulated every year in hydrological cycle?
9. What are the major stages of hydrological cycle?
10. At which place, the maximum depth of the

water body is found?

Short type questions

11. What is hydrological cycle?
12. What are the major stages of hydrological cycle?
13. What are the factors that affect the structure of hydrological cycle?
14. What are the factors that affect the structure of waterbodies?
15. What are Central water bodies?

Essay type questions

16. What is hydrological cycle and water bodies, explain the importance of hydrological cycle in nature.
17. What are water bodies and explain its distribution pattern.
18. Differentiate between equatorial and Central water bodies.

Answer Key

- 1.(A). 2.(C). 3.(B). 4.(B). 5.(C)

Lesson - 18

Movements of Ocean Water

Ocean water is never static as it is affected by different factors. Its circulation is a very complex process which is controlled and affected by various factors. The waves on the ocean surface originate due to the friction of the air with water. The effect of the winds is upto 200 m of depth in the oceans. There are three basic movements of oceanic water:-

1. Waves.
2. Tides.
3. Ocean currents

1. Waves of the Ocean

The waves are the regular feature over the surface of the ocean water. According to Richard, "the waves are the disturbance of liquid surface of the ocean." This is the most extensive and universal movement of ocean water. The ocean waves originate due to two causes:-

1. Blowing of winds
2. Vibrating surface of the ocean water due to motions in the earth's surface.

Waves are the oscillatory movements of the oceanic surface. The level of the water in the sea moves up and down, but does not travel from its place. If anything (as a piece of wood), which can float on water, is thrown on surface of water, it will move up and down on its place while wave will appear travelling further.

Structure of the waves

The structure of the wave is divided into following parts:-

1. Wave Crest- the top part of the wave is called crest.

2. Wave trough- the lower part of the wave is called Wave Trough.
3. Wavelength- the distance between two wave crests, is called wavelength.

Speed of the wave

The speed of the wave is related to its wavelength and wave period. It can be calculated by using following formula:-

$$\text{Speed of the wave} = \frac{\text{Wavelength}}{\text{Time period}}$$

Causes of Wave formation

The waves are formed due to pressure and friction of winds. The velocity and shape of the Waves depend on the following factors:-

1. Speed of the wind
2. Duration of the wind
3. The distance over which wind blows uninterrupted.

Therefore, if the speed of the wind continues uninterrupted and it continuously prevails for more than 1600 kilometers for 50 hours, at the rate of 160 km per hour, then it can create 15 m high waves in the water.

The waves generated due to wind are of three types:-

1. Sea Wave- when the waves of different wavelengths moving from different direction together they form an irregular wave structure which is called sea wave.
2. Swell- when the waves of different wavelengths

move away from the area of winds where they were generated, they begin to move in an uniform pattern of equivalent period and height. They are called swell.

3. Surf- when the waves reach near the sea coast, their slope becomes steep and height is increased. After reaching the shore, it returns back towards the sea. The waves breaking in coastal areas are called surf or fanil.

Other Waves

Apart from the waves formed by winds, there are many other types of waves. The major ones are Tsunami waves, Stormy waves etc. These waves are formed due to volcanic eruptions, earthquakes or landslides.

Tides

Tides are one of the most significant oceanic movements, because being formed by gravitational force of the moon and seen these tidal waves regularly rise and fall. The sea level does not remain constant always. The sea water regularly rises and fall, twice a day at a definite interval. The rise of the sea water is called tide and its fall is called Ebb. The Rise and fall of seawater is due to the gravitational force of the earth, moon and sun. The nature and the height of tides differ from place to place.

Origin of tides

The main cause of the origin of tides is reciprocal gravitational forces of the moon, the sun and the earth. The entire earth is attracted towards the sun and the moon, due to their gravitational forces, but its effect on sea water is more than that landmass. The gravitational force of the moon is two times more than the sun, despite it is much smaller than the sun. This is because the sun is far away from the earth than the moon.

Major Characteristics of Tides

- (1) Due to uninterrupted flow of water in open seas and oceans, low tides occur. High tidal waves occurs in shallow seas and Gulfs.
- (2) The difference between maximum and minimum fall is called tidal range.
- (3) The difference of tides is less in open seas and oceans, and it is comparatively more in shallow seas and gulfs.

- (4) The height of the tide is affected by the coastline.
- (5) The time of occurrence of tide is different at different places.

Difference in time of the tide

Every place experiences tides after the interval of 12 hours 26 minutes. The earth completes its rotation in 24 hours. Every place should experience tides after 12 hours but this does not happen. This difference occurs because of rotation and revolution of earth and moon, as the Earth completes its rotation, the moon which is also revolving around the earth, moves ahead. The moon completes its revolution in 28 days. It covers $\frac{1}{28}$ th part of the circle within 24 hours. As a result the tide centre takes 52 minutes to come in front of the moon. Therefore at every place the next tide occurs 12 hours 26 minutes. It could be understood through the given diagram.

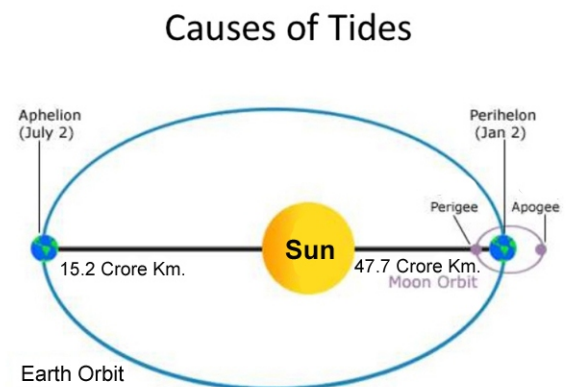


Fig. 18.1 : Interrelationship between Tides and gravitational force

Types of Tides

The height of the tides increases and decreases, according to the respective positions of the Earth, Moon and Sun,. On this basis of this, the tides are of following types:-

- (1) High tide
- (2) Neap tide

(1) High tide

This situation occurs on full moon and new

moon day. When the sun, earth and moon are in straight line. This position is called Syzygy. Once a month, the moon is so thin that it appears like a thin thread of silver in the sky. Opposite to this position, the moon completes all its phases and shines as full moon, once in a month. Thus high tides occur on these two days in every month. When the sun and moon are in one side of the earth, it is called conjunction. When the position of the Earth is between sun and moon it is called as Syzygy. In this way, conjunction occurs on no moon day and Syzygy occurs on full moon day. In this way, the combined gravitational force of sun and moon, affects the Earth, which causes high tides.

(2) Low or Neap Tide

They are 20% less in height than High tides. The earth, sun and moon come in the position of right angle on every 7th or 8th day of fortnight of a month, this results in the formation of low tides. The gravitational force of sun and moon works in opposite direction. This results into the formation of low tides which is called Neap tides.

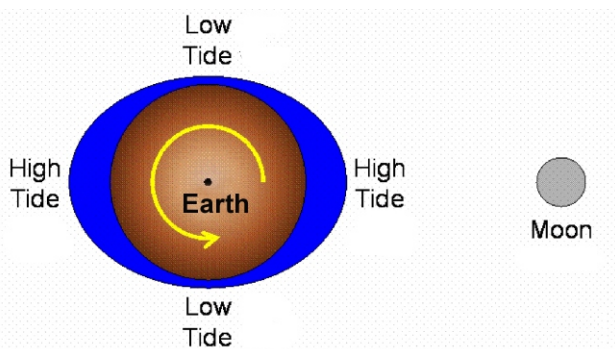


Fig.18.2 : High and Low tides

Advantages of Tides

1. Tides are the sources of energy, because on the rise and an fall of water, energy can be generated. France and Japan produce tidal energy.
2. Some of the big harbours are situated at river mouths at greater distances from the sea. During tides, ships can easily navigate inside, through tidal waters.
3. Sailors safely go for fishing in open sea during high tide and return safely to the coast with ebb.
4. The receding tides carry away most of rubbish of the coastal towns to sea.

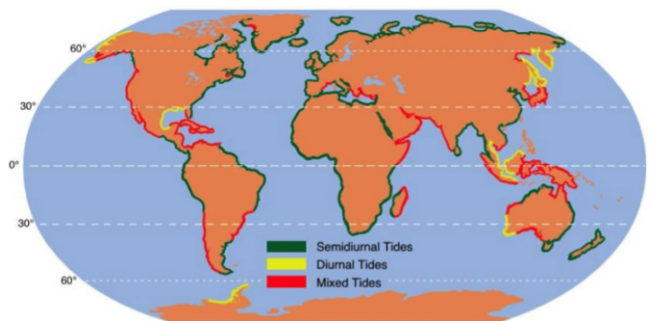


Fig.18.3 : Distribution of Tides in the world

5. The receding Tides, leave many sea products such as shales etc on the coast.
6. Due to Tides the sea water remains moving and clean and water does not freeze.65

Ocean Currents

The continuous flow of the ocean water in a definite direction from one part to another part of ocean, is called ocean current. The water remains stable beneath the current and along its margins. In other words, ocean currents are similar to rivers, but they are much more extensive than the rivers flowing on the land mass. According to Monkhouse, the of a mass of circulation of ocean current occurs in a definite direction.” The movement of the water in the ocean currents is not only on the surface but also at greater depth. On the basis of temperature, the ocean currents are of two types-(1) Warm ocean currents and (2) Cold ocean currents. They vary in speed, size and direction.

(1) Warm ocean current

They flow from warm regions towards colds regions. They move from equatorial regions towards polar regions. As the temperature of these currents is higher, they also increase the temperature of coastal area from where they flow.

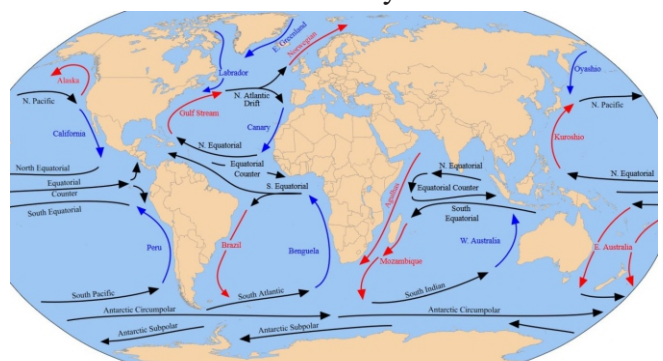


Fig. 18.4 : Ocean Currents

(2) Cold ocean current

These currents flow from colder regions towards warmer regions. They flow from poles towards the equator. The temperature of water of these currents remains low. Thus it also lowers the temperature of the areas in which they flow.

Factors responsible for the origin of ocean currents

- 1) Nature of Earth- Gravitation and Rotation
- 2) External Oceanic Factors- Air Pressure, Winds, Evaporation and Rainfall.
- 3) Internal Oceanic factors-Pressure, Temperature, Salinity, Density, melting of the Glacier.
- 4) Factors that transforms Ocean Currents- Shape of the coastline, Change of Seasons, structure of ocean bottom.

Currents of Atlantic Ocean

The Atlantic Ocean is divided into two parts-North Atlantic ocean and South Atlantic ocean.

Ocean currents of North Atlantic Ocean

1. North equatorial warm current

This current flows between 5° to 20° north latitudes near the equator. This current flows in the east from African coast to west Indies in the west. Fidler in 1853, was first to mention about this ocean current.

2. Antillies Ocean current

The south equatorial current is divided into two branches near Sao Roque of Brazil. The northern branch merges with North equatorial current and enters in Caribbean Sea and Gulf of Mexico. The other part flowing on the eastern margins of west Indies, is known as Antilles current.

3. Florida current

It is actually the extension of north equatorial current which flows through Yucatan channel and enters into gulf of Mexico. It possesses similar characteristics of equatorial watermass.

4. North Atlantic Ocean current

The influence of the westerlies on Gulf stream, away from Grand Bank is quite visible. It flows towards east.

5. Warm Gulf Stream

The ocean current from cape Hatteras up to Grand bank is called Gulf stream. The Gulfstream receives sufficient amount of hot water in the Gulf

of Mexico, which is carried by it to cold areas.

6. Canary Current

This current flows along the Western coast of North Africa between Maderia and Cape Verde islands. The warm water of Gulf Stream convert into cold water as it reaches here. This ocean current finally merges with North equatorial current. There are seasonal changes in this current.

7. Labrador cold current

This is a cold current of North Atlantic Ocean which flows from the gulf of Baffin to Davis strait in the south. This current balances the ocean bottom. Thick fog is formed due near New Foundland. It creates ideal conditions for fishing near New Foundland. It creates ideal conditions for fishing to confluence of warm and cold currents.

8. Sargasso Sea current

The calm and motionless waters found in the North Atlantic ocean between the circular motion of Gulfstream, Cannery and North equatorial current, is called Sargasso sea. A type of oceanic grass grows on its coast which is called Sargassum in Portuguese. Its name is after the Sargasso sea is named after the grass. Its area is about 11000 sq. km.

Ocean currents of South Atlantic Ocean

1. South equatorial current (Warm)

This current flows in east-west direction the south, in the south of equator almost parallel to it.

2. Brazilian warm current

The South equatorial current after reaching West, flows along the coast of Brazil. It is a weak ocean current.

3. Falkland Cold Current

It flows along the south-east coast of South America from South to North. It brings along with it, the icebergs from Antarctic region. Fog appears as the warm and cold currents merge here.

4. Benguela Cold Current

This current flows northward along the South West Coast of Africa. It is an irregular and weak ocean current.

5. South Atlantic Drift

This ocean current flows under the influence of westerlies between 40° to 60° south, from west to east direction. It is actually the eastern extension of Brazilian current but its nature is totally different.

Ocean currents of Pacific Ocean

In order to study, the currents of the Pacific Ocean are also divided into north and south ocean currents, which are as follows:-

1. North equatorial current

This current originates on the western coast of Central America and flowing from east to west direction reaches Philippines.

2. Kuroshio Warm currents

The north equatorial current after reaching the Philippine Islands, starts flowing towards north along the coasts of Taiwan and Japan and is known as Kuroshio current.

3. North Pacific warm current

After reaching the south east coast of Japan, under the impact of westerlies, Kuroshio current start flowing from west to east direction.

4. California cold current

It is regarded an extension of north Pacific current because it flows from cold regions to warmer regions. Therefore it is called cold current of California.

5. Alaska current

Another branch of north Pacific ocean current, flowing anticlockwise on the west coast of North America, turns towards north.

6. Oyasiwo cold current

It is a cold current that starts from Bering Strait and flows southward near the coast of Kamchatka Peninsula.

7. Okhotsk or Kurile cold current

It starts from Okhotsk sea and flows along the east coast of Skhalin Island, where it merges with Oyasiwo cold current near Hokkaido island of Japan.

South Pacific ocean currents

1. South equatorial warm current

This is a warm current, which flows in the east from the coast of Central America to east coast of Australia in the west.

2. South Pacific ocean current

When the east Australian current near Tasmania, comes under the influence of westerlies and start flowing from west to east, it is known here as South Pacific current.

3. East Australian warm current

It flows along the Eastern coast of Australia. It is a warm current.

4. Cold current of Peru

It turns towards north after reaching on the Southwest of South America and flows along the coast of Peru. It flows from cold region towards warm region.

Ocean currents of Indian Ocean

Indian ocean is just half an ocean. It is surrounded by India in the north, by Australia in the east, and by Africa in the west. It has less extension in the north of equator, therefore its currents are affected very much by monsoon winds. With the change in the direction of winds during, Summer and Winter seasons, the currents also change their direction. When the currents are affected by monsoon winds, it is called monsoon drift. Similar to Pacific and Atlantic Ocean, the ocean currents of Atlantic oceans are also divided into two parts-

- (1) North Indian ocean currents
- (2) South Indian ocean currents

(1) North Indian ocean currents

1. North East Monsoon Drift

It is also called North East monsoon drift. It starts from Malakka strait and flows along the Bay of Bengal and enters Arabian Sea.

2. Counter Equatorial Current

It starts in the west, near the islands of Zanzibar and flows towards east.

(2) South Indian ocean currents

1. South Equatorial Current

It flows south of equator from east to west

2. Madagascar warm current

The southern branch of South equatorial current which flows near the eastern coast of Madagascar Island is called Madagascar current.

3. Mozambique Warm Current

The South equatorial current after reaching near the Madagascar Island, divides into two branches. One of its branch turns towards the south from the islands and the other branch enters Mozambique channel.

4. Agulhas current

Mozambique current and Madagascar current join each together beyond Madagascar Islands in the south, and thus the combined current is called as Agulhas current.

5. Westerlies drift

It flows from west to east in the south of the Indian Ocean and reaches the southern end of the west coast of Australia.

6. West Australian Cold Current

One of branches of Westerly drift flows through the south of Australia and the other branch turns towards north from the western coast of Australia. Its second branch is called west Australian cold current.

Effects of ocean currents

The ocean currents affect the climate of nearby coastal areas the coastal margins of the continents. They affect the temperature, humidity and rainfall. Cold currents of Polar and sub polar regions bring along with them planktons which is a source of food for fishes. This results in the increase of fishes in the region. The major sea routes follow these currents.

Important points

1. The factors that affect the origin of ocean currents are-
 - (A) Factors related to rotation of the earth.
 - (B) Factors related to oceans - difference in temperature and salinity
 - (C) External factors related to oceans- direction of prevailing winds other secondary factors that causes hindrance
 - (D) Transforming factors- shape of the coast, and bottom and seasonal changes.
2. The rise of the sea water is called tide and its fall is called ebb. Originating factors are due to the gravitational force and the centrifugal force.
3. The same tide is delayed by 52 minutes on the same place ,due to the revolution of moon. The direct tide occurs due to gravitational force and indirect tide occurs due to the centrifugal force.
4. When sun, moon and earth are in a straight line high Tides occur and when they are in perpendicular position , low tides occur. It is called Syzygy and conjunction respectively.

Exercise

Multiple choice questions

1. How many movements occur in ocean waters-
(A) 1 (B) 2 (C) 3 (D) 4

2. What is the cause of High Tide-
(A) indented coastline
(B) when sun, earth and moon are in perpendicular position
(C) when sun, earth and moon are in straight line
(D) none of the above
3. What is the interval of occurrence of tides?
(A) 12 hours 26 minutes
(B) 12 hours 56 minutes
(C) 12 hours 36 minutes
(D) 12 hours 46 minutes
4. Gulfstream is a-
(A) Cold current (B) Warm current
(C) Humid (D) Temperate
5. Which of the following is not the current of Atlantic Ocean?
(A) Gulf Stream (B) Labrador
(C) Falkland (D) Kuroshio

Very Short type questions

6. Write the major movements of oceans.
7. What are the causes of origin of ocean waves?
8. What is tidal range?
9. What are the types of tides?
10. Which currents are called warm currents?

Short Type questions

11. What is the difference between wave crest and trough?
12. What are the different types of the waves?
13. What are tides?
14. What is the difference between high and low tide?
15. What are ocean currents?

Essay type questions

16. Describe the movements of ocean water and waves and explain the types of waves.
17. What are tides? Explain its origin and types.
18. Define ocean currents and write the description of the currents of the oceans of the world.

Answer key

1. C. 2.C. 3.A. 4.B. 5.D.

Lesson - 19

Ocean: Relief, Temperature and Salinity

71% of the Earth is covered by water and it is called Hydrosphere. It includes seas and oceans. There is no other planet except earth where water exists in such quantity. This is the reason why it is also called planet of water. The ocean bottoms are also as complex as the land mass. The average depth of the oceans is much more than the highest peaks on the landmass. The highest peak of the landmass is Mount Everest which is 8850 m in height, whereas the deepest trench, Mariana trench in Pacific Ocean is 11,033 m deep. The average elevation of the continents is 840 m where as the average depth of the oceans is 3808m.

Relief features of oceans

Similar to land mass there are mountains plateaus, Plains and deep trenches in the ocean bottom. In topography, the relief features of a place are described. There is no uniformity of relief features in all the oceans of the world.

Pacific Ocean

It is the largest ocean which covers 1/3rd part of the earth. It is triangular in shape and extends 18000 km from east to west and 16740 km long from north to south.

Volcanic mountain ranges, earthquake zones and island groups are found on its coasts. There are more than 20,000 islands which are divided into three parts-

- (1) Melanesia
- (2) Micronesia
- (3) Polynesia

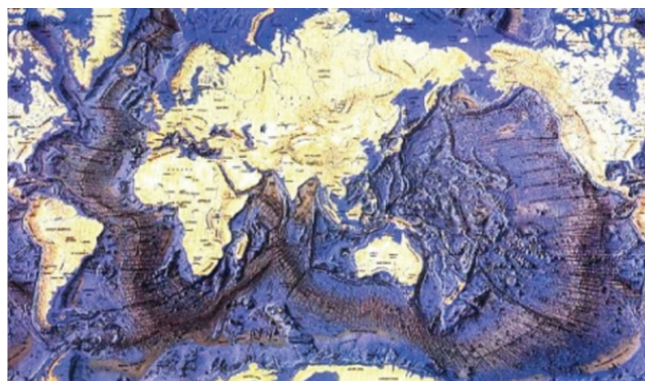


Fig. 19.1 : Ocean relief features

Many trenches, long ridges plateaus , ocean platforms are found here.

In the same way on both the sides of the Atlantic Ocean which is the most busiest ocean of the world, most developed countries of the world are situated. Its shape is similar to english alphabet 'S'. The gulf of Mexico, Mediterranean sea, North sea Gulf of Biscay, Baltic Sea ,Caribbean Sea ,Black Sea are its maginal seas. This ocean is quite narrow at the equator. It is divided into two parts -North and South Atlantic Ocean. North Atlantic Ocean is 5400 km in width and South Atlantic Ocean is 9600 km wide. There are many trenches found here like Brazilian basin, Cannery basin, Guinea basin and North America basin. Besides these basins, the other major deeps are Puerto Rico basin and Romanche.

Relief features of Indian Ocean

Peninsular India, plateau of Africa, western part of Australia and Continental shelves are the part of Gondwana land and they are located in the north of Indian ocean. The major basins are Sidmali basin, Andaman-Nicobar, zanzilar and Reunion are main islands. Arabian basin, Mauritius basin, Andaman basin and Sunda basin. Many submerged faults and rift valleys are found here.

Relief features of Arctic Ocean

As maximum portion of this region remains covered with snow throughout the year, not much is known about this Ocean which is situated near the northern pole. The continental shelf of this ocean is very wide. There are many islands like Barents, Hope, Spitsbergen islands, Novaya, etc. The major seas are Norway sea, Laptev sea, East Siberian sea and Greenland Sea. There are many ridges which are submerged here.

Topography

The relief features on the earth surface that include mountain, plateau and Plains means landscapes are called topography of a region. This term is used often to explain the similarities and variations in the forms of landforms. The bottom relief features found in the oceans, are caused due to four major activities. This results due to the interactions between tectonic activities, volcanic activities and depositional processes.

The ocean bottom, beneath the surface of the water, is formed due to the configuration of the ocean bottom and elevation processes, that indicates, what is the extent of heights and depths on the ocean floor. Oceans similar to the continents are the first order landforms. The height of a place and depth of the ocean is depicted through hypsographic curve. On the basis of this the ocean bottom relief features are categorised into following divisions:-

- 1. Continental shelf**
- 2. Continental slope**
- 3. Deep sea plain**
- 4. Ocean deeps**

1. Continental shelf

This refers to the submerged Continental coast. Therefore those Continental coasts which are submerged in the sea are called as Continental

shelves. It's maximum depth is 100 fathom and its slope varies between 1° to 3°. The continental shelf with gentle slope has greater width whereas the continental shelf with steep slope has less width. Its average width is 75 km. It covers about 7.6% of area of the entire Ocean. There is growth of vegetation and living creatures as the sun rays penetrate in this part. There is also the deposition of sediments brought by the rivers. Therefore this region of the oceans are usefull for human beings. Many minerals, fishes, food products, mineral oil, gas etc. are mainly found here.

2. Continental slope

At the outer edge of continental shelf. The slope suddenly steepens. The most important characteristic of these slopes is that it extends upto 3600 m to 8100 m of depth. The deposition of Alluvial soil is found in much lesser quantities. In the absence of sun rays and lack of food material very less quantity of living creatures and vegetation is found here. It occupies about 8.5 % of the entire area of the oceans. The slope varies between 2° to 5°.

3. Deep Sea Plains

The end of the continental slope marks the beginning of deep sea plains. It is an extensive plain region of the oceans which has negligible slope. There is almost absence of erosional activities here.

4. Ocean Deep

It refers to deep depressions and trenches found on ocean basins. On the basis of size they are divided into two parts-1) Deeps and 2) Trenches. Long, narrow and very deep depression existing on the deep ocean basin is Ocean Deeps. They are formed due to folds or faults. Its average depth is 5500 m. They are also called ocean canyons. Its major examples are Mariana, Challenger, Tonga and Sunda.

Oceanic temperature

The temperature of the ocean is important for vegetation as well as living creatures. The temperature of the oceans not only affect the living creatures and vegetation of the oceans but it also affect the climate (as a result, organisms and vegetation too) of the coastal areas. This is the reason why the study of temprature of sea water has

gained importance. The most important source of temperature for Ocean is the Sun. Besides this negligible amount of temperature is also contributed by the interior of the earth beneath the ocean bottom and the pressure of the water.

The factors that affect the temperature of the oceans.

1. Latitude

The temperature starts decreasing from the equator towards the poles as the rays of the sun become oblique towards the poles, therefore the amount of solar radiation keeps on decreasing towards the poles. Therefore the temperature of the ocean water between 40° north and south of the equator remains lower than the temperature of the winds but it increases beyond 40° latitude towards the poles.

2. Variation in the distribution of land and sea

Variation in distribution of temperature occur due to dominance of land mass in northern hemisphere and dominance of water in southern hemisphere.

3. Duration of the day

If the length of the day is longer, the amount of radiation received will be greater and the ocean water will be comparatively more warm, contrary to this the amount of insolation received by ocean water will be less if the length of the day is short.

4. Clear Atmosphere

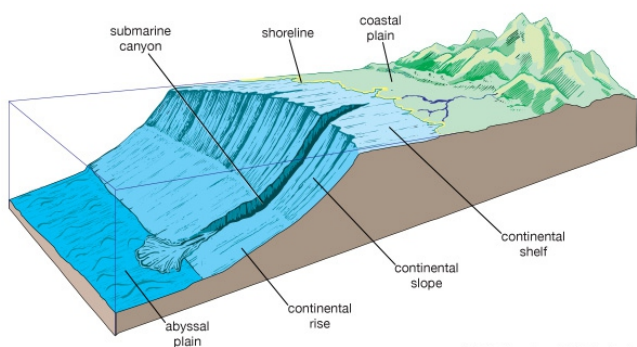


Fig.19.2 : Relief of the Ocean

When the atmosphere is clear, the insolation reaches in greater amount on the surface of water which warms water more. In the absence of transparency of weather, lower amount of insolation is received due to which the ocean water gets lesser heated.

5. Distance of Earth from the Sun

When the earth is closest to the sun, the sea water gets more heated, due to the receipt of solar radiation in greater amount.

6. Number of Solar Spots

With the increase of number of sunspots on the sun towards the earth, the solar radiation increases and when its number is less, there is lesser solar radiation. The sun spots are related to sun's gravitational force.

7. Ocean Currents

The ocean currents affect the temperature of the sea water. Cold ocean currents reduce the temperature and warm ocean currents increase it.

Horizontal distribution of ocean temperature

Generally the temperature of ocean water decreases with the increase of latitudes.

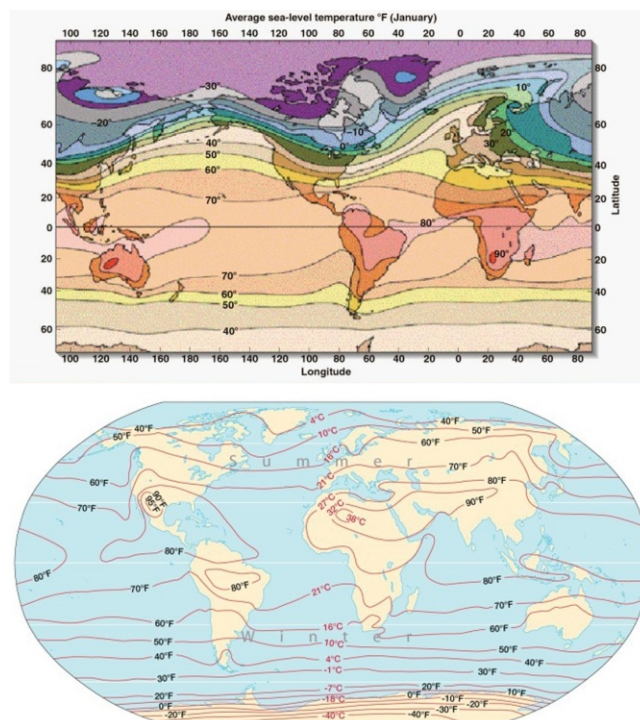


Table 19.1
Surface Temperature of the Oceans (in °C)

Latitude	Atlantic Ocean	Indian Ocean	Pacific Ocean
70-60 N	5.60	-	-
60-50 N	8.66	-	5.74
50-40 N	13.16	-	9.99
40-30 N	20.40	-	18.62
30-30 N	24.16	26.14	23.38
20-10 N	25.81	27.23	26.42
10-0 N	26.66	27.88	27.20
0-10 S	25.18	27.41	26.01
10-20 S	23.16	25.85	25.11
20-30 S	21.20	25.53	21.53
30-40 S	16.90	17.00	16.98
40-50 S	8.68	8.67	11.16
50-60 S	1.76	1.63	5.00
60-70 S	1.30	1.53	.03

Fig.19.3 : Temperature of January and July

A detailed description of horizontal distribution of temperature of the ocean water is given in the Table 19.1.

On the basis of the above table, it is observed that the temperature decreases towards the poles. There is minor increase in temperature between 20° to 30° North latitudes and the sequence of decrease in temperature continues again only in atlantic ocean. Due to the lesser extension between 20° to 30° latitude in the Indian Ocean, the rate of temperature decrease is very low.

Broadly, the rate of decrease of temperature from equator towards the poles is 1½° degree per latitude.

Vertical distribution of temperature

The vertical distribution of temperature depends on the amount of solar radiation

absorption, horizontal displacement and vertical movement of water.

The sun rays provide heat up to 25 m depth by entering in ocean water. Beyond this depth, the heat received by the solar radiation is almost negligible. Therefore the surface of the ocean water is more heated. The cold water of the poles becomes heavier, and it settles in the bottom, on the other hand the equatorial warm waters being lighter flows in the form of surface currents towards the poles. This way the temperature of ocean water remains in circulation constantly.

The temperature of ocean water decreases at a rapid rate upto 2000 m of depth. After this the rate of decrease of temperature slows down. This fact can be observed in open oceans. In partially surrounded oceans such as the Mediterranean Sea and the Red Sea, the decreasing rate of the temperature is much lower than the nearby open oceans

Oceanic salinity

Generally, 'the ratio between the weight of the water and the weight of the dissolved material in it' is called oceanic salinity.

Sea water is salty due to salinity present in ocean water. About 4.10 million tonne of salt is present in 1 cubic km of ocean water. On this basis, if the salt of the entire hydrosphere is laid uniformly on the earth, a layer of 150 m thick of salt will cover the whole Earth. The salinity of the ocean is expressed in terms of amount of salt present per

Table 19.2
Salts found in ocean Water

Sr. No.	Name of the Salt	Amount per thousand gram	%age of total Salt
01	Sodium Chloride	27.213	77.8
02	Magnesium Chloride	3.807	10.9
03	Magnesium Sulphate	1.658	4.7
04	Calcium Sulphate	1.260	3.6
05	Potassium Sulphate	0.863	2.5
06	Calcium Carbonate	0.123	0.3
07	Magnesium Bromino	0.076	0.2
	Total	35,000	100

thousand grams of water ($^{\circ}/00$). The salinity of the ocean water is 35 per thousand ($^{\circ}/00$) or one thousand grams of ocean water contains of 35 gm of salt. The main source of salinity of the ocean is the earth. The major sources of salinity are rivers, sea waves, winds and volcanic eruptions.

Although the amount of salt varies in the ocean water but the relative ratio of salts almost remains similar.

According to W.Dittmar (1884), there are 47 different types of salts present in the ocean water.

The percentage of main salts is given in table 19.2.

Approximately the total amount of different salts present in ocean water is 50 lakh billion tonnes, in which the quantity of sodium chloride is highest.

Sources of salts

The rivers are the most important source of salt in ocean water, as it deposits 16 million tons of salt every year brought from the terrestrial regions to the oceans. Ocean water keeps evaporating but the salinity is accumulated in it. According to some scholars, most of the salts were received from the layers of the crust, during the formation of the oceans.

Factors affecting salinity of the oceans

1. Evaporation

There is a direct relationship between evaporation and salinity thus it means, as the rate and intensity of evaporation increases, the salinity will also increase in the same proportion. Low humidity in the wind, is essential along with the evaporation. The rate of evaporation and salinity is higher in the areas with high temperatures, like regions near Tropic of Cancer and Capricorn.

2. Availability of water by rain

The salinity decreases due to availability of a higher amount of the fresh water. Salinity is reduced in the regions, which receive high amount of rainfall. Despite of high temperature in the equatorial regions, salinity is low in due to heavy rainfall on the other hand in the tropics which receive comparatively low rainfall and high range of temperature, have higher salinity. The excess water in the temperate regions, is supplied by the melting of the glaciers from the polar areas which

increases the volume of water and decreases the salinity.

3. Influx of river water

The rivers bring salt along with them despite this, the extensive volume of water of the rivers, decreases the salinity at their mouths. For example low salinity is found at the mouth of the rivers Ganga, Congo Niger, Amazon and St. Lawrence.

4. Prevailing winds

The winds blowing from the tropical and arid regions, towards oceans increase the rate of evaporation. Thus, highest salinity is found in these regions. Contrary to this, lesser salinity is found in the regions where cold, humid and low velocity winds prevail.

5. Ocean currents

The ocean currents flowing from areas with low salinity tend to decrease the salinity along their course. On the other hand the ocean currents flowing through the areas of the higher salinity, increase the salinity of the regions along their course.

6. Circulation of oceanic water

The distribution of salinity in the open seas is continuously effected by circulation of ocean water. The water with higher salinity gets heavier and descends downwards and moves towards lesser saline water. The surface water, which has low salinity moves along the surface of the ocean. In this way salinity balance is maintained in the ocean water.

Horizontal distribution of salinity in ocean water

Uneven distribution of salinity is found in tropics. Uneven distribution of salinity is also found in open seas, landlocked Seas or partially enclosed seas.

Distribution of salinity in open seas

Highest amount of salinity (36 per thousand) is found in the Tropical regions. High temperature, warm and dry prevailing winds, high rate of evaporation, less rainfall, lesser influx of fresh water are the main causes of higher salinity in these

regions. But the amount of salinity decreases towards poles and equator. But low amount of salinity is found in polar regions in comparison to equatorial regions. The melting of the glaciers in the polar regions provide freshwater and lower rate of evaporation are the major causes behind this. The influx of fresh water and rate of evaporation, both are more in equatorial regions. Local difference are found in the distribution of salinity along the coastal regions. For example low salinity is found at the mouth of rivers Amazon, Congo, Niger and Indus due to ample supply of fresh water.

The salinity of 38 ‰ is found in the Saragossa Sea of North Atlantic Ocean. The main cause of high salinity in this region, is the circular motion of the ocean currents, as this water does not mix with the water of nearby regions.

The lines joining the regions of equal salinity, are called Isohaline.

Distribution of salinity in partially enclosed Seas

The distribution of salinity in marginal seas depends on local conditions. The distribution of salinity in the mediterranean sea, varies to a great extent. The salinity in its north- eastern regions, is 39 ‰ and in the south- east regions it is 41 ‰. The northern part of Red Sea records 41 ‰ salinity and in its southern part the salinity is 36 ‰. The salinity of the Persian Gulf is 48 ‰.

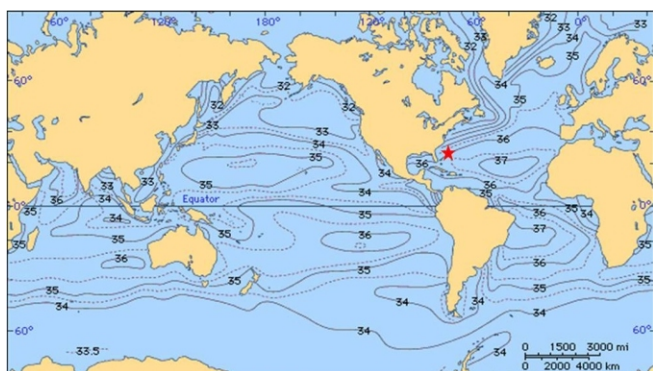


Fig. 19.4 Distribution of Salinity in the Oceans

Lack of rainfall, lower influx of freshwater and higher rate of evaporation etc are the main causes of higher salinity in this region.

The abundant influx of freshwater by rivers, supply of freshwater by melting of the glaciers, lesser rate of evaporation are some of the causes of low salinity in Black Sea (18 ‰), Baltic Sea

(15 ‰), Gulf of Bothnia (8 ‰) and Gulf of Finland (2 ‰).

Distribution of salinity in Inland Seas

Inland Seas and lakes are completely surrounded by land. High temperature, very hot and dry winds, high rate of evaporation, lack of rainfall are some of the causes of high salinity (238 ‰) in Dead Sea. The salinity in the southern part of Caspian Sea is 170 ‰, whereas in its northern part, it is only 14 ‰. The northern part of Caspian Sea is drained by rivers like Ural, Volga which provide influx of fresh water. Highest salinity (330 ‰) is found in Lake Van of Turkey in the world.

Vertical Distribution of Oceanic Salinity

No distribution pattern of salinity is observed towards the depth of water. But still, some trends that have emerged regarding the distribution of salinity along the depth of the ocean are as follows:-

1. The salinity in the polar regions is lesser on the surface and it tends to increase with the increase in depth. The salinity at the surface of the ocean is low, as the fresh water is constantly available, as the melting of glaciers.
2. The salinity increases in mid latitudes upto the depth of 400 m, it start decreasing beyond this depth. This happens due to more of evaporation and lesser influx of fresh water.
3. In the equatorial regions, the salinity on the surface is low, then it increases upto the depth of 1000 m and beyond this, it start decreasing again.

The trends which are described above are generalized. The trends differs with different oceans. For example the salinity of the surface water of South Atlantic Ocean is 33 ‰, at the depth of 400m it is 34.5 ‰ and it becomes 34.8 ‰ at the depth of 1200 m but near the 20° South latitude, the salinity on the surface is 37 ‰ and it is 35 ‰ at ocean bottom. In the equatorial regions the salinity at the surface is 34 ‰ and at its bottom it is 35 ‰. the salinity on the surface of Atlantic Ocean is 35.5 ‰ and at its bottom it is 34 ‰. There is lot of variation found in the distribution of salinity in partially enclosed seas.

Important points

1. The ocean bottom relief feature consists of four major parts- Continental shelf,

- Continental slope, Deep Sea plains, and oceans deeps.
- Atlantic Ocean- it occupies 16 percent area of the entire world and is half of Pacific Ocean. Its average depth is more than 3 kms. It is similar to 'S' shape alphabet. The continental shelf are comparatively broader, Dogger and Grand Bank are the major ones. Many ridges are found on its floor, one of the major ridges, is Mid Oceanic Ridge. Many trenches are found here like Guyana Trench in terms of depth and North America trench, as the most extensive trench. There are 19 ocean deeps and many islands.
 - Pacific Ocean-it is the largest ocean and extends on one third of the entire world area, triangular, surrounded by new folded mountains. The continental shelf narrow, number of ridges few in comparison to its extension, trenches are more and deeper, Philippines trench is deepest, the number of trenches is 32 and they are deeper, Mariana Trench is the deepest of all, there are more than 20 thousand islands.
 - Indian Ocean- It is small in extension, it is surrounded by land in the north, it is also surrounded by ancient plateaus on all its sides, it consists of broader Continental shelves, Chaigosa- Lakshadweep Ridge is the longest ridge, 90° East ridge is an important ridge and extends in north to south direction, it also has many basins, islands and have 6 trenches.
 - The factors affecting the temperature of ocean water are- slanting rays of the Sun, duration of the day, clarity in the atmosphere, distance between sun and the earth, number of solar spots etc.
 - The average density of ocean water is 36°/00. Major salts are- Sodium Chloride, Magnesium Chloride, Magnesium Sulphate, Calcium Sulphate, Calcium Carbonate and Potassium Sulphate.

Exercise

Multiple choice questions

- What percentage of the Earth is covered with water?
(A) 29 (B) 67 (C) 71 (D) 81

- The average height of the continents is-
(A) 10m (B) 400m
(C) 840m (D) 1000m
- The amount of salinity found per kilogram of ocean water is -
(A) 35 gm (B) 45 gm
(C) 15 gm (D) 25 gm
- Where is Mariana Trench situated?
(A) Pacific Ocean
(B) Indian Ocean
(C) Atlantic Ocean
(D) Mediterranean sea
- The ocean water receives heat from-
(A) Sun
(B) Moon
(C) Warm Ocean Currents
(D) On its own

Very short type questions-

- In which ocean Mariana Trench, is located?
- What are relief features?
- What is topography?
- What is the average salinity of ocean water?
- What is the source of salinity of ocean water?

Short type questions

- Describe relief features of Pacific Ocean.
- What are the different parts of the relief features found in oceans?
- What is continental slope?
- What are the factors that affect the temperature of ocean?
- What are the factors that affect ocean salinity?

Essay type questions

- Explain the concept of topography and describe the topography of the oceans in detail.
- Explain the factors that affect the distribution of temperature of ocean water.
- Explain the concept of salinity and describe the factors that affect it.

Answer key

- 1.C. 2.C. 3.A. 4.A. 5.A.

Lesson - 20

Oceanic Resources

71 % of the Earth's surface is covered with water and the rest 29% is the landmass. The oceans which are extended on the earth's surface are categorised with reference to location of continents, into three major and one secondary oceans. Pacific Ocean, Atlantic Ocean and Indian Ocean are the major ones. The fourth Ocean is Arctic Ocean, which is smaller in area and depth in comparison with other oceans. Pacific Ocean is the largest and deepest of all the oceans of the world.

Human beings are affected by the oceans directly or indirectly. A great mass of water of oceans provide many challenges and resources to human beings. There are many types of minerals and energy resources present in the oceans.

Importance of Oceans

The oceans provide us various types of resources. The oceans also influence our climate and are the cheapest source of transportation. Marine minerals, food and transportation are the direct advantages of oceans, whereas the effect of the oceans on the climate is its indirect advantage. The resources available on land are almost exhausted. The oceans are the only storehouses of resources for the future. The proximity of the oceans is favourable to human health. The seas provides the facility of recreation, scene visualisation, sports, swimming and navigation. The human civilization is greatly affected by oceans. Oceans are the only source of rainfall on the continents. Therefore, the oceans are of immense importance for the man.

Utility of the oceans

With the rapid growth of population, it is certain that it will create a crisis of food and lack of natural resources. Oceans are capable of saving mankind from this horrible crisis.

Oceanic resources

The resources of the oceans are divided into following categories-

1. Oceans and Mineral Resources
2. Oceans and Food Resources
3. Oceans and Energy Resources
4. Oceans and Drinking Water Resources
5. Oceans and Transportation, Trade
6. Oceans and Strategic Importance

1.Oceans and Mineral resources

There are many types of mineral resources available in the ocean water and it's bottom, but their extraction is very limited. According to an estimate , in one cubic km of ocean water , 50 tonnes of Silver, 25 tonnes of Gold, 11 to 35 tonnes of copper, manganese, zinc and lead 42 tonnes of Potassium Sulphate, 185 lakh tonnes of Magnesium chloride and many minerals and chemicals are present. Following are the major mineral resources:-

Mineral oil

This is the most important resource, which is available in the oceans. 40% of the world's mineral oil reserves are found in ocean basin. Many countries are extracting mineral oil from the oceans. Mineral oil is also being extracted in India, at the

depth of 2000 kms at Mumbai High, which is 150 km away from the Indian coastline.

Phosphate

The non- detrital sediments which contain minerals are called Phosphorite. It is found in form of nodules in the oceans.

Manganese

The Nickel and copper obtained from its nodules are of the same amount as obtained from terrestrial sources. It is found in maximum quantity in Pacific Ocean.

Salt

It is an important mineral obtained from the sea. Since the oceanic water is salty, the amount of salts dissolved in it is 3.5 percent. 78% of total salts, is sodium chloride, which is made edible after vaporization. The salt worth of 200 million dollar is manufactured yearly.

Other Minerals

Sand, Gravels, Gold ,Platinum, Tin, Magnetite, Iron, Tungsten and Thorium are some other important mineral resources.

2. Oceans and food resources

About 10% of the total food products of the world is obtained from oceans. Fish is the best protein diet which is an Oceanic resource. Fishing is one of the major occupations of the world. Fishing is a major source of livelihood in the world. Besides fishes there are many types of algae, plants, planktons, mollusk and marine organisms obtained from the oceans. With the increase in pollution, the existence of Coral reserves are in danger. Its natural colour is changing because of chemical pollution.

3. Oceans and Energy Resources

The oceans absorb three fourth of the solar radiation received by the earth. Winds and ocean currents move by this energy, and it increases the temperature of the ocean water. The energy from the oceans include Tidal energy, Hydrothermal energy and Geothermal energy. By receiving tidal energy from tides electricity can be produced. This type of electricity can be produced in Gulf of Khambat and Kachcha in India. Many countries are receiving energy from sea waves. Geothermal energy can be received from volcanic eruption.

4. Oceans and Drinking Water resources

The ocean water is not potable but it may be used in future for domestic works and industries. It is important to convert this saline water into potable. About 500 plants have already been set up for this purpose in the world. These types of plants have already been set up in large numbers in Gulf countries.

5. Ocean and Transportation, Trade

In ancient times, the oceans were considered as barriers between two landmasses, but today they provide easy and cheap transportation facilities. They are highways provided by the nature. As the surface of the oceans are flat, lesser thrust force is required. The oceans offer such routes for transportation which can be used independently as they are not under the governance of any country. There are several major international sea routes in the world. North Atlantic sea route is one of the major International sea routes. This waterway connects North America to Western European countries. About one fourth of the total international trade (in reference to total weight carried) is done through this sea route. As this sea route connects two major industrial countries, it is considered highly significant. Suez route is important international water route which connects Japan with Tokyo. This sea route is long enough through Asha Foreland.

6. Oceans and Strategic Importance

Oceans were considered as barriers in communication between continents but with the development of navigation, their commercial and strategic importance have increased. There are many reasons for this.

Many countries want to be dominant in the extraction of minerals from the oceans. In the present era, the importance of navy has increased significantly due to the growth in economic activities and competitions. India is constantly making efforts to keep the Indian Ocean, independent of naval competitions at international forums. The naval activities have been expanded extensively due to the growing international tensions. By making Pakistan a pawn, many big countries, especially like America, China, Russia, are constantly making efforts to increase their dominance in the Indian Ocean. The increasing

unwanted dominance of the foreign and far-off countries, on Indian ocean, may be dangerous and challenging for our country and it may also create unrest in this region. Our country should be cautious about these kinds of mala fides.

Important points

1. Oceans greatly affect the climate and weather of the earth. Oceans play an important part in all types of circulation.
2. Oceans are the store houses of resources. Both types of biotic and abiotic resources are found here.
3. Oceans play an important role in energy transportation and trade. Mineral Oil is also extracted from here.
4. Due to industrial development, the oceans are currently being wracked by different types of pollution. This is leading to loss of biological resources.
5. Corals, which are found in the oceans are changing their colour due to chemical pollution and their growth is also affected.

Exercise

Multiple choice questions

1. Which is the largest ocean of the world?
(A) Pacific Ocean
(B) Indian Ocean
(C) Arctic Ocean
(D) Atlantic ocean
2. Which ocean is mostly called sea?
(A) Indian Ocean
(B) Pacific Ocean
(C) Arctic Ocean
(D) Atlantic ocean
3. What is the total percent of oil reserves present in Ocean basins?
(A) 20%
(B) 30%
(C) 40%
(D) 50%
4. What is the name given to the energy obtained from tides?
(A) Geothermal energy

- (B) Tidal energy
- (C) Wind energy
- (D) Solar energy

5. At what place in the India the mineral oil is extracted in India?
(A) Gulf of Kutch
(B) Gulf of Khambhat
(C) Bombay High
(D) Coast of Kerala

Very short type questions

6. Which is the most important mineral obtained from oceans?
7. Which mineral is in the form of nodules obtained from oceans?
8. Write the names of two types of energy obtained from the oceans.
9. What is the source of geothermal energy?
10. Write the names of the food products obtained from oceans?

Short type questions

11. Describe the direct and indirect advantages of oceans.
12. What is the importance of oceans?
13. What are the different needs which will be fulfilled by oceans?
14. Write the names of marine resources.
15. Mention the major mineral resources obtained from the oceans.

Essay type questions

16. Describe the importance of oceans and explain their utility.
17. What are the different categories of oceanic resources? Describe them in detail.
18. "Oceans are an important link for the existence of Earth" Critically examine the statement.

Answer key

1. (A). 2. (C). 3. (C). 4. (B). 5. (C)

Lesson - 21

Biodiversity

Concept of biosphere

All the places on the earth where life is present in one form or the other are included in Biosphere. On the basis of the scientific information received so far, it can be said that the conditions that support life are found only on the earth. Although the various forms of life on the earth are found from the maximum depths of the oceans to the highest mountain peaks but in fact, the most influential life forms are found only up to a few meters of height or depth from the earth's surface.

Organisms from microscopic protozoa to giant whales, from microscopic lichen, to huge trees, all are part of biodiversity which is available on earth. This biodiversity is the result of constant process of earth's development. All the living organisms found on earth are dependent on available food sources in that environment, which provide them the energy and nutrition. This energy and nutrition are transferred constantly from one consumer level to the other. Biosphere is also called Biosystem as there is constant cyclic process of movement of energy and nutrition.

Biosphere is the result of mutually complex actions of organic (biotic) and inorganic (abiotic) elements found on the earth. Ecological science studies these mutually complex processes between biotic and abiotic actions and reactions. All biotic elements are sensitive to the changes in environment and most of their activities are towards findings suitable ecological environment and maintaining distance from un-suitable stimulations. Thus, all organisms are adaptive to environment.

The adaptations of organisms are of two types:

1. Inherited
2. Acquired

Inherited adaptation is obtained from birth as sense organs, while acquired adaptation are produced as a response to any special stimulation. For example, the production of antibiotics for protection against disease.

In the same way, in addition to organisms' response to environmental changes, organisms have ability of adjustment to the environment. This results in their existence and equilibrium of biosphere.

Structure of Biosphere:

The study of structure of biosphere can be done on the basis of lithosphere, hydrosphere, and atmosphere as follows:

(a) Lithosphere:

Lithosphere is the solid portion of the earth that covers 29.2% part of earth in the form of continents and islands. The upper layer of this is formed of unorganized soil and rocks are found beneath this layer. From the perspective of biosphere, the upper layer of the surface of the earth is important because all forms of organisms receive nutrition from the soil found on lithosphere.

(b) Hydrosphere:

About 70.8% of the whole earth is covered by oceans. If we add rivers, ponds, and other sources of water, about 72% of earth's surface is covered with water, which is called as hydrosphere. Water is the most important need of organisms after oxygen, hence water is also called as life. The required

oxygen and hydrogen by the body is met by water. According to an estimate, about 1360 million cubic kilometre of water is available on the surface of the earth, out of which 97% i.e. 1320 million cubic kilometre of water is present in oceans and remaining 30 million cubic kilometres is in the form of ice and remaining less than 1 percent is available in the form of groundwater. The water present on the surface of the earth is transformed in a cyclic process and again in the process of condensation, it comes down in the form of rain on the earth.

(c) Atmosphere:

The layer of gases that surrounds the earth from all the directions, is called atmosphere. This atmosphere extends for thousands of kilometres height over the earth's surface. It has many types of gases, water vapour and dust particles mixed in it. The mixture of these elements is not uniform everywhere. It changes with altitude, latitude, and weather conditions. Troposphere, the lowest layer of atmosphere; has uniform average percentage of gases except water vapour and dust particles because circulating nature of gases, air masses and winds help in maintaining its average.

Nitrogen (78%) and oxygen (21%) constitute the largest quantities of gases in atmosphere. In the remaining 1% constitutes Carbon dioxide, Neon, Argon, and Ozone are included.

Various investigations have suggested that there is difference in average percentage of atmospheric gases in troposphere up to the height of 50 kilometres. Heavy and dense gas like carbon dioxide is found only up to the height of 20 kilometres. At the height of 140 kilometres, the oxygen and nitrogen gases are also reduced to negligible amount. Hydrogen, is the only significant gas, found above the height of 150 kilometres in the atmosphere.

Oxygen is necessary for respiration of organisms while carbon dioxide is very important for the process of photosynthesis in plants. All the organisms have nitrogen as an important component which is received through food.

The above interpretation clearly states that all the organic elements of the biosphere derive all the important elements from three spheres. While atmosphere provides oxygen, hydrosphere provides water which forms 75% portion of protoplasm.

Food is supplied by lithosphere, hence it is said that there is no possibility of life beyond biosphere.

Biodiversity

The number of species of animals and plants found in any natural region, is called biodiversity. The word 'biodiversity' was first used by American entomologist E.O. Wilson in 1986, which was then accepted as a concept by other scientists and environmentalists.

There are countless organisms which have genetic, species and ecological diversities. Biodiversity in organisms is necessary for maintaining equilibrium in eco system.

(1) Genetic biodiversity:

The characteristics of all organisms are determined at the genetic level by genes. Difference in interpretations of same genes in various forms of organisms of any species, is called genetic biodiversity. The species will be able to adjust to environmental changes. Contrary to this, on reduction of genetic biodiversity, the chances of extinction of specie increases as that specie will not be able to adjust to the environmental changes. The genetic biodiversity helps in creation of new species in plants.

(2) Species biodiversity:

The number of organisms of available species of various types in eco system are called species biodiversity.

(3) Ecological diversity:

The diversity in natural habitats .i.e. forests, deserts, grassland is called ecological diversity. The ecological diversity involves the processes like transfer of energy in food chains, circulating process of balanced diet, water, and minerals. There is difference of biological diversities in salt water system and non-salt water systems. While, the salt water ecosystem contains big fishes like whale, shark. These fishes are not found in the non-salt water ecosystems. The different species of plants and organisms are found in the forests, plains and deserts.

Biodiversity in India

Biodiversity is not distributed evenly across the world. It is absent in some places, lesser in some and in abundance in some places. Due to geographical diversities and differences in climates

found in large of India, a great Biodiversity is found in plants and animals. Indian climate is mainly tropical, but due to physical differences like Himalayas in north, vast oceans in the south, humid regions on east and dry region in west, the climatic conditions are diverse. India occupies about 24% of earth's surface while 6.5% of species of organisms and 8% of plant species are found in India. India is one of the 12 countries with diverse biodiversity in the world. After the survey of about 70% of the entire area of the country, 46,000 species of plants and 81,000 species of organisms have been classified. National biodiversity policy and action plan was issued on January 6, 2000. The objective this policy is to push the efforts of conservation of biodiversity and sustainability for future use. The biodiversity bill was passed in Loksabha on 02, December 2002 and in Rajyasabha on 11 December 2002. The main objectives of this policy are conservation of India's biodiversity, checking the unilateral use by foreign agencies and citizens and stop bio piracy.

Hot spots of Biodiversity in India:

Those parts of the world that have abundance of organisms and rare species but the existence of these species is in danger due to excessive exploitation, are called hot spots of biodiversity. A total of 1.4% part of world is considered as hot spot where 60% of the biodiversity is found. In year 1988, British environmentalist Norman Mayers first introduced the concept of hot spot. Till today, about 25 hot spots have been identified. Among these, 2 of the hot spots are identified in India.

1. Western Ghat Hot spot: This hot spot is spread along the western coast in 1600 kilometers Sq. kilometer area in Maharashtra, Karnataka, Tamilnadu and Kerala. This accounts for only 5% of total geographical area of country but about 25% of plant species are found here. Two centres are important from biodiversity point of view:

- a. Amambalam Reserve
- b. Agasthyamlai Hills

2. Eastern Himalayan Hot Spot: The temperate forests are spread at height of 1700 to 3500 meters in which 11540 plant species are found out of which, 4052 are local species.

Threats to Biodiversity:

From ancient times, various species have been in the process of extinct in natural way and due to genetic diversity, new species have been evolved in changing environment. In the past century, human beings have harmed the nature by over exploitation of natural resources in pursuit of higher standards of living using science and technological advancements. This has resulted into increased rate of extinction of natural species in eco system from one species per decade to 100 species per decade. If this rate of extinction continues at this rate, many of species of plants and organisms will face extinction in near future. The human effect has caused serious threat to the survival of remaining species at present.

Destruction of natural habitats of animals, hunting, increasing pollution due to economic activities of human being are the main causes of decrease of biodiversity at present. Natural factors like increase in global warming, climatic changes, shallowing of ozone layer, acidic rainfall etc. are also responsible for decreasing rate of biodiversity.

Conservation of Biodiversity

In order to control the constant decline of biodiversity and to conserve the biodiversity and the natural resources, through proper management, keeping in mind the interest of human, is termed as Conservation of biodiversity. Since ancient times, the culture of our country admires forest and wildlife. Our ancient texts provide detailed description of the magnificence of trees. According to Matysya Purana, the magnificence about the trees has been described as-

" Dash koop- smapwapi , ashwapi samohraday |
Dash hrbye smh putroo, das putr smodudrmah ||"

It means 10 wells are equal to a step-well, 10 step-wells are equal to a pond, 10 ponds are equal to a son, whereas 10 sons are equal to a tree.

Not only this, in our culture, in order to protect the trees, they have been described as the abode of various deities. For example , God Vishnu in Ficus Religiosa (Peepal tree), Goddess Laxmi in Phyllantchus Emblica tree (Amla Tree), Lord of Universe, Lord Bhrama in Banyan tree, Lord Shiva in Aegle Marmelos (Belpatra Tree), Lord Krishna in Neolamarckia Kadamba (Kadamh Tree), Lord

Gandhrva in Buteamonosperma (PalasTree), Lord of Moon in Cinnamomum Camphora (Kapoor), Lord Indra in Saraca Asoca (Ashoka Tree) and many other deities dwell in trees.

Two valuable epics of our country Ramayana and Mahabharata provide detailed descriptions of Arynaye culture. The main basis of Buddhism and Jainism is non-violence, the ultimate duty (religion). The great emperor, Ashoka prohibited wildlife hunting, which is mentioned in his inscriptions. Later, during the ruling periods, there was considerable emphasis on conservation of the nature.

In our culture, along with tree magnificence, the attention of the society has been attracted towards the protection of animal life by key note of non-violence, a great religion. Many creatures were considered as deities and provisions were made to prohibit their hunting. For example Garud (Eagle) as the Vahana of God Vishnu, Nandi (White Bull) as the Vahana of God Shiva, Lion as the vahana of Goddess Durga, Elephant as the Vahana of God Indra, Peacock as the vahana of God Kartekey, Rat as the vahana of God Ganesha, Swan as the vahana of Goddess Saraswati, and many other animals are given divine attribute, in the same way, many Avatars of God Vishnu like Kurmaavatar, Varahaavatar, Matsyaavatar, Nershinghavatar are considered as deities.

No other country in the world possesses such a enriched nature based culture. The following measures have to be taken to preserve the rapid decline of bio-diversity.

(i) Artificial Stocking

Under the artificial stocking, the protection of those species are included, which are at the high risk of extinction. Such species can be easily protected in the areas where they are on the verge of extinction.

(ii) Improvement in Dwelling Place

The human has either destroyed or demolished the natural habitats of living creatures for the sake of their own advancement and prosperity. These destroyed habitats need improvement so that it may provide food and other essential requirements to the species that are living there. So far 18 Biosphere reserves have been established in India. They are

Nilgiri, Nandadevi, Sunderban, Nokrek, Great Nicobar, Gulf of Mannar, Manas, Similipal, Panchmani, Kanchenjunga, Agasthyamagal, Panna, Achanakamar- Amarkantak, Seshachalam Lamdapha, Uttrakhand, Thar desert, Rann of Kutch, Kanha, North Andaman etc. 9 of these 18 bio reserves - Nilgiri, Sundarban, Gulf of Mannar, Nandadevi, Great Nicobar, Similipal, Panchmani and Achanakamar- Amarkantak have been recognised by UNESCO.

(iii) Restricted Hunting

Restricted hunting may be practiced, in the regions where high fertility rate is found among the large number of wild animals, otherwise the areas which are sensitive should be restricted.

(iv) Wildlife Conservation Act

International Union of Conservation of Nature and Natural Resources (IUCN) and United Nations Environment Programme (UNEP) have asked all the nations of the world to develop such an effective system of rules for the protection of environment, that can secure the human rights, and at the same time, the interest of the future generations may not undergo any sort of atrocities.

Our country is one of the few selected countries where forest policy has been implemented since 1894. This forest Policy was amended in 1952 and 1988. The basis of the amended Forest Policy 1988 was the protection, conservation and development of the forests. Not only this, a substantial plan was prepared under the National Forest Programme, for the next 20 years, which is focused on prevention of deforestation and to cover one-third of the country with forests. In the same way, the National Wildlife Workshop, 1983 was revised and a new wildlife plan (2000-2016) has been prepared, in which programmes are being prepared for the conservation of wildlife and conservation of species which are getting extinct.

(v) Establishment of National Parks and Sanctuaries

So far, 89 National parks and 490 Sanctuaries have been established in our country, which occupies about 1,50,000 sq km of the entire area of our country. Their main objective is the conservation and protection of wildlife against

illegal hunting and trade of their products and to develop ecology in the regions which are located near the national parks and wildlife sanctuaries.

4 National parks, 26 Sanctuaries, 35 Prohibited regions and 5 wildlife parks (zoo) have been established in Rajasthan for the conservation of wildlife. National parks included are Rajiv Gandhi National Park, Ranthambore (Sawai Madhopur), Ghna Keoladeo Bird National Park, (Bharatpur) National Desert Park, (Jaisalmer), Sariska National Park, (Alwar). The important wildlife sanctuaries are Darra (Jhalawar), Talchhapar (Churu), Nahargarh (Jaipur), Jaisamand (Udaipur), Kumbhalgarh (Pali), Bandh Baretha (Bharatpur), Van Vihar (Dholpur), Sita Mata (Chittorgarh), Mount Abu (Sirohi), Rawli Tatgarh (Ajmer), Chambal (Kota), Jawahar Sagar (Kota), Jamuva Ramgarh (Jaipur), kailadevi (Karauli), Gajner (Bikaner).

Variations in nature

Variations are the law of nature and they are universally present in almost the organisms of nature. These variations found in the organisms, is the culmination of organic evolution, that took place in millions of years. The entire biosphere is operated and controlled through these variations. These are called biodiversity in scientific language.

Biodiversity is also called as biological diversity, as in simple words it means the totality of genes, species and ecosystem of a region or different organisms and their different species found in the world. Biodiversity varies from place to place.

Biodiversity can be defined as follows-

"The diversity, variations and complexity of ecosystems of living organisms is termed as biodiversity"

Some other definitions of biodiversity are as follows-

- (A) Convention on Biological Diversity- CBD- According to Johnson (1993)- "Biological diversity are found in terrestrial, sea and fresh water ecosystems, this diversity can be within species of population, between species and species of ecosystem"
- (B) Biodiversity is the basis of human life on the

Earth-like a Ship of Habitat.

The thick growth of forest increases biodiversity. Maximum species of organisms, animals and birds are found in dense equatorial forest of Brazil. In the world, after Brazil, our country India is the most fortunate country where maximum biodiversity is found. Biodiversity is found maximum on both the sides of the equator and minimum at the poles.

In order to balance the ecosystem, biodiversity should be present in the living organisms (living creatures, vegetation, micro-organisms) otherwise the diversity in the population will be low at the gene level, and there will be a strong possibility of its extinction.

Biodiversity is a unique natural source. Its extinction is for forever, for example we cannot regenerate the dinosaur anymore.

Biodiversity was considered variability present in species in a discussion session of earth summit organised in 1992 in Rio de Janeiro, the city of Brazil. This variations includes all the terrestrial, marine and aquatic ecosystems which are the habitat of these living creatures. The Earth Summit II, held in Johannesburg, an African city in 2002, expressed a major concern, that the global environmental partnership may not become a new profit-oriented approach to harness the environment.

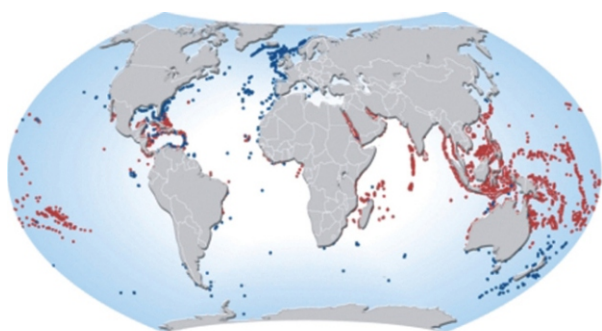
Most of the Biodiversity in the world is found in Coral Reefs, wetlands, Mangrove Ecosystem and Tropical Ecosystems. Most of the biodiversity is found in the regions of coral reefs. 1% of ocean floor, which is occupied by coral reefs, provide protection to 25% of aquatic life of the entire ocean.

Concept of Biodiversity

The body of each organism is made of his genes and the activities of the body are also controlled by these genes.

The genes in the biosphere form the fundamental basis of the biodiversity. In the past years, the concept of biodiversity has evolved as a result of decline in the environment. Biological diversity and its affluence is one of the most important characteristics of nature, which is the result of the developmental process on the earth and demands continuous protection. The unimaginable destruction of natural habitats caused the crisis of

biodiversity in the recent years. For example incidents like hunting of blackdeer in our province, Rajasthan, hunting of half a dozen of elephants in the world renowned Jim Corbett National Park in Uttarakhand, 13 deaths of Lions in Nandan Kanan Wildlife Sanctuary due to Trypanodomiiasis disease, have proved this strongly that even in our country the biodiversity is not untouched by the crisis.



■ Tropical Coral Reef ■ Temperate Coral Reef

Fig. 21.1 : Distribution of Coral Reefs in the world

The existence of biodiversity is very essential for the sustainability of human life. The origin of pollution is entirely due to human activities. The constant increase in pollution is causing constant decrease in the graph of biodiversity. So far, human beings have caused the extinction of many species, by exploiting nearly one lakh living creatures and about 76% of wild animals for their own benefits.

Presently, the decrease in biodiversity is the most important problem of the world. Its reduction affects the evolutionary capabilities of the creatures and they find themselves helpless to struggle with the changing environment.

The species occupy a crucial position in the concept of biodiversity. The living organisms found in nature, which are able to breed and are capable of reproducing fertile offsprings, are called species. The species in nature by conjointing, give birth to a new offsprings through hybridization. Biodiversity, in this way, is a very important condition to maintain the continuity of life and a sustainable environment.

Value of Biodiversity

The species of flora and fauna found in nature are useful to human beings in many different ways. Since ancient period, the human beings are directly

or indirectly dependent on biodiversity, for their food, clothes, habitat and medicines etc. Our mental, religious and cultural diversities are part of biodiversity. The economic system of the state, country and the entire world is dependent on natural resources. The country rich in biodiversity, will also be economically independent. Thus, biodiversity is not only important in terms of its utility but it also has productive importance.

(I) Food Value

According to the famous Ecologist, Norman Mayors, man consumes about 80,000 flora species as a food product. The availability of the entire food for the world is dependent mainly on wheat, rice, maize, jowar, Bajra, millet, soybean, beetroot, and split gram, coconut, potato, coffee, Chickbeans, Fieldbeans, sweet potato, sugarcane etc. Besides these, many types of fruits like banana, mango, custard apple, papaya, grapes, apple, orange, watermelon, muskmelon and many types of vegetables like brinjal lady finger cauliflower, tomato and many types of fishes play a significant role in the food supply. Some types of vegetations like Ginger, Turmeric, Saffron, Coriander, Asafoetida, Fennel seeds, Cumin, Celery, Cinnamon, Black pepper etc are used for domestic and commercial purposes.

(II) Medicinal value

Many different types of medicines are obtained from animals and plants. Their description is as follows :-

Anti- Cancerous drugs are derived from Madagascar Periwinkle, Catharanthus roseus or evergreen Vinblastine and Vincristine herb. The leukemia that occurs in childhood is controlled successfully upto 99% by the use of these drugs. Antibiotics are prepared from fungi like Penicillin, koinin is prepared from the peel of Cinchona tree, Anthromycin, Tetracycline medicins are prepared from the bacteria.

(III) Social Value

The social value of biodiversity has been a part of human life since the ancient times. Man is a social beings and the diversity of life reflects the social values in various forms for example basil, Banana, Peepal etc. are plants that are an integral part of

every religious ceremony organized in our homes. The leaves of Ashoka and Mango trees are essentially placed during religious rituals as 'Vandanvara' on many sacred religious ceremonies, Yagya and marriages. Indeed, this kind of perspective of man keeps the vegetative resources of nature, safe.

(IV) Ethical Value

Indian society has always been a pioneer in protecting trees by worshiping them. According to the general assembly of United Nations Organization, each ethnic group has a moral right to live independently. Our society, religion and civilization have moralized us, which has helped us to preserve biodiversity. For example, in our country, Kadamb tree in Rajasthan, Mango and Tamarind tree in Orissa, Dhak tree in Madhya Pradesh and Mahua tree in Bihar are worshipped. In this sequence, another unique and exemplary example of ethics is presented before us.

The citizens of the United States of America have decided not to buy a fish Tuyna because these fishes were hunted with the help of a small aquatic animal named Porpoises.

(V) Aesthetic Value

Diversity also encompasses beauty in it. The more the diversity in nature, more it will be beautiful. Biodiversity plays an important role in imparting beauty to the nature. Visitors to the zoo find it more entertaining with more of biodiversity in it. It is utmost important to guide in realizing the importance of biodiversity to this generation so that they can preserve it for the future generations. Beauty of nature plays an important role in the extension of tourism that strengthens the economy. The existence and growth of wild animals in their natural habitats without any fear is called as ecotourism. This is an inseparable part of modern tourism industry. In addition, doordarshan, cinema, literary books, novels, entertaining books reveal the aspect of beauty of biodiversity. Some plants are planted on both sides of road for beautification which includes Bauhinia, The Golden Shower Tree, bougainvillea tree, North Indian Rosewood tree, yellow oleander, and erythrina tree.

(IV) Genetic Value:

There are many traits in living beings which are yet to be researched on. Traits play important role in survival of species. Every species is a representative in a gene pool. The meaning of Gene pool is joining of genes of any system. Preservation of these are necessary to reap benefits in the future. Gene pool is important in agriculture for resolving future food supply needs which can be successfully met with these.

Conclusion

It can be concluded from above details and analysis that natural biodiversity is boon for mankind. Biodiversity supplies many important components to human being in direct or indirect ways without asking anything in return. The nature expects human beings to preserve biodiversity for the coming generations. Endangered species can be preserved by creating sperm bank and seed bank.

Important Points

1. Variations is legal aspect of nature and are present universally in all the organisms of the world. Biodiversity is also called as biological diversity. Biodiversity in simple word means; The number of all the genes species, and ecosystems found in a region or various living organisms and their species in the world. The variations, inequalities and ecological complexities present in organisms is called biodiversity. The rich forests adds value to the biodiversity.
2. Biodiversity is a natural source and it can get extinct forever. The Earth summit organized in Brazilian City of Rio de Janero in 1992 had discussions and mutually agreed to define biodiversity as variability found in various species. Second earth summit was organized in Johannesburg city of South Africa in 2002. The members expressed worry that world environment partnership should not turn into another opportunity of profit earning. Maximum biodiversity is found in coral reefs, damp region, mangrove ecological systems, and hot temperate ecological systems. All living organisms are formed of genes. The functions of human body are also controlled by these genes. Genes are at the root of all biodiversity in biosphere. The diminution of

environment in recent times led to the concept of biodiversity.

3. The ever increasing pollution in environment has decreased the graph of biodiversity. The reducing biodiversity impacts the evolutionary abilities of nature. Hence the organisms's ability to face the changes in the environment reduces. The species play very decisive role in the concept of biodiversity. The organisms that are suitable for recreating productivity, and similar kind of organisms are called species. The species in nature reproduce new species by meeting mutually in the process of hybridization.
4. Our intellectual, religious and cultural diversity is also part of biodiversity. Quinine drug is derived from cinchona tree. Garlands and wall hangings are made from leaves of Mango and Ashoka trees that are used during religions occasions. People worship burflower tree in Rajasthan, mango in Orissa, flame of the forest of Palash tree in Madhya Pradesh, butter tree in Bihar has been worshipped since ages. To observe wild animals in their natural habitats in free and borderless settings is called as ecotourism. Some plants are planted on both sides of road for beautification which includes Bauhinia, the Golden Shower Tree, bougainvillea tree, North Indian Rosewood tree, and erythrina tree. Traits play significant role in survival of organisms. Every species is a representative in a gene pool. The meaning of Gene pool is joining of genes of any system. Preservation of this is important so that upcoming generations can get benefit from this. The gene pool is also significant in areas of agriculture, as future needs in food supplies which can be met successfully with the help of this.

Questions

Multiple choice Questions

1. Which country has the highest biodiversity in the world?
 - a. Brazil
 - b. India
 - c. South Africa
 - d. Germany
2. The leaves of which trees are commonly used for vandanwar?
 - a. Ashok and Peepal

- b. Mango and Jamun
- c. Ashok and Mango
- d. Banyan tree and Peepal

3. In which maximum biodiversity is found?
 - a. Damp region
 - b. Coral reefs
 - c. Mangrove ecosystems
 - d. Tropical ecosystems
4. Ranthambor National Park is situated in-
 - a. Bharatpur
 - b. Alwar
 - c. Jaipur
 - d. Sawai Madhopur
5. State tree of Rajasthan state is –
 - a. Palash
 - b. Khejri
 - c. Tamarind
 - d. Burflower tree

Very short type questions

6. Define biodiversity
7. The dense concentration of what causes increase in biodiversity?
8. What is the basis for the development of the concept of biodiversity?
9. Quinine is derived from which plant?
10. What is the meaning of ecotourism?

Short type Questions

11. Comment on the food value of biodiversity.
12. Explain with examples, the social value of flora.
13. What is the significance of gene pool in the areas of agriculture?
14. Write the definition of biodiversity in the words of Johnson (1993)
15. Write a short note on the medicinal value of biodiversity.

Essay type questions

16. Define biodiversity. Give a brief description of its concept.
17. Write a brief article elaborating the value of biodiversity.
18. Explain "Biodiversity is a boon for man."

Answer Key

- 1.A 2.C 3.B 4.D 5.B

Lesson - 22

Concept of Ecosystem

Although the term ecology may be the contribution of the 19th century, but the concept of ecology is very ancient in terms of our culture. Since ancient times, the Indian sages and the intellectuals have linked the interrelationships of nature and organisms in the form of symbols of religion social norms and conduct to make it a part of mass consciousness. Like a cow is considered as a mother. As a result, these interconnections were carried on as friends for thousand of years, but in the modern era, the human aspiration of conquering the nature has abandoned the eternal rules and practices and has considered the physical pleasures to be the only basis of life. Consequently, there was deterioration in the interrelationships between organisms and nature, which resulted in the emergence of the ecological concept.

The term ecology was the first of all used by Hackel (1869) for the areas of vegetation. the term Ecology as framed by hackel is formed of two Greek words 'Oikos' meaning habitat and 'Logos' meaning study. Many scholars before Hackel have presented their ideas about ecology indirectly. Humboldt (1769) was of opinion that Earth is not just a substance. in the same way Ritter (1779-1859) wrote that on the Earth's surface there is a harmony in the spatial distribution of various elements. These elements are so interconnected that they provide that area a distinct status. Ritter further stated that the rules of the origin of the earth are not framed by man, but the Earth has its own rules which are important for human welfare.

Although Hackel started the ecological study, but in fact, in 1935, the use of the term

ecosystem in the study of biosphere carried out by A.G Tansley, attracted the attention of the world towards ecosystem. According to Tansley, "the system resulting from the interrelationship of all living and nonliving factors of the environment is called ecosystem". R.Dajoz has defined ecosystem in the following way

"Ecology is the science concerned with the study of the condition of existence of living organism and the interrelation between the organism and the environment in which they live".

From the above discussion it is clear that ecosystem is a system which is the result of the interactions between organism and their environment. This system is developed under natural laws. So in the study of the ecosystem, the secrets of such arrangements are ascertained. This system is so complex that just as scholars are exploring these secrets, new secrets are being revealed. Although the man in the pride of scientific achievements and technological advances has started accepting that he is not a slave of nature. He is free to use and consume nature according to his own wishes. The adverse consequences of this trend of human beings have now started to appear in different forms of environmental deterioration.

Concept of Ecosystem

A timely and sequential study of interconnections between organisms living in a geographic unit and the environment of that unit, is called ecosystem. According to A. G Tansley (1935) the system in which all biotic and abiotic factors of the environment are inter-connected, is called a

ecosystem.

The following definitions are presented by many other scholars related with ecosystem. According to **R.L Lindeman** (1942) the term ecosystem applies to 'any system composed of physical -chemical -biological processes, within a space-time unit of any magnitude.'

F.R Fosberg (1963) defined ecosystem as 'a functioning interacting system, composed of one or more living organisms and their effective environment both physical and biological' **E.P Odum** (1971) stated that 'living organisms and their non-living environment are inseparably interrelated and interact with each other' According to **A.N Strahler and A. H Strahler**, (1976) "The total assemblage of components interacting with a group of organisms is known as ecosystem. Ecosystems have inputs of matter and energy, which build biological structure..."

An ecosystem is the basic unit of an ecological study, which may vary in size and extent. For example an ecosystem may be as wide as global ecosystem which may cover the entire globe, on the other hand it may be as small as a bird cage in a zoo or may be limited to a lake. An ecosystem may be natural or man made.

Types of Ecosystem

(A) On the Basis of Sources of Energy

(i) Natural Ecosystem

The ecosystems developed of natural stages is called the natural ecosystem, these ecosystems are of two types- Terrestrial and Marine. In the terrestrial natural terrestrial ecosystem, forests, grasslands, pond, river, desert, mountainous region etc are included. The marine ecosystem is the largest and permanent ecosystem. Forests, grasslands, deserts, open seas are all examples of Natural Ecosystem.

(ii) Man-made or Artificial Ecosystem

Man-made and well maintained mechanisms are called artificial ecosystems, like farms, zoo, kitchen garden, aquarium etc.

(b) On the Basis of Habitat-

- (i) Terrestrial ecosystem
- (ii) Marine ecosystem

(c) On the basis of usage

- (i) Agriculture Ecosystem
- (ii) Non-agriculture ecosystem

(d) On the Basis of Development-

- (i) Well developed ecosystem (Mature)
- (ii) Undeveloped ecosystem (incomplete)
- (iii) Mixed ecosystem
- (iv) Inactive ecosystem

Structure of Ecosystem

The structure of an ecosystem is formed by the mutual interactions of biotic and abiotic components of the environment.

Biotic components

All living organisms of an ecosystem are called Biotic components of that ecosystem, these organisms are interconnected through mutual interactions. They are also related with each other on functional basis. Therefore, separating any one type of organisms from any ecosystem can threaten the existence of other remaining organisms of that system, which may create imbalance in the ecosystem.

Biological components can be classified on the basis of their nutritional potential and functionalities as follows:-

1. Classification on the basis of nutritional potential

(i) Autotrophs Components

Autotrophic components, which are also called primary producers, they prepare their own food, by the process of photosynthesis from solar energy and from the soil through their roots and provide food products for other vegetarian organisms. Green plants capable of Photosynthesis, Blue green algae, Photosynthetic bacteria are autotrophic components of the ecosystem.

(ii) Heterotrophs components

These are those Heterotrophs components which consumes the food provided by the autonomous primary producers. Heterotrophic components that consume the food produced by the autotrophs are also called consumers. On the basis of the process of consumption of food, they are classified into three parts.

A) Sarophyte

They survive on the organic compounds

found in the solutions that are derived from dead plants and animals.

B) Parasites

They are dependent for food and survival on the other living organisms.

C) Holozonic

These organism get their food through their mouth. All large animals, including man, are included in this category.

2. The components of the ecosystem are divided into three different categories on the basis of their functions:-

(i) Producers

This include all the green plants which prepare their own food from the soil through their roots and with the help of photosynthesis and are known as primary producers.

(ii) Consumers

They obtain their food from the primary producers. They are of three types:-

a) Herbivorous or Primary Consumers

All living organisms that obtain their food from plants or their food products like Rabbit, Deer, Goat and cow etc and different types of marine organisms are included in this category.

b) Carnivorous or Secondary Consumers

They obtain their food by hunting herbivorous organisms. They are also called as secondary consumers like frog, cat, fox, dog and lion etc.

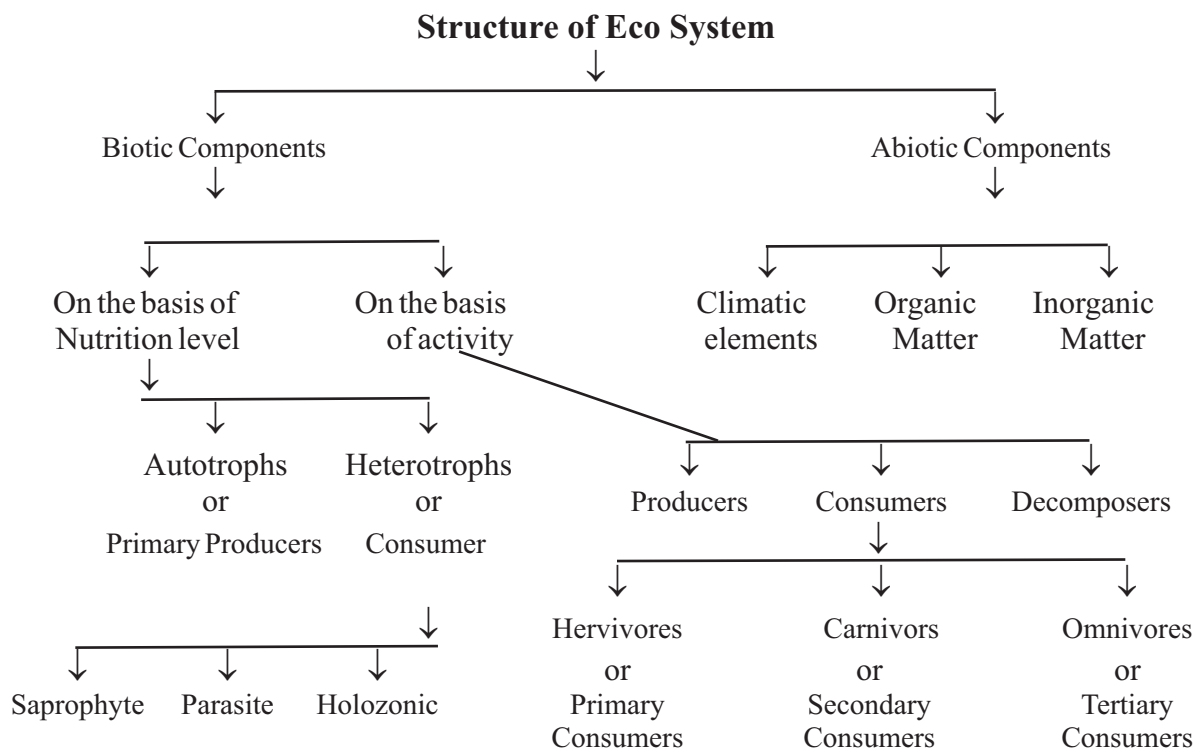
c) Omnivores or Tertiary Consumers

Those creatures are included in this category that obtain their food from plants, herbivorous and carnivorous animals.

Man, Eagle, vulture, fishes and lion are included in this. This is the reason why they are called tertiary consumers and are often referred as Top consumers.

(iii) Decomposers

The microorganisms are included which decomposes all dead plants and animals and other organic substances. These organisms during the process of decomposition receive their food as well



as rearrange organic substances so that these may be available to primary producers for their use.

All the components that are discussed above are helpful in balancing the ecosystem.

Abiotic components

Abiotic components are of three types:-

(i) **climatic elements**:- like sunlight temperature, rainfall, humidity, water vapour etc.

(ii) **carbonic substances**:- protein, carbohydrate, fat, oil products etc. They are called the body building substances.

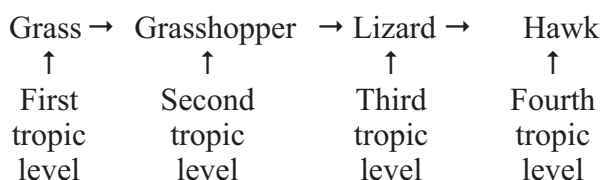
(iii) **Non -carbonic substances**:-like oxygen, carbon dioxide, nitrogen, hydrogen, water, carbon sulphur calcium and mineral salts etc. These elements play a special role in the cycling of substances in the ecosystem and provide strength to the organism.

Food Chain

In the ecosystem all the organisms that are included under the category of producers and consumers are organized in a sequence or series, this organised sequence of organisms by which food energy and nutrients are transferred is called food chain.

Tropic Level

Every level of the food chain is called as tropic level.



Food Web

Many food chains are active in every ecosystem at the same time. There are many food options available to herbivores and carnivores, in this way many food chains get interconnected and this forms food web. If the food web is more complex, the ecosystem will be more permanent and will last for a longer period of time.

Ecopyramids

All the producers, consumers and carnivores are arranged on the basis of their number,

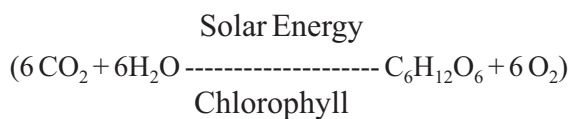
biomass and amount of flow of energy, in rectangular form, this representation is called ecological pyramid.

Energy flow in Ecosystems

The biotic and abiotic components of an ecosystem function actively in a certain process and are controlled by the ecological conditions of that system. Energy is required in order to remain active. This energy keeps an ecosystem active. This entire process is called energy flow. This energy flow is kept under control in its natural form by nature. The ecosystem will be in danger, if there is a slight change in this process, due to human or natural reasons.

The energy flow is continuously required to keep the ecosystem active and functioning smoothly. The main source of energy on the Earth is Sun, but in fact, very less amount of solar energy is used in ecosystems. Like only 0.02% of the solar energy is transformed by plants in form of chemical energy and some portions are used in other functions of the ecosystem. This small portion of solar energy is capable of keeping the ecosystem active.

Chlorophyll, that is found in plants, absorbs the solar energy and transforms it into organic molecules. This process is called photosynthesis. The plants with the help of carbon dioxide and water, convert the solar energy into the food through the process of photosynthesis, by the following chemical formula:-



Thus the solar energy, carbon dioxide, chlorophyll present in the plants is absorbed for the process of photosynthesis, and are converted into biological elements like oxygen, glucose and carbon dioxide by atomic actions. The plants develop from glucose and carbon dioxide and the oxygen and water vapour are released in the atmosphere through the respiratory action of the plants.

The stored chemical energy in the plants are obtained as food by the Herbivores animals. During the transfer of energy from plants to herbivores

animals, there is loss of energy. Further more when carnivores animals feed upon herbivores animals, the energy is again diminished. In this way when the energy is transferred from one trophic Level to the other, this transfer of substantial portions of the energy is lost. Thus the amount of energy keeps on reducing at every trophic level.

According to Odum we receive 3000 kilo calories per sq m energy everyday from solar radiation. Out of this, about 1500 kilocalories are absorbed by the plants and only 1% (15 kilo calorie) of this amount is converted into chemical energy. This amount is further reduced to 1.5 kilo calorie and 0.3 kilocalorie at second and third trophic levels respectively. Generally, most of the energy is lost while transferring from one trophic level to another trophic level, but its quality increases. It is also necessary to know that the rule of energy conservation is enforced everywhere in nature, according to which energy can neither be generated nor destructed, although the form of energy can change. In this way the amount of incoming and outgoing energy remains same in an ecosystem.

Human Influence

The ecosystem is the result of the interaction between the organisms and their environment, residing in a geographical unit. Among all these creatures, human beings are such organisms that influence the environment through their various actions, in order to get maximum benefit from it. In fact, the basis of the development of human civilization has been the exploitation of the nature. The nature replenish some substances on its own but there are many elements that can not be replenished. This results in imbalance in ecosystem, which may be dangerous for both, human beings as well as their environment. The favourable and unfavourable effects of human beings can be seen on the ecosystem. Both humans and the environment are benefited from favourable effects, but there is some kind of loss to any one of them due to adverse effects.

Positive Impact of Man on Ecosystem

Man has tried to use and control the natural resources by his intellectual knowledge and technological development, from the very beginning. Man has achieved success to solve his

problems by his knowledge of land use development of agriculture, forestry, wild life management etc. For example, the fast growing population gave birth to many problems such as lack of land, lack of food grains and various diseases, but the man tried to solve these problems by better land use, use of chemical fertilizers, seeds developed quality and developed agricultural equipments for the maximum production of food grains and by inventing medicines to control diseases and achieved success in all his efforts.

Negative Impact of Man on Ecosystem

Unfavourable effects of man has created more adverse effects on ecosystem than the favourable ones. It is due to these adverse effects, many severe environmental problems have been generated. If these problems are not controlled timely, one day the human life will be wiped off from the Earth, The adverse effects of the human beings on the ecosystems are as follows:-

1. Adverse impact of Agriculture activities
2. Adverse impact of Deforestation
3. Adverse impact of Mining
4. Adverse impact of Industrialisation
5. Adverse impact of Climate Change
6. Adverse impact of Natural Disasters

1. Adverse impact of Agricultural activities

In order to solve the problems arising due to the rapid increase in the population, the man has expanded the agricultural land and developed chemical fertilizers, high yielding variety of seeds and agricultural equipments and other instruments, but at the same time, adverse effects have also occurred on the ecosystem as a result of these developments. Man has not only cleared the grasslands and forests for the expansion of the agricultural land but he also tried to extract the land from the sea, which directly and adversely effected wildlife, pastures and marine ecosystem. Similarly, the usage of chemical fertilizers and pesticides for the more production of food grains, has not only done the task of making the land infertile for agriculture but it has also contaminated the groundwater. In order to get higher production of crops, there has been continuous use of ground water for irrigation, which has decreased the level of ground water, thereby, drinking water crisis has risen in areas with scanty rainfall like Rajasthan.

2. Adverse Impact of Deforestation

An adverse effect of the uncontrolled deforestation, for the expansion of agriculture and other economic activities by man can be easily seen on the climate, soil, wildlife and birds of the ecosystem. As the result of deforestation, climate becomes warmer, the amount of rainfall received is also decreased, land erosion occurs and there is destruction of wildlife. Today, in many parts of the world including India, due to uncontrolled deforestation many wildlife species are extincted or are on the verge of getting extinct. This has caused imbalance in the ecosystem, because natural vegetation is the main basis of forest ecosystem.

According to the Forest Report of 2015, the total forest area of the country is approximately 7,01,673 square kilometre which is about 22.02% of the total area of the country. In which dense forest area is 4,80,214 sq km (13.92%) and open forest is 2,21,459 sq km (8.10%). The geographical area covered by trees, is 92,572 square km which is 2.82% of the entire geographical area. India is one of the few countries where forest policy has been implemented since 1894. This policy was amended in 1952 and 1988. The main basis of the amended forest policy of 1988, was protection, conservation and development of forest. National Forest Programme has also been prepared in the form of a long-term strategy for the next 20 years. The purpose of this programme is to prevent the deforestation and cover one-third of the country with trees.

3. Adverse Impact of Mining Activities

With the industrial and technological development, the mining process also increased but this has caused many environmental problems. Under the mining process, the land is dug widely, due to this deep pits are created on the earth's surface and this causes destruction of the natural vegetation and wildlife of that region. Lakhs of square kilometres of land of the region, becomes unusable. The incidents of landslides increases. The amount of dust particles in the atmosphere increases due to underground explosions which are done for mining operations, which causes adverse effects on the health of the people residing in these areas. As a result imbalance is created in the ecosystem.

4. Adverse Impact of Industrialization

As a result of industrialization, environmental pollution has increased tremendously. Industrial units are the main source of air and water pollution. The Industrial units are the main source of air and water pollution. The atmosphere is constantly being polluted due to the poisonous gases emerging from these units on one side and on the other side the chemical waste water fluids coming from these industrial units are polluting rivers, groundwater and sea water. Due to the polluted rivers and groundwater, the problem of drinking water in the neighboring areas of industrial cities is now very critical. A vivid proof of this, is the emergence of chemical water in tube wells of Pali city. Depletion of ozone gas due to toxic gases and acidic rainfall near industrial areas, has become normal event. All these processes affect the ecosystem indirectly.

Central Pollution Control Board has been established for the monitoring and controlling water and air pollution, in our country, which holds the responsibility of the implementation of the Water Pollution Prevention and Control Act of 1971, Air Pollution Prevention and Control Act, 1981, Water cess act 1971. Standards of industrial effluents and emission of various categories of industries have been notified under this Act. Cement, Thermal Power Plants, Wine Making Factory, Sugar, Fertilizer, Iron and Steel Industry, oil refineries, paper and pulp industry, petrochemical industry, pesticides manufacturing, leather industry, Pharmacy and manufacturing industry of pigments, caustic soda and zinc ,copper and aluminum smelting industries are all kept under the category of industries which cause severe pollution. Out of the total of 1551 industrial units of these industries, 1350 units have installed adequate facilities for pollution control.

Hazardous Waste Management Department has been set up to protect, manage and maintain hazardous chemicals and wastes so that health and environment can be protected from pollution. The activities of this department are important in these three areas- chemical safety, Better management of hazardous wastes and municipal solid waste management. It is estimated that approximately 4.4 million tonnes of hazardous substances are emitted in the country. The management of dangerous

substances and waste in the country were provided legal form through Municipal solid waste (management and handling) Rule 2000, Fly ash notification 1999, plastic recycling (action and usage) rule 1999/2000.

(5) Adverse Impact of Climate Change

Ecosystem of any region is controlled by the climate. Since the Industrial Revolution, climate is undergoing changes by many actions of human being, which also affects the ecosystem indirectly. The following actions of man are important factors for climate change :-

1. Deforestation

The man is over exploiting the forests for his own convenience and benefits, which has resulted in irregularity in the rain and increase in temperature.

2. Industrialisation

Poisonous Emissions of poisonous gases from industrial units not only pollutes the air but also influences the ozone layer. The ozone layer prevents the ultraviolet and infrared rays coming from the sun, from reaching the earth's surface by absorbing them. As a result of the toxic gases, there has been an unprecedented increase in the number of skin and respiratory cases in the world.

3. Invention of Nuclear Power

The most devastating scientific invention of man is the discovery of atomic bomb, underground explosions or explosions in the sea, affects the climate. The excess rainfall in the Barmer area after the pokaran explosion is the vivid proof of this.

Whatever is being done in the name of scientific progress by the man, it is directly affecting the climate and indirectly the ecosystem. From December 6 to 17, 2004, a meeting on climate change in Buenos Aires did not reach on any consensus on deciding the changes in weather and their causes and efforts to control them. The developed countries like United States of America, Soviet Union and Italy etc. are main source behind it. Not only these but other countries such as Saudi Arabia, Oman, Qatar are also opposed to reduce the carbon emissions, because by doing so, it could

cause a crisis for their economy.

Today, the weather conditions of every country of the world is disturbed. It appears as there is no definite weather of rainfall.

There is no fixed place for snowfall because snowfall has been observed in Dubai, there is no fixed season for blossoming of flowers, it is also not possible to determine when the summer season will start and what will be the maximum temperatures. The main reason for this unusual behavior of the weather is the increase in global temperature. The Environmental Panel on Climate Change has given serious warnings about global Warming, That if it is not controlled then there will be a large number of storms and floods. The temperature will increase and the number of people who die from the heat stroke will also increase. The only way to reduce this, is to reduce the emissions of greenhouse gases from 50% to 70% by the level of emissions observed in 1990.

In June 2004, the Government of India released the first National Communication Report on climate change. In which the effect of greenhouse gases and their emissions were made clean for the first time. According to this report, due to the increase in the average temperature of 0.4°C in the last hundred years, there is increase of 10-12% of rainfall in the western, north-western part of the country and north of Andhra Pradesh.

(6) Adverse Influences of Natural Disasters

Human activities have resulted in increase of which natural disasters like floods, droughts, famine, landslides etc. The construction of dams on rivers has caused an increase in earthquake activity. Koyna dam was considered to be responsible for the earthquake of Latur in Maharashtra. In the decade of 1980, due to natural calamities in the world, the average loss of property was of 2 billion dollars, whereas in the 1990's the average loss increased to 12 billion dollars.

On December 26, 2004, more than 2, 00,000 people died due to tsunami waves. The sea level has risen near Andaman Nicobar coastal regions. Therefore it is clear that natural disasters have caused imbalance in the ecosystem.

Balance in the Ecosystem

From the description of the impacts of the

human actions on the ecosystem, it is clear that only the human actions are responsible for creating an imbalance in the ecosystem. But this does not mean that the man should stop the scientific and sit idle development. But there is a need to establish a balance between human activities and the environment. The destruction of the forest should be stopped, there should be increase in the forest area by planting trees, proper and effective measures should be taken to control the pollution, activities that cause imbalance in the ecosystem should be controlled so that a balance is maintained in the ecosystem and the future of the coming generations should be secured.

(i) Natural Balance

Various types of organisms are found in the world. In the community of any ecosystem, the size of the mass of any animal specie remains stable until a natural outbreak does not break its stability. This stability is called balance in nature in the field of ecology.

Presently famines, floods, irregularities in rainfall, earthquake extra are the examples of imbalance in the nature.

(ii) The System of Balance in nature

In order to maintain balance between biological community and the environment in nature, there are the following systems:-

A) Competition

Competition among organisms is helpful in controlling their population. Mostly the sources of food are limited in an ecosystem. There is a conflict between organisms in order to get food. Predator keeps a control on its own complexity through hunt. In the same way the animal which is being hunt, controls predator's complexity on the basis of its availability of being hunt.

B) Ecosystem

The biotic and abiotic components of the ecosystem and their interactions keeps the balance in the ecosystem. They create a network of interrelationships which keeps a control on their population. Every animal specie creates a functional image by its lifestyle, which is called Niche. In brief Niche is the ecological role of a specie and plays a

significant role in the transfer of energy and substances between the ecosystems. Thus, each specie balances the ecosystem in its own way. The specie may be of a plant or an organism, it plays a significant role in an ecosystem. Every specie maintains a natural balance through the food web and energy flow. The consumers of every higher order, by feeding on their lower order organisms, keeping the balance of biomass and pyramid of numbers, provides self control form to the ecosystem.

C) Behaviour

The population of some organisms is influenced by their behavior.

(iii) Barrier in natural balance

Human has created a great deal of barrier in the natural equilibrium by his activities. There was a time when the rabbits were not found at all in the continent of Australia. In the 19th century some tourists brought their rabbits here. Because in Australia there were no animals that could hunt rabbits, as a result of this, the number of rabbits increased steadily, as a consequence the rabbits started destroying the crops. To manage it, foxes were introduced there, which successfully controlled the number of rabbits. Thereafter, the foxes started hunting other animals as well as the birds that had settled there. This strengthens the fact that the process of balance is self controlled in nature.

(iv) The role of keystone species in maintaining the balance of nature

Keystone Species are such species that affect most the ecosystem of a particular area. Keystone species provide stability to the ecosystem and in the absence of such species, there are changes which can change the nature of the ecosystem and it may likely to end. Thus, the role of Keystone species in the ecosystem is very effective. Main predator species are Keystone Species, and they reflect their effect on the ecological community. The increase in the number of predators is an indication that it will limit the number of prey using them as their food. In the absence of predators, the number of prey species will also increase and in this situation there is a possibility of the destruction

of the entire ecosystem. In this way the key stone species determines the number of other species in the community.

An elephant is a keystone species. It dwells in the grasslands. Elephant is herbivores but it does not use the grass for its food. Its main food is shrubs and trees, and thus fruits and shrubs do not grow in a large number. As a result, grasslands remain in existence, which means that it prevents grassland from turning into forest. Similarly, the frog is also the Keystone Species, that keeps mosquitoes and insect kites restricted to their number. The absence of frogs will undoubtedly increase their numbers and the lives of the creatures will in trouble. In this way the keystone species keeps the balance in the ecosystem and it is also in favour of human beings.

(v) Role of wild animals in the maintenance of Natural balance

Wildlife have their own significant place and importance for the maintenance of balance in the nature. Wildlife maintain ecological balance in nature and once of the is balance is disturbed, its direct effect is seen on human beings. For Example: if the Carnivores are eliminated by hunters , then the number of Herbivores will increase in such an unimaginable way that they will let all the forests and forests will be totally destroyed. As a result the rainfall will be low and the crops will not be good in the absence of rain and as a result human beings will suffer loss due to crop failure. Thus the fact is highlighted that the wild creatures play an important role in the balance of nature.

Conclusion

Thus the above explanation indicates that the key stone species and wildlife have their important contribution in maintaining the balance of nature. Their conservation will establish balance in the nature.

Important points

1. The word Ecology is formed by the two Greek words, Oikos meaning dwelling place and Logos that means to study.
2. Ecosystem is the result of the interaction of organisms and the environment. the concept of Ecosystem was propounded by A.G. Tansley.
3. The ecosystem is that system in which all the

biotic and abiotic factors of the environment are interrelated.

4. An ecosystem may be natural or manmade. The structure of the ecosystem is made by the interactions between biotic and abiotic elements.
5. The biotic and abiotic components of an ecosystem require energy to remain active, this energy keeps the ecosystem active and, This process is called energy flow in the ecosystem.

Exercise

Multiple choice questions

1. Who propounded the word 'biodiversity'?
A) E.O.Wilson
B) Desid Tilman
C) Norman Mayors
D) None of the above
2. How many hot spots of biodiversity are found in the world?
A) 12
B) 20
C) 25
D) 34
3. The total number of national parks in India is
A) 103
B) 72
C) 89
D) 96
4. The propounder of the word 'ecosystem' is
A) A. G Tansley
B) Fosweg
C) E.P Odum
D) Petter Hagett
5. Which statement is correct in reference to ecosystem:-
A) ecosystem is the study of effects of environment on its organisms.
B) ecosystem is the study of air, water and soil pollution
C) ecosystem is the study of human environment
D) Ecosystem is the study of organisms and their interrelationships with their environment

Very short type questions

6. What percentage of the entire earth, is land?
7. Biosphere is the result of which activities?

8. What percentage of plants species of the entire world is found in our country?
9. Name the green pigment present in the plants.
10. According to Odum, how much percentage of energy is received from the sun by the earth per sq m per day?

Short type questions

11. Define the term biosphere.
12. Write a short note on biodiversity in India.
13. Describe briefly the objectives of establishing national parks and wildlife sanctuaries.
14. Define ecosystem according to Tansley.
15. Describe energy flow in the ecosystem

Essay type questions

16. Write an essay on the concept of ecosystem.
17. Describe the energy flow in the ecosystem.
18. Describe the effects of industrialisation on ecosystem in detail.

Answer Key

- 1.A. 2.D. 3.A. 4.A. 5.D

Lesson - 23

Study of Ecosystem of Ganga River

Ecosystem is a landscape of a special biotic and abiotic identity. Ecosystems can be divided into aquatic and terrestrial systems. This system presents major conditions of life on earth. There is a deep mutual relationship between biological and abiotic components of the ecosystem. Terrestrial ecosystem includes forests, pasture lands, desert, mountain and islands while aquatic ecosystem includes the pond, lake, swamp, river, delta and the oceans. Some basic elements in each ecosystem such as nature of ecosystem, structure, uses, extinction of ecosystem, rescue activities and preservation are given importance. With aquatic conservation, man gets biological and abiotic resources. These resources are helpful in human development. Human beings are facing various problems due to mismanagement of aquatic resources. Due to excessive use of water, there is serious problem of drinking water. Chemical fertilizers, fertilizers, increasing population, pollution, mixing of solid waste in water have caused many problems. This polluted water is

Table 23.1
Facts about Ganga Basin

Length of Ganga	2,071 Km.
Total drainage region	9.51 Lakh Sq.Km.
In India	8.61 Lakh Sq. Km.
Total % of area of India	26%
Total % of Population residing	45%



Table 23.2
Statewise distribution of Drainage Region of Ganga

States	Total no. of cities situated on its bank	Drainage area (Km.)
Uttarakhand & U.P.	890	294,364
M.P. & C.G.	394	198,962
Bihar & Jharkhand	130	143,961
Rajasthan	222	112,491
West Bengal	373	71,485
Haryana	106	34,341
Himachal Pradesh	57	4,317
Delhi	01	1,484
Total	2073	861,404

Source : CWC Publication No.50/59 Major Drainage Region of India 1990

harmful for both aquatic organisms and human beings.

The aquatic ecosystem can be divided into flowing and stagnant or salty and sweet or freshwater. The ecosystem of rivers is included in freshwater or sweet and flowing ecosystem. Many kinds of flora and fauna are found in this ecosystem. All the civilizations of the world originated and flourished on the banks of river ecosystems. These are known as cradles of human civilization. Hence in all civilizations, the flowing rivers are equated with mother. Humanity is sustaining on river valleys in India for centuries. Some of the oldest human civilizations were originated on the banks of Indus and Saraswati river basin systems. The northern fertile plain of India is formed by Ganga, Yamuna, Sindhu, Saraswati, and Brahmaputra rivers. This fertile region accommodates large portion of world population.

Ecosystem of Ganga River

1. Mountainous Region:

Ganga is the national river and considered as the most sacred river of India. Since ages Aryan Indians have been residing along this river. Ganga has nurtured Ram, Krishna, Guatam, Mahavir and Nanak in its cradle. It is believed that this sacred river washes sins and thus making the way to heaven easier. The origin of Ganga river is in the form of Alaknanda and Bhagirathi. The height from the sea level of the place of its origin is about 3140 meters. The main branch of Ganga is Bhagirathi, which originates from Gomukh in Gangotri Glacier of Kumaon Himalayas. It incarnates from a small cave like structure, the water basin source of which is at 5000 meters from sea level. Many associate rivers play important role in formation of Ganga

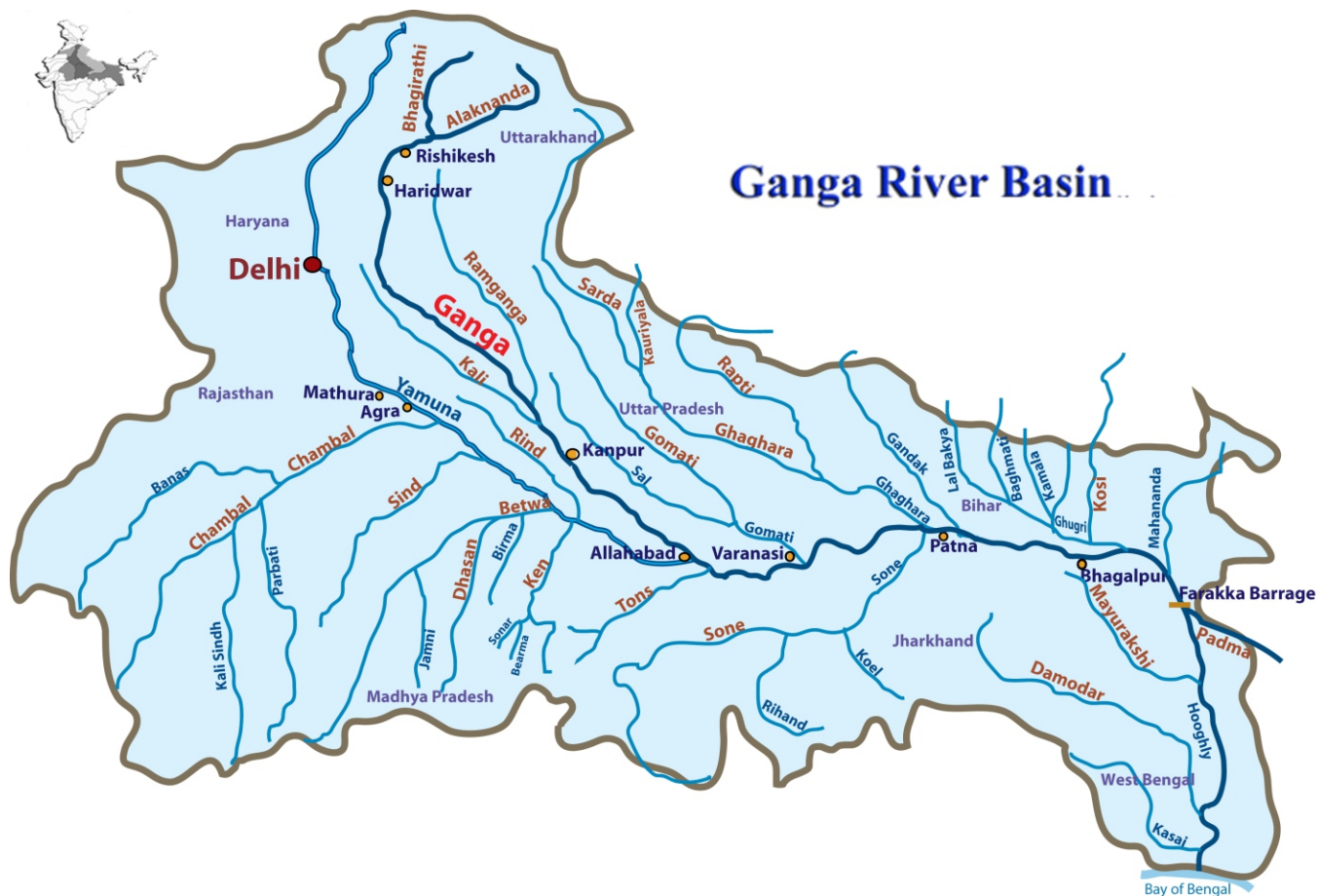


Fig.23.1 : Ganga River Basin

river. At DevPrayag, these rivers confluence to form Ganga river. It travels through narrow mountainous route in Shivalik Himalayas for 200 kilometers enters through Hrishikesh into plain areas at Haridwar. On this travel route, it creates deep valleys passing through zigzag route. One can find valleys upto 600 meter deep at some places. Rocks, boulders pebbles, stone and sand are found on both banks of the river. The slopes on each side are very steep.

2. Upper Plain Region:

Biodiversity, cultural and spiritual aspects are of much significance in this area. The species of Torfish are found in this region and biodiversity is abundant near Shivpuri. Sand dunes, flood plains and of how lakes are formed at Gad mukhteshwar area. Dolphins, crocodiles and tortoise are found in this region. This place is called as Ramsar. The quantity of debris increases as the river approaches Farukhabad. The flood plains become broader. Agriculture, fishery, animal husbandry, human population and settlements increases in this region. The religious rituals like holy bath and funerals are performed on the banks of river. This increases pollution in the river. The number of organisms like insects, birds of different species and creeping organisms increases. The region from Bithur to Kanpur pollutes Ganga the maximum. Especially the leather industry of Kanpur has polluted Ganga river the most. The faecal sludge that flows into the river by the cities situated on the both side of river have greatly affected the sacredness of the river. The growth of plankton and amount of Nephrectile invertebrate are found in abundance in this region. These are very sensitive which are affected by the human activities like bathing, religious rituals and boating. Various species of birds, insect-moths, fish, tortoise are found in this region. Agriculture and animal husbandry are the main occupations of the region. This place is important from the perspective of religion and archaeology. An ancient Brahma Temple in Bithur is of much significance. Meanders, flood plains, lakes are the most common landforms in this region. This is the region of special landforms of Khadar and Bhangar. Dense forests are found in Doab and

lowland and swamps or muddy areas are found in the region. Gomti and Ghaghra are the main rivers of this region.

3. Mid Ganga Plains:

Eastern Uttar Pradesh and Bihar constitutes the mid Ganga Plains. These are densely populated areas. Major occupations of the residents in this region are agriculture, animal husbandry, fishery and small industries associated with these occupations. The main tributaries of Ganga in this region are Ghagra, Gandak, Kosi and Son. The pace of flow of Ganga becomes slower in this region and mixing of sand, soil, waste, excreta, and chemicals etc. increases the pollution of river. The land forms like meander, alluvial, soil planes, lakes etc. are formed in this region. The water is not suitable for drinking and bathing due to excessive pollution. The floods in Kosi river causes damages to human property. Shark, crocodiles, tortoise, alligators and fishes are main living organisms of the river. The Vikramshila Dolphin sanctuary is spread over 50 kms of region in Bhagalpur district. In this series Dolphin has been declared as national aquatic organism on May 05, 2010. The Dolphins are also called as fresh water tiger. This region is also full of dense forests and wild animals.

4. Lower Ganges Plains:

The region from Kishanganj (Purnima-Bihar) to whole of West Bengal (excluding northern mountainous region) and Bangladesh come under the lower Ganges plain. In this region, Ganga and its tributaries are divided into many small stream.



Fig. 23.2 : Sunderban Delta Region

Low slope and presence of alluvial soil presents a magnificent view of deltaic region. The total area of this delta region is 60,000 square kilometres. The forests found in the swampy areas se facing side are called as sunderbans. This area is preserved area in both countries India and Bangladesh. It is one of the foremost areas in terms of biodiversity in the world. Mangrove and tidal type plants are found in this region. Sundari plants are found in large numbers in the region and hence the name of the region is Sundarvan. The characteristic of this ecosystem is the plants and living organisms can survive in the mixture of both fresh water and brackish water. This largest delta region of the world is spreading towards sea. The world famous Royal Bengal Tigers are found in these forests. Apart from this all type of herbivores and carnivores organisms, birds etc. are found in sunderbans. This region is known for rice production and jute production in the world. This region is affected by tropical cyclones that cause huge losses to human property. The region has hot and humid monsoon type climate. Hence tropical wet Mangrove forests are found here. Since the production of rice and fishes is in abundance, the rice and fishes form the staple food.

Dams and Barrage on Ganga River:

The number of dams and barrages built on Ganga river are important parts of Indian economy and public life. The most important among these is Farakka Barrage (2,240 meters length, started on April 21, 1975) located at India Bangladesh border. This serves the purpose of irrigation, fishing, water in Hoogly (in summer), and to prevent the Kolkata port from silting. Tihri Dam was also made for execution of multi-purpose projects on Bhagirathi river. The height of this dam is 261 meters. It produces 2400 MW electricity, irrigates 2,70,000 hectare area and supplies 102.20 crore litres of drinking water to Delhi, Uttar Pradesh and Uttarakhand. The third biggest dam was built at Haridwar known as Bhimghoda. It was built by British rulers in 1940. The water from this dam is used for irrigation, drinking and fishing purposes. Apart from these, barrages were built on Sharda, Kosi and Gandak rivers near Nepal border. These are useful for production of electricity, irrigation and drinking water. These dams have benefitted the region a lot but it has problem of deposition of silt.

Farakka barrage is most affected by it.

Pollution in Ganga River:

The total length of Ganga river is 2071 kms. It has many small and big tributaries. Some join it from northern Himalayan region while some join from southern peninsular region. About 2500-3000 cities are found on the both banks of river Ganga, which are densely inhabited. Agriculture and Animal husbandry is practised on both sides of river. Various type of industries are set up in cities. The solid waste from chemical, leather, fertilizer, and other industries and human excreta, waste etc are mixed in Ganga that is causing severe pollution in Ganga river. The water is not suitable for use for drinking and bathing purposes. This pollution is spoiling the ecosystem of river. The dissolved oxygen found in the river is at 6.8-7.2 mg per litre which is very high. The normal range for dissolved oxygen is 4.0 mg per litre. This is found highest in Haridwar, Allahabad, Patna and Varanasi. Bio-chemical oxygen (BOD) is found maximum from Kanouj to Varanasi. Near Kanpur it is recorded at 16.39 mg per litre. In the mountainous region, it is recorded at 15.58 mg per litre. The quantity of DO and BOD is found at different levels before and after monsoon season. The quantity of coliform is recorded maximum at Kanouj, Kanpur, Allahabad, and Varanasi. Increased levels of DO, BOD and coliform has caused maximum pollution in the water.



Fig. 23.3 : Dolphin in Ganga

Conservation Measures:

In Ganga Action Plan I & II, has arrangements were made for treatment of pollution of the river and plants were established for its cleaning and purification of water. Billions of rupees have been

Maha Khumbh Mela

At Prayagraj (Allahabad) the confluence of River Ganga, Yamuna and Saraswati, a mega fair known as Maha Khumbh is organised at the interval of every 12 years, in which lakhs of tourist come from own country and abroad. It is largest halt of faith and reverence of human beings on the earth. According to Indian Mythology, few drops of nectar achieved from 'Sagar Manthan' were fallen here. It is organised during a special astrological position. 'Purna Khubb' is held once in 144 years. It is believed that bathing in this Maha Khubb Mela will lead to Salvation. Harvard University of USA have included the celebration of 'Maha Khubb Parv' in its study. The arrangements of this fair has been highly praised and the research team felt that the arrangements are better than FIFA World



Sagar Manthan and Maha Khumbh - Prayagraj

spent since 1985. These efforts have not yielded good results. Administrative and political will and foresight are greatly lacking in efforts. In addition, corruption has been a big problem for the country. Preservation of Ganga river will help in smooth functioning not only river but also for human beings flora, fauna, environment, and highest ecosystem. There is dire need to preserve dolphins, Mahasheer fish, alligator, Bengal Tiger, Mangrove and tidal type forests. Number of dams and barrages have been built in the name of development on Ganga

river. Settlements have been established in flood plains. Deforestation has increased occurrences of soil erosion, landslide, and flooding. Saving and preserving Ganga is essential for survival of human beings. Rise in temperatures are melting the glaciers. This can be a great trouble for survival of Ganga and other rivers. The responsibility of cleaning Ganga rests with Government as well as people residing nearby it. Unless we truly respect the Ganga river as mother, the government machinery will not be able to maintain its purity.

Important Points

1. Biotic and abiotic components of environment are studied in Ecosystem.
2. Ganga is a national river of India. Increasing pollution is causing imbalance in its ecosystem. There is dire need to save and preserve dolphin and Mahashir fish species.
3. Vikramshila dolphin sanctuary is established at Bhagapur for preservation of dolphins. There are only 2000-2500 river dolphins remaining in country.
4. Ganga river originates at Kumaun Himalaya and travels to Rishikesh and Haridwar plain region and further moves to Uttar Pradesh, Bihar, Western Bihar, and Bangladesh and then creates Sundarban delta region.
5. Sundarban are one of the foremost region for biodiversity. Royal Bengal tigers are found in this region. This is the protected region.
6. At Devprayag, there is confluence of Alaknanda and Bhagirathi rivers.

Exercise

Objective questions

1. Which species of animal is preserved at Vikramshila Sanctuary?
A. Dolphin B. Shark
C. Alligator D. Mahshir fish
2. The source of origin of Ganga is
a. Shivpuri b. Prayag
c. DevPrayag d. Gangotri
3. What are found in Sundarbans?
a. Sher b. Royal Bengal Tigers

c. Camel d. Hippopotamus

4. Bhagirathi and Alaknanda are
a. Rivers flowing in Uttar Pradesh
b. Tributaries of Ganga in Bihar
c. Watercourses from glaciers in Uttarakhand
d. Tributaries of Brahmaputra in Assam.
5. Tihari dam is constructed on which river
a. Yamuna b. Alaknanda
c. Mandakini d. Bhagirathi

Very short Answer Questions

6. What is the total length of Ganga river?
7. Where does Ganga river enter into plain region?
8. Name the most polluted region of the Ganga river?
9. Name the components of ecosystem?
10. Where is Farakka Barrage located?

Short Answer Questions:

11. Explain the importance of ecosystem.
12. Name the fresh water ecosystems.
13. The purest water in Ganga river is found in which region.
14. What is Sunderban?
15. What is the meaning of extended delta ?

Essay type questions

16. Make clear the river ecosystem and explain mid Ganga Valley area ecosystem?
17. Explain the pollution of Ganga river and analyse the reasons and various measures for tackling pollution.
18. Explain biodiversity and explain in detail the biodiversity of Sunderban.

Answer key:

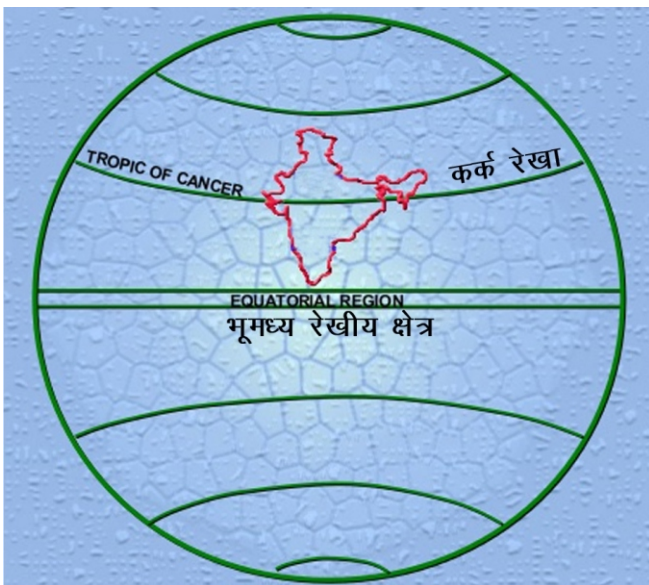
1.A 2.D 3.B 4.C 5.D

Lesson - 1

Location, Extent & Situation of Bharat

Our country was named Bharat on the basis of the great man **Bharat** or an important branch of Aryans, which was also known as Bharat. Formerly, Bharat was also known as Aryavarta, the land of Aryans. Iranians called the inhabitants of Sindhu coastal region as **Hindus** and the land was named as **Hindustan**. Romans named Sindhu River as **Indus** and Greeks called it as **Indos** and this land was known as **India**. Today our country is famous as Bharat in the world.

cultured country. Our old culture bestows on our country the boon of unity. Geographical personality had special contribution towards this glorious history of Bharat. Foreign attacks, plunders and occupations during middle ages had impeded the progress and blurred the prestige of our country. Later on, fortunately the awareness among the people of Bharat and unparalleled path of peace and non-violence under the leadership of Mahatma Gandhi, our country got freedom. Our country is regularly and speedily progressing after achieving independence. But at present we are facing the



Civilization and culture in our country had developed long ago, while at that time most of the countries of the world were either uncivilised or semicivilised. The credit of spreading the light of knowledge and culture across the world goes to our country. Bharat is a great, prosperous and a highly

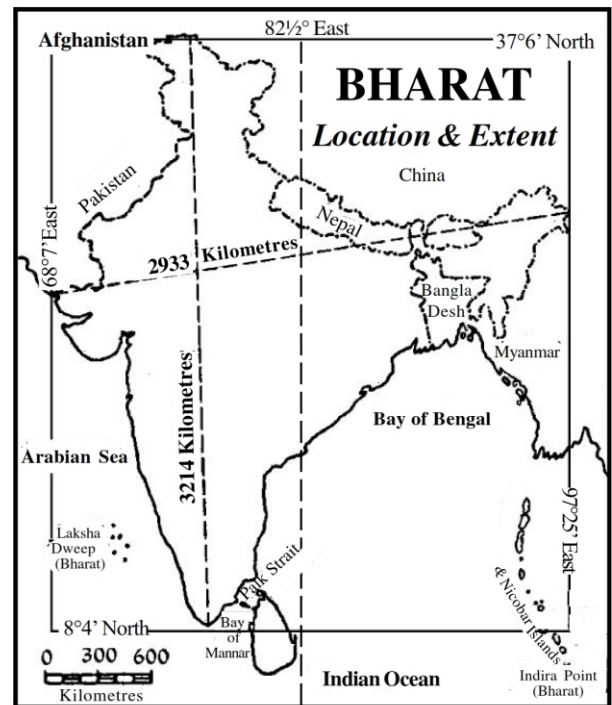


Fig. 1.1 : Bharat : Location & Extent

transitional problems, related to economic exploitation by foreign powers during long pre-independence period, pressure of increasing population and the admixture of various religious philosophies into our indigenous culture and national mainstream. The past of Bharat was golden, present is in transition but we can regain our lost pride and become prosperous by developing love for the nation, religious meakness, wisdom, honesty and hardwork, and can make homogeneous well cultured society. Again, the intensive efforts for all round development, the geographical personality of Bharat offers the prospect of bright future.

Location & Extent

Bharat extends to the north of equator from 8°4' to 37°6' latitudes and from 68°7' to 97°25' east longitudes. Tropic of Cancer or 23½°N latitude passes through the middle of our country. This line divides Bharat into two halves – (1) **Northern Bharat**, extending in the **temperate zone** and (2) **Southern Bharat**, extending in the **torrid zone**. The northern most point of Bharat is part of the snow capped Himalayan Mountain System. The area known as the **Roof of the World**, lies in the heart of Asian Continent and spreads upto the south of Pameer. Kanyakumari is its southern most tip. Both these tips are located at the distance of 30° latitudes. This distance is one-third of the total spread between equator and the north pole. Bharat is located in the northern hemisphere. Equator lies at the distance of only 876 kms. south of Kanyakumari. At this point Sri Lanka is separated from Bharat by Bay of Mannar and Palk Strait. Peninsular Bharat tapers off towards the south of the tropic of Cancer up to Cape Comorin. Peninsular Bharat divides Indian Ocean into two parts. Its western part is known as Arabian Sea and its eastern part is known as Bay of Bengal (Fig. 1.1).

The far western point lies in the Rann of Kutch, which is a marshy area. The mountainous region, covered with virgin forests, lie in the eastern most part of our country. At this point our country's boundary touches Myanmar (Burma) and China. The longitudinal distance between these two extreme points of Bharat is also approximately 30°. This longitudinal spread is almost 1/12th of the total

longitudinal spread of the globe. Because of such a large longitudinal extension, sun is seen two hours late in Kathiawar as compared to Arunachal Pradesh. To avoid discrepancies of time, local time of 82½° east longitude has been determined as **Indian Standard Time**. This line passes through Allahabad (Prayagraj).

The maximum length of Bharat from north to south is 3214 Kms. and the maximum width from east to west is 2933 kms. Total area of Bharat is approximately 32.88 lakh square kms. In terms of area, Bharat occupies seventh place in the world after Russia, Canada, China, U.S.A., Brazil and Australia. Bharat is nine times larger than Japan and 14 times larger than England. Its total area is approximately 1/46th of the world. Its land boundary is 15,200 kms. long and the coastline is 6100 kms. long.

Coast Line

The length of the coastline of Bharat is insufficient as compared to its total area. Our coastline extends only 6100 kms. in length. This coastline is almost straight and unindented. It is for this reason that there are very few natural and good ports. There are very few islands near the coast. Important islands on the eastern coast are Haire islands, Pamban islands and Harikota islands and Lakshyadweep and Trombay are important islands on the western coast. Andaman and Nikobar islands have a long spread in the Bay of Bengal. Mumbai is situated on Salset island near Elephanta island. Parikud islands are found between Lake Chilka and Bay of Bengal.

The coastline of Bharat can be divided into two parts-

(1) **Eastern Coast** - It spreads from Ganga Delta to Cape Comorin. Its northern section is known as **Northern Sarkar Coast** and its southern section is known as **Coromandel Coast**. Northern Sarkar Coast extends between the deltas of Ganga and Krishna rivers. It is a shallow coast. Kolkata is situated here on the shallow coast. Therefore, the port lacks natural facilities for the movement of big ships. To overcome this problem, Haldiya port has been developed as an assisting port. Haldiya port enjoys the facility for the movement of ships with greater drought and is endowed with mechanised

docking system. The location of Vishakhapattanam and Paradip ports is good for commercial activities because of calm oceanic conditions. These ports also enjoy the facility for anchoring of big ships. Kakinada, Waltair, Vimpilattam, Gopalpur and Puri are other ports on this coast.

Coromandel coast spreads from the Delta of Krishna river in the north upto Cape Comorin in the south. It is a straight, shallow and sandy coast. Chennai is the largest artificial port on this coast. Kanyakumari, Rameshwaram, Dhanushkoti, Karikal, Pondichery, Cuddalor, Puttuchchori, Nagapattam and Tuticorin are other important ports on this coast. Setubandh and Rameshwaram are important attractions for pilgrims on this coast.

(2) Western Coast - This coast extends from Gulf of Cambay in the north to Cape Comorin in the south. It is sub-divided into three sections -

(a) Malabar Coast - It extends from Goa to Cape Comorin. There are natural ports on this coast because it has indented coastline. But because of the fast blowing winds in this section, large volume of sand accumulates on the coast. Lagoons are characteristic features of this coast. Cochin is situated on one such lagoon, and hence it is a good

natural port. It also possesses a well developed ship-building yard. Manglore, Aleppi, Kozikod, Thiruvananthapuram etc. are other ports on this coast.

(b) Konkan Coast - This coast extends from Goa to Surat. It is a straight coast backed by hard rocks. This coast remains safe from the monsoonal storms because it is protected by the dense forest found on the island and in the coastal area. Surat, Mumbai, Ratnagiri, Goa etc. are important ports of this coast.

(c) Saurashtra Coast - It spreads from Surat to Kutch. It is an indented coastline with various gulfs and bays like Kori, Kriv, Khambhat (Cambay) and Kutch. There are many islands near the coast. Porbandar, Okha Port, Kandla, Bhavnagar etc. are important ports on this coast. Kandla has been developed to provide commercial and trading facilities to the states of Punjab, Haryana and Rajasthan.

Our Boundaries

Our southern boundary is fully natural, formed by Arabian Sea, Bay of Bengal and Indian Ocean. No other country situated along Indian Ocean has such a large coast line as Bharat has. The total water front of Bharat is almost equal to the radius of the earth. Besides, there are many islands of Bharat which add to the total water front of our country. These are mainly Andaman Nikobar islands, Lakshyadweep, Pamban Islands etc. Yet the total water front of Bharat is not too large in the light of the area of our country. The main reason is that its coastline is straight and unindented. Because of the increasing oceanic trade, commerce and naval activities, the importance of our water front has increased considerably in the light of the global and Indian Ocean strategy (Fig. 1.2).

Boundaries of five countries meet at the northern head of our country. These are Pakistan, Afghanistan, China and Bharat. The boundary of Tajikistan seperated from Soviet Sangh is also near to this area. Therefore, this point is of tremendous strategic importance to our country. Traditionally, Himalayas are considered as our northern guard. Hindukush, Mushtagh, Kunlun and Agril mountains



Fig. 1.2 : India and adjacent countries

meet at this strategic point. Approximately 2400 kms. long stretch of Himalayas, south-east and eastwards from this point, possess many ice-capped ranges and peaks which are our northern guard.

Mountainous states like Nepal and Bhutan lie in this region. We have deep historical and cultural relations with these countries. Mackmahon boundary spreads between Bharat and China east-



Fig. 1.3 : India : Political

wards from Bhutan and passes through the ice-capped peaks. Boundaries of three countries meet in the far eastern region. These are China, Myanmar and Bharat. Various branches of Himalayas like Mishmi, Patkoi, Naga and Mizo hills turn towards the south and form the eastern boundary between Bharat and Myanmar. These hills spread as Arakan Yoma in Myanmar further southwards. The continuation of the higher parts of these hills in Bay of Bengal appears as a long chain of Andaman-Nicobar islands. Traditionally these high mountain ranges forming our northern and eastern boundary have been considered as highly inaccessible. A few passes and river valleys were the only easy passages through them. But Chinese attack on Bharat has proved that the mountainous boundaries are no more inaccessible and safe now due to developed technology of advanced aircrafts. Therefore, the strategic importance of our northern and eastern boundaries has greatly increased in the modern period.

Our eastern boundary also meets with Bangladesh. Our five states are located along the boundary of Bangladesh. These states are - Mizoram, Tripura, Meghalaya, Assam and West Bengal.

Pakistan, which was separated from our land in the year 1947, lies on our western boundary. Mohanjodaro in Sindhu Valley bears the testimony of our cultural relations with that land. Our boundary with Pakistan is artificial and land boundary. Jammu-Kashmir, Punjab, Rajasthan and Gujarat states lie on the boundary with Pakistan. Pakistan has illegally occupied some portions of our Jammu and Kashmir state. Therefore, it is the major reason of tension between Bharat and Pakistan, whereas love for peace is the root of Bhartiya culture. Many articles recovered through excavations in some cities of central Asia, various Baudha manuscripts lying in Chinese monasteries, various temples in south-east Asian countries etc. provide proofs of our love for peace and coexistence. There are no evidences in history to the effect that Bhartiya armies ever attacked on other countries. But at the same time we are very conscious of and loyal in protecting the integrity of

our boundaries. National unity is our biggest strength.

Situation of Bharat - A Factor

Sub-continental situation – Of the three peninsulas of South Asia, Bhartiya sub-continent is the largest. There is no other area in the world so clearly defined and demarcated as Bharat. Therefore, it has been rightly designated as a **sub-continent**. China, Nepal and Bhutan lie towards its north, Sri Lanka and Indian Ocean towards south, Bangladesh, Myanmar and Bay of Bengal towards the east, and Pakistan and Arabian Sea towards the west.

Perhaps no other region and country in the world is so well defined and demarcated by nature than Bharat. That is why it has been termed as a sub-continent. The sub-continent is well demarcated by high Himalayan girdle in the north, vast desert in the west, densely forested mountain ranges and deep valleys in the east and huge expanse of water bodies elsewhere. As a matter of fact there are many natural and cultural diversities found in the Bhartiya Sub-continent. Highest mountain ranges, vast level plains, newly folded mountains, old plateaus, hot deserts, evergreen forests, most humid as well as dry areas of the world, backward agricultural practice like Jhooming, most developed mechanised agriculture, handicrafts as well as modern industrial production, horse-mule carts, bullock carts as well as the most modern means of transportation, habitations in the forested areas as well as metropolitan cultures, coexistence of indigenous and various foreign religions, diversities of languages, dresses, customs, traditions etc. are just few examples. But in the presence of these vast diversities, **Bhartiya Sub-continent is a unique geographical unit bound in a magnificent natural and cultural unity**. Therefore, the most unique feature of Bharat is its **Unity in Diversity**.

Situation with reference to neighbours – Indian ocean has played a useful role in increasing the importance of Bharat with reference to its neighbouring countries. Indian ocean also plays a unifying role in the oriental world, encompassing the countries of east Africa, west and south-east

Asia. For the last more than four thousand years, Bharat had been maintaining commercial and cultural relations as far as Babylon, Egypt etc. in the west and the countries of Indo-China and south-east Asia in the east. Before the development of oceanic trade routes, Bharat also extended its territorial relations through land routes. Although inaccessible and high Himalayan mountainous girdle makes our northern boundary, its passes and valleys facilitated the development of land routes through them. Many invaders also came through these routes while Buddhist monks went to Tibet, China, Korea and Japan through these routes and took message of peace with them. It became possible for Bharat due to its situation between West, Mid-east and South-East Asia.

Situation with reference to the World -

From global point of view, the situation of Bharat at the head of Indian ocean is extremely important in the eastern hemisphere. Because of this situation Bharat has become the meeting point of international trade routes. Suez route, Atlantic route, Cape of Good Hope route and Pacific Ocean trade routes meet in Bharat. Import and export trade has developed fast in Bharat because of its being the meeting point of these international trade routes. Not only the oceanic routes from western countries to the far East but air routes also pass through Bharat. Delhi, Mumbai, Chennai and Kolkata are airports of international significance. Trade, commerce and communication facilities have developed rapidly due to the meeting of international trade routes here.

Advantages due to situation

Bharat is proud of its glorious past, dignified present and prospective future. The basis of Bharat's glorious past is due to its unique geographical location. Bharat is situated in the centre of the eastern hemisphere, a location which has a specific importance -

1. Situated at the head of the Indian ocean, Bharat has become a meeting point of important trade routes. International trade routes like Suez route, Cape of Good Hope route, Atlantic route and Pacific Oceanic trade route converge here. This has contributed to the enhancement of import and export trade of our country.

2. All air routes originating from the western

countries and destined for the Far East pass through Bharat. Delhi, Mumbai, Chennai, Kolkata etc. are airports of international significance. Therefore, communication facilities have been developed here.

3. Because of Bharat's location in both - the torrid and temperate zones, all agricultural crops are produced in our country.

4. Because of India's location, all our sea ports remain open throughout the year.

5. Bharat's neighbours like Nepal, Bhutan, Bangladesh, Myanmar, Sri Lanka, Afghanistan, Pakistan and African countries are less developed. Therefore, these countries provide good market for Bharatiya products.

6. Bharat is girdled by Himalaya mountains in the north. It protects our country from Siberian cold winds on one side and check the south-western monsoon and help providing rain in Bharat only.

7. Because of Bharat's specific location, its regional and international importance has considerably increased. Having jealousy with this situation and with the intention of increasing their undue influence in the region, some foreign powers continuously try to destabilize our country. We have to be cautious against such forces.

8. The importance of the situation of Bharat is also evident from the fact that its neighbouring ocean has been named as Indian Ocean on the basis of the name of our country.

9. The unique situation of Bharat in Indian Ocean makes it a unique Bhartiya **Sub-continent**.

Important Points

1. The past of Bharat had been glorious.
2. Future of Bharat is also bright depending upon the unique formula of **Unity in Diversity**.
3. Location - Bharat is located between $8^{\circ}4'$ to $37^{\circ}6'$ north latitudes and $68^{\circ}7'$ to $97^{\circ}25'$ east longitudes.
4. Tropic of Cancer passes almost through the middle of our country.
5. The local time of $82\frac{1}{2}^{\circ}$ east longitude has been determined as the standard time of our country.
6. The maximum length of Bharat from north to south is 3214 kms. and maximum width from east to west is 2933 kms. and the total area is 32.88 lakh square kms.

7. Bharat is the seventh largest country in the world in terms of area after Russia, Canada, China, U.S.A. Brazil and Australia.
8. Land boundary of our country is 15,200 kms. and water front is 6100 kms. long.
9. Eastern coast - Northern Sarkar Coast and Coromandel coast.
10. Western coast - Malabar coast, Konkan coast and Saurashtra coast.
11. Situation of Bharat is very important as a resource factor.
12. Bharat enjoys various advantages due to its location and situation.

Exercise

Multiple Choice Questions

1. The coast between Kanyakumari and Goa is known as –
 (A) Konkan (B) Malabar
 (C) Saurashtra (D) Coromandel
2. The state of Bharat, whose boundary does not meet with any other country, is -
 (A) Punjab (B) Meghalaya
 (C) Tripura (D) Haryana
3. Out of the following groups of countries, select smaller group than Bharat in terms of area -
 (A) Pakistan, Australia, Myanmar & Afghanistan
 (B) China, Australia, Cuba & Brazil
 (C) France, Canada, Afghanistan & Iraq
 (D) Myanmar, Pakistan, Afghanistan & Iraq

Very Short Answer Type

4. Local time of which longitude is determined as standard time of Bharat?
5. Which is the main latitude that divides Bharat into two halves?
6. Why is our water front shorter considering the total area of our country?

Short Answer Type

7. Boundaries of which three countries meet in north-eastern Bharat?
8. Why is our northern head strategically very

- important?
9. What are the characteristic features of Bhartiya water front?
10. What are the characteristic features of the situation of the Bharat with reference to its neighbouring countries?

Essay Type

11. What is meant by sub-continent? What is the relevance of designating Bharat as a sub-continent?
12. Describe the importance of location and situation of Bharat.

Skill

13. Draw a map of Bharat showing its situation with reference to its neighbouring countries.
14. Draw an outline map of Bharat and show in it latitudinal and longitudinal extensions and also name its coasts.

Answer Key

1. (B), 2. (D), 3. (D).

Lesson - 2

Unity In Diversity In Bharat

Naturally and culturally, Bharat occupies a distinct place in the world. Variety of regional characteristics can be observed even by making short trips in our country. These diversities are reflected in various aspects as physical features, climate, vegetation, soil, agriculture, industry, means of transportation, standard of living of people, dress, language, dialect, songs and music, customs, food habits, social behaviour, religious beliefs, methods of worship etc. Even short visits in our country can clearly exhibit a variety of relief features covering high mountain ranges, plateaus, plains, valleys, desert etc. Even one can observe the changing colours of soil. Variety of vegetation and a large variety of crops can also be easily visible. Local dialects, pronunciations and methods of expression are distinctly different throughout the country. A variety of dresses and food stuffs are attractive aspects of our country. But in spite of these diversities, our journey through out the country never lets us feel that we are in some unknown area. Rather we everywhere realize some sort of uniqueness in our country. It is a distinct characteristic of Bharat. This distinct characteristic relates to our **unity in diversity**.

Diversities

From the above description, it is clear that there are various diversities found in Bharat. These diversities contribute not only a variety of colours to our society but these help in the distinct harmonious unification of our society. In order to develop a better comprehension of the diversities of Bharat,

these can be grouped into three major categories –

- A. Natural Diversities,
- B. Economic Diversities and
- C. Demographic Diversities.

A. Natural Diversities

1. Topographical Diversity - Bharat possesses a variety of topographical features which have their own natural, economic, tourist and philosophical importance. On one side, there are high and snow covered mountain ranges spread on our northern boundary, while on the other side there is a vast stretch of Brahmaputra-Ganga-Sutlej river plains. The deep and narrow gorges of Brahmaputra and Sindh rivers, the residual mountains in the form of Aravallis, hot and dry Thar desert, estuaries of Narmada and Tapti, coastal plains, islands, and groups of islands are just a few examples of the ornamentation of topographical diversities. For ages, peaceful, natural, snowy and solitary high mountainous environment of Himalayas have been favourable for meditation for our saints. This region is also the source of many perennial rivers of our country. These mountains also attract a large number of tourists every year and provide them comfort from the scorching heat of the plains.

2. Structural Diversity - Bharat is one of the few countries in the world having rocks of different ages. On one side, India possesses the oldest formations of Deccan plateau which is one of

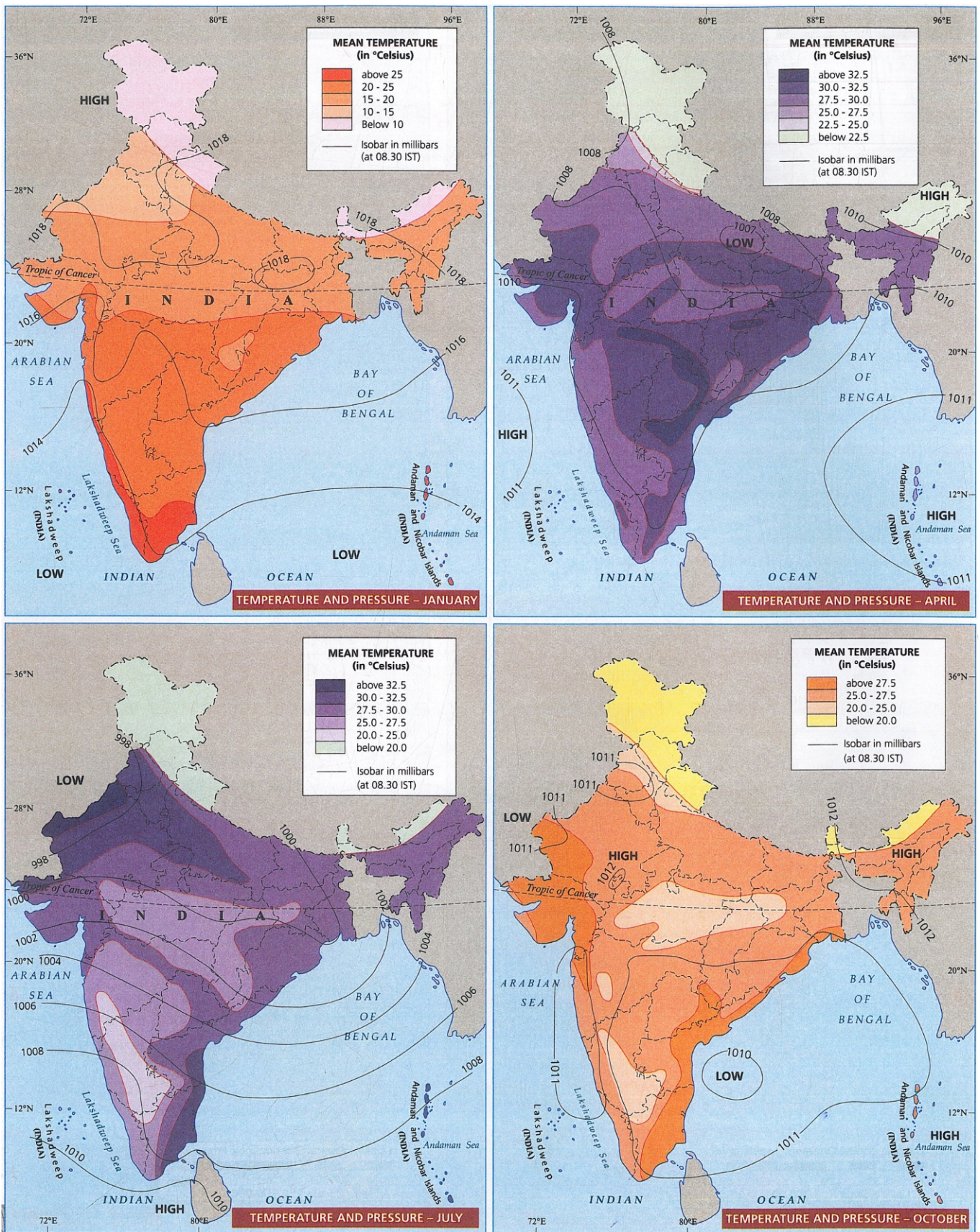


Fig. 2.1 : Climatic Diversity in India

the oldest plateaus (**Old Massifs**) of the world. Similarly, Aravallis, Satpura, Vindhyachal etc. are included among the oldest mountains of the earth. On the other hand, Himalayas on northern borders are part of the newly folded mountain system. The newest deposits of alluvium are found in Ganga-Sutlej plain, Deltas and the flood plains.

3. Diversity of Drainage - There are many diversities related to drainage system in our country. Its main reason is the monsoon climate of our country. The climate is characterised by a long dry period and a very short rainy season. Resultantly, most of the rivers of our country are seasonal and flow only during rainy season. These are called as seasonal rivers. But rivers originating from the Himalayas are perennial rivers because they are fed by snow melted water in dry period. Similarly, diversities are also found in the lakes of our country. On one side, Rajsamand, Jaisamand etc. are sweet water lakes while on the other Sambhar, Deedwana, Lunkaransar, Pachpadra etc. are salt water lakes, providing large quantities of salt.

4. Climatic Diversity - Different parts of our country have different types of climatic conditions. These diversities are also important in terms of seasons. Maximum temperature in summer season is found in Thar desert where it rises to more than 45°C at several places. Summer temperatures usually decline towards south and in the coastal areas. In these areas, summer temperatures usually ranges between 28° to 30°C. Contrarily, winter temperatures fall below freezing point at several places in northern Bharat and these temperatures increase towards the south and coastal regions where the average fluctuates between 25° to 30°C. Thus, there are large seasonal diversities of temperature in our country (Fig. 2.1 & 2.2).

The other important aspects related to temperature are pressure and winds. Pressure and temperatures have **inverse relation** or **negative correlation**. Resultantly, lowest atmospheric pressure prevails over the Thar desert and the

highest pressure prevails over the surrounding oceanic areas in summer season (Fig. 2.4). Contrarily high pressure prevails over northern Bharat and low pressure prevails over the surrounding oceanic areas in winter season (Fig. 2.5). Thus, there is a complete seasonal reversal in the pressure system. Due to the reversal in the pressure system, wind direction also experiences seasonal reversal. In summer season winds blow from oceanic areas to land and in winter season, winds blow from land to oceanic areas.

Great diversities are observed in the seasonal and regional distribution of rainfall in Bharat. About 90% of our rain is received in the summer season, while the winter season is mostly dry, except a few areas. Only 10% of our rain is received in winter season. In terms of regional distribution, Mawsinram has an annual average exceeding 1300 cms., while on the other hand the average is reduced to less than 5 cms. in western Rajasthan.

5. Diversity of Water Requirement - Bharat is an agricultural country. Enough quantity of water is not available for agricultural purposes in most of the areas of our country due to monsoon climate. Resultantly, there are large diversities of water requirements for agricultural purposes in various parts of our country. Water requirements mainly depend upon rainfall variability. The **rainfall variability** is defined as the proportion of fluctuation of rainfall above or below the annual average in a region. Water requirements are higher in the areas where the rainfall variability is higher. It is mainly due to the fact that rainfall variability is higher in the areas having low annual average. If a region has an annual average of 10 cms., and if the actual amount of rainfall occurring in a year is 15 cms., the rainfall variability will be +50 per cent. If an annual average is 100 cms. in a region and the actual amount of rainfall in a year is 5 cms. higher (105 cms.), then the rainfall variability will be only +5 per cent.

Some parts of Bharat frequently experience

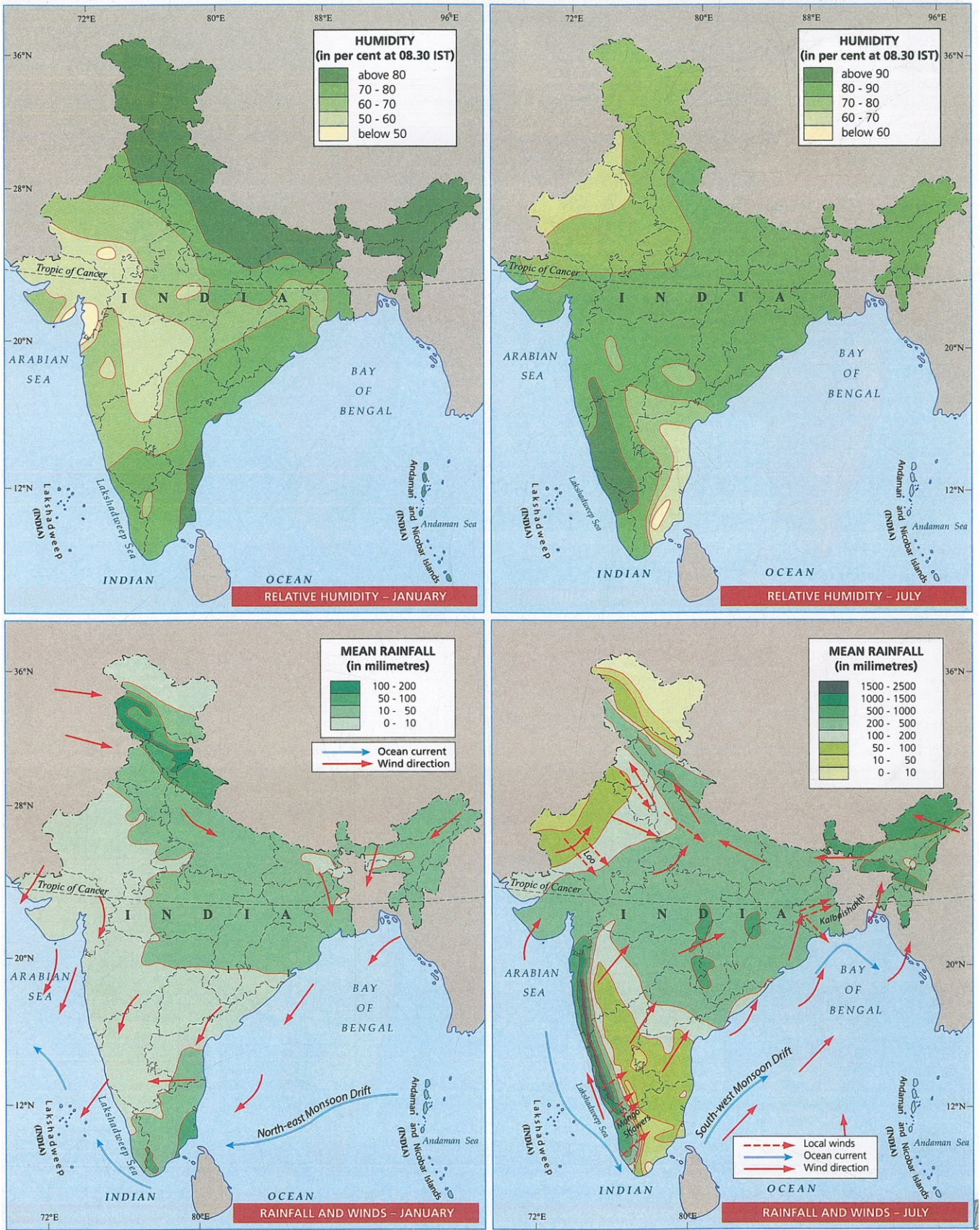


Fig. 2.2 : Climatic Diversity in India

droughts and floods due to these characteristic of rainfall. Such areas are termed as **drought prone** and **flood prone** areas. These also symbolize the diversities of the amount of water availability.

6. Soil Diversity - Variety of soils are found in our country due to topographical, structural and climatic diversities. Major soils of our country are alluvium, black, red, yellow, brown, sand, clay, laterite etc. Diversities of their fertility are also important. Alluvial and black soils of our country are most fertile soils. Laterite soil is relatively less fertile. Sandy soil cannot be used for agricultural purposes due to scarcity of water.

7. Vegetational Diversity - Large variety of vegetation and forests are found in our country due to diverse natural conditions. Higher slopes of the Himalayas are covered with coniferous forests while broad leaved forests cover their lower slopes. Evergreen forests are found on the hot and humid western slopes of Western Ghats. Evergreen forests are also found in north-eastern Bharat. Other parts of our country are mostly covered with deciduous forests. Dry and semi desert areas are covered with desert scrubs, thorny bushes and scattered grasses. **Sam** area near Jaisalmer lacks vegetative cover.

B. Economic Diversities

1. Agricultural Diversity - Various stages of agricultural development can be seen in our country. In remote and densely forested areas, practice of shifting cultivation exists even today. It is considered as the most undeveloped form of agriculture. It is known as **Jhooming** in Assam. On the contrary, mountain slopes in various parts of north-eastern Bharat have the developed form of **plantation agriculture**. It is a well planned and developed form of agriculture mainly involving skilled management. Subsistence mixed agriculture is practiced by small farmers in most parts of our country. These farmers rear animals besides agricultural pursuits. **Commercial agriculture** is practiced on large scale in the prosperous and developed areas of our country.

Variety of crops are grown in different seasons and in different parts of our country due to natural diversities. Our country is unique in this respect, having the prevalence of sub-tropical crops like rice, tea, coffee, jute etc., temperate crops like wheat, cotton, maize, tobacco etc. and crops of dry regions like Jowar, Bajra etc. Thus, a large variety of crops are grown in our country.

Use of variety of agricultural implements and methods of agriculture symbolize the diversities of the stage of development. Most of our small farmers still practice agriculture with the help of indigenous plough, domestic animals and use dung manure. This is usually subsistence agriculture. Contrarily prosperous farmers use sophisticated agricultural machinery to procure large production. This type of agriculture usually yields surplus production which enters into trade.

2. Diversity of Means of Irrigation - The degree of requirements for irrigation vary greatly in different parts of our country. These requirements are mainly caused by seasonality of rain, seasonal flow of most of the rivers etc. The most popular means of irrigation in our country are wells, tanks, tube wells and canals. Tank irrigation is more popular and easier in southern Bharat because of its hard surface. Canal irrigation is more convenient in the plains of northern Bharat. Wells and tube wells are also in large number in the region.

3. Diversity of Power Resources - Wood and kuccha coal were the traditional means of power in Bharat. With the course of development, easy availability of means of transport, discovery of a variety of new sources and higher technology have contributed to the easy availability and increasing use of good quality of coal, hydroelectric power, mineral oil, natural gas, atomic power and solar energy in various parts of our country. The degree of the use of these various sources of power greatly differs in different parts of our country.

4. Diversity of Minerals - Bharat possesses large structural diversities. It endows Bharat with a huge variety and ample availability of minerals,

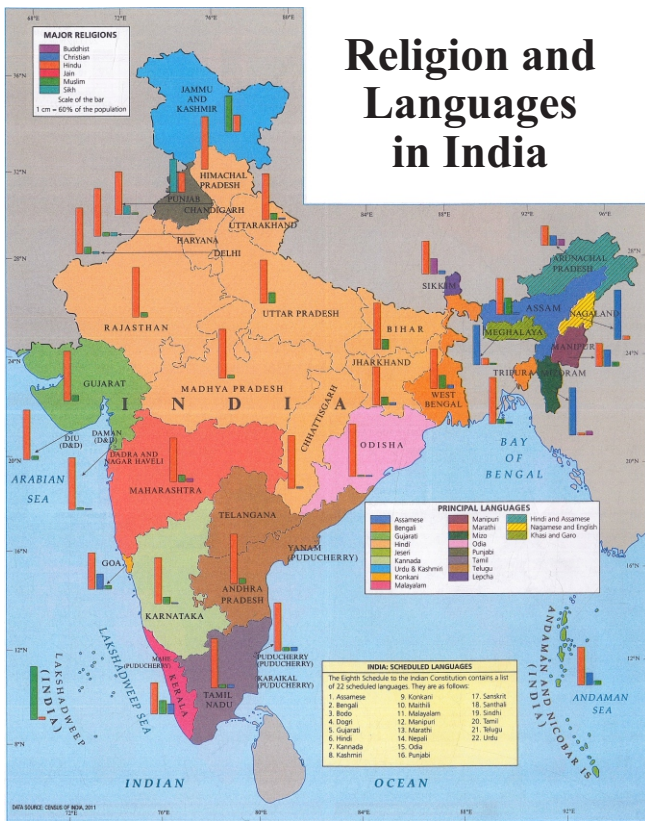


Fig. 2.3 : India : Religion and Languages

comparable with a few such lucky countries in the world. Bharat monopolises in the production of various minerals. Mica is one such example. Bharat possesses a large variety of metallic and non-metallic minerals and fuel minerals. Continuous discoveries have contributed to an increase in the production of mineral oil and natural gas in our country. There are large possibilities of the development of atomic power, solar energy, wind energy etc. in our country with the technological development.

5. Industrial Diversity - Like agriculture, various stages of industrial development can also be seen in our country. Traditionally, Bharat had been known for its cottage industry, though today the cottage industry is in doldrums in our country. Large variety of cottage industries, handicraft industry, handlooms, small scale and large scale industries are found in different parts of our country.

6. Diversity of Means of Transportation -

Big cities of Bharat present very interesting scenario of the admixture of a variety of means of transportation moving together. In the big cities of Bharat, coexistence of cycle rickshaw, tonga, bullock-carts, camel-carts, autorickshaw, taxis, cars, trucks, buses, trains, aeroplanes etc. can be seen even today.

7. Diversity of Means of Communication - Like means of transportation, various stages of means of communications are also found coexisting in Bharat. Many tribes of our country still communicate by drum beat and variety of sounds. On the other hand, Bharat has made great strides in the field of satellite communication. Telephone, mobile phone, telegraph, fax, radio, television, internet etc. have become the popular means of communication in Bharat.

C. Demographic Diversity -

Bharat is a unique country in the world in this respect. There is no other country in the world having such a large demographic diversities as Bharat does. Bharat is inhabited by huge population of various races, castes, sects, religions and cultures bound in a unique aphorism of unity. Therefore, a variety of languages, fairs - festivals, art, dances, music, dresses, customs etc. provide pleasant colour to the Bhartiya society. A major characteristic, which is found only in Bharat, is that people belonging to almost all the major religions of the world live in peace, cooperation and good will. Various fairs, festivals, dances, music etc. symbolize the cultural prosperity of our country. Holi, Diwali, Lohari, Id, Christmas etc. are spectacular events of our society.

The cultural and demographic diversities of our country are so multifarious that it is not possible to include all of them under one heading. These diversities are not only related to the cultural aspects of our country but are also intricately related to social dimensions. Hence, the detailed description of social and cultural diversities have been included in a separate unit.

Unity in Diversity

It is clear from the above description that our

country has been gifted with the multiplicity of diversities related to natural, economic and demographic dimensions. The nature has given yet other matchless gift to our country in the form of **UNITY IN DIVERSITY**, which means that there is inherent unity in a variety of diverse threads. From our daily experiences, this aspect appears so normal that behaviourally these diversities symbolize homogeneity and harmony. This is the reason that we have been always one as **BHARTIYA**. **Our national strength is inherent in our unity**. Our welfare and prosperity lies in this good will and concordance underlying the unity. History bears the testimony to the fact that whenever foreign powers or the selfish elements had been partially successful in disturbing the unity, our country had become weak, and had been subjected to political subjugation and economic exploitation. But whenever any danger had hovered over our country, our countrymen had shown exemplary unity as Bhartiya. Such unfortunate incidences have always encouraged us to remember that despite all diversities, our strength, power, political independence and economic prosperity lies in being one and united. Maintenance of our social and economic safety and national pride is possible only in being united. Therefore, we have to maintain it at all cost.

Some foreign powers and selfish elements project these diversities as the **centrifugal forces**. But we have to be cautious against such malafied intentions and conspiracies because these are simply intended to divide, weaken and economically harm our country. These foreign powers and selfish elements are jealous of our speedy progress and increasing power in the world scene. Hence it is clear that they want to divide and weaken our country and harm our economy. Therefore, we have to maintain this matchless unity in order to enhance prosperity and strength of our country, so that we can live with pleasure and pride.

Important Points

1. Our country is endowed with many diversities.
2. The diversities found in Bharat can be grouped into three major categories - natural, economic and demographic.

3. Natural diversities - topographical, structural, climatic, related to drainage, water requirements, soil and vegetation.
4. Economic diversities - related to agriculture, means of irrigation, power resources, mineral resources, industries, means of transport and communication.
5. Demographic diversities.
6. **Unity in diversity - A unique natural gift to Bharat, symbolic of our national unity and pride.**

Exercise

Multiple Choice Questions

1. The oldest topographical feature of our country is –
(A) Thar Desert (B) Coastal Plain
(C) Deccan Plateau (D) Himalaya.
2. The most primary form of agriculture prevalent in Bharat is –
(A) Shifting (B) Plantation
(C) Commercial (D) Mixed.
3. Winter monsoon blows from –
(A) Land to sea (B) Sea to land
(C) West to east (D) South to north.

Very Short Answer Type

4. Name any residual mountain range of our country.
5. Name the topographical regions of Bharat where newest deposits are found.
6. Which mountain range of our country is related to the newly folded mountain system?

Short Answer Type

7. Why our country experiences seasonal reversal of winds?
8. Why low pressure develops in the Thar Desert in summer season?
9. What diversities are found in Bharat with respect to the means of communication?
10. What is meant by the diversities related to water requirement.

Essay Type

11. Write an essay on the natural diversities of Bharat.
12. Explain the economic diversities of Bharat and discuss their unity.

Skill

13. Represent the diversities related to water requirements in an outline map of Bharat.
14. Represent the areas of shifting cultivation and jowar-bajra cultivation in an outline map of Bharat.

Answer Key

1.(C), 2.(A), 3.(A).

Lesson - 3

Bharat : Cultural Unity In Geographical Diversity

We have learnt about the geographical diversities and social and cultural characteristics of Bharat in previous chapters. After studying and understanding these characteristics, it is apparent as to how rich is Bharat in geographical diversities. These geographical diversities have inspired the people of Bharat in different areas to perform diverse activities. As a result, varied cultural landscapes are visible in different geographical areas. The cultural diversity has endowed the country with multidimensional culture. It has always provided significant status to our country in the world.

Geographical conditions influence both the physiology and thoughts of man. People of Bharat whether living in the vicinity of Kanyakumari or Kashmir have different physique, skin colour etc. due to geographical factors, but their feeling of belongingness to the country is the same. It is attributed to the philosophy or culture of our people.

Civilization - Culture and Geography

Geographical conditions have a major contribution in the development of civilization and culture of a region. Food habits, living and even the philosophy of the people of a region are affected by geographical conditions. Civilization develops in accordance with the physical needs of man, where as culture develops in accordance with the spiritual development of man.

There are a lot of diversities of relief, climate, vegetation, soil and water availability in Bharat. These diversities have differently shaped

the social structure in different areas of Bharat but the culture and cultural heritage of this country have always kept all the segments united.

Culture means cogent, refined, sophisticated and logical response according to the situation and possession of constructive and lively behaviour and thoughts.

Geographical conditions directly or indirectly influence the development of culture in a region. Its direct effect is seen on food habits, system of medical treatment, living conditions etc. and indirectly on fairs, festivals, language, literature, religion and philosophy. It can be seen and experienced in different areas. Influence of geography on various components of civilization and culture can be understood under the following heads –

1. Food Habits – Geographical influence on food habits is obvious in Bharat. There are variations of climate, soils and other conditions in Bharat. As such, a variety of agricultural crops are grown in different areas of Bharat eg. - rice in hot and humid areas with ample availability of water, wheat in temperate areas, Bajra in areas of scarce water supply and maize and jowar in areas with moderate water supply.

Variety in cereals is the contribution of geographical diversity but cultural refinement identifies Bharat as a vegetarian society. It follows the philosophy of **live and let live**. Vegetarians live in all parts of the country. Bhartiya society is identified as vegetarian society in the world. World Food Organization has also recognized

vegetarianism as the best dietary system, western society is also heading towards its adoption. Milk occupies highest place in Bhartiya food. Cow milk

is the top priority. For this reason, cow is given the place equivalent to mother in our country.

Education and means of communication



Fig.3.1 : India : Tourism and Cultural Center

have strengthened the cultural unity, e.g., Punjabi, Gujarati, Rajasthani, Bengali and South Indian dishes together with a number of other types of food have not only regional identifications but are also popular part of the menu in almost all social functions in every corner of our country. Besides their taste, these dishes bring the hearts of people closer.

2. Medical Treatment – Many systems of treatment are prevalent in India - Ayurvedic, Unani, Allopathy, Homeopathy etc. Ayurvedic system of Bharat is a standard and age old system of treatment. Extensive resources of bio-diversity provide many useful herbs in Bharat. These are not only locally useful but are also sent to all the parts of the country for use. Therefore, trees have been provide the status of God in Bharat. Tree plantation and their protection have been considered as pious task.

Ayurved has not only provided cultural unity to our country but now even the world society is realising it's importance. Bharat is famous for variety of herbs in the world. Internationally known doctors have accepted that many incurable diseases can be treated with Bhartiya herbs. Hence, many countries are trying to extend their clutches on the use of Bhartiya herbs by Patent Laws, whereas Bharat had been using these herbs for thousands of years and had been propagating their use. Medical treatment has been considered as a service and not a business in Bhartiya culture. Bhartiya culture follows that the benefits of medical research should be provided to the society as service and not a business.

3. Living – The same unity is seen in the life style and dresses. Punjabi Salwar suit, Muslim Pathani suit, Lucknowi Kurta-Pajama, Bhartiya Dhoti-Kurta, Rajasthani Ghaghra-Lugri, Gujarati Lahanga-Chunari etc. are worn popularly everywhere in our country. The diversity of dresses can be seen in any ceremony. Bhartiya male normally consider Dhoti-Kurta and Kurta-Pajama as their major traditional dresses while Saree has been traditional costume of ladies for centuries in Bharat. Saree is worn in different ways in Bengal, Maharashtra, Orissa, Uttar Pradesh, Karnataka, Keral, etc. Domicile of women can be easily identified on the basis of the style of wearing sarees. Saree is identified as the main costume of Bhartiya

ladies on international platform.

Influence of geographical environment can be easily understood by the costumes of southern Bharat. Rainy season continues for several months in southern Karnataka, Kerala and Tamil Nadu in southern Bharat, where plateau like surface configuration has a network of small rivers and nallas. Therefore, local residents have to face flooded paths in their movement. Hence, use of lungi and chappals, instead of shoes, are prevalent.

The seeds of our cultural unity germinate among children as they begin to identify our country by observing a variety of costumes since their childhood. They weave their beads of unity while presenting fancy dresses of different regions in the cultural programmes of their schools (Fig. 3.1).

Similarities of customs and traditions, whether it is a birth ritual or a marriage ritual, are observed throughout Bharat. Maiden occupy a special status in the society and giving her away in marriage ritual (Kanyadan) is considered as the greatest sacrifice, because she plays a constructive role as a sister, wife and mother in future. The fact that Sita-Ram, Radha-Krishna, Laxmi-Narayan etc. enjoy an important place as ideals of Bhartiya society, proves that women occupy a special respectable status. Their names are placed first while mentioning the couples.

4. Fairs and Festivals – Fairs, festivals and folk arts are mesmerizing characteristics of Bhartiya culture. Bhartiya are always full of zeal and energy. It appears as if various streams are pervading and intermingling in the ocean when people belonging to different cults and sects meet in these fairs and festivals.

All the festivals are celebrated by the people of various religions together in Bharat whether it is Deepawali, Holi and Dushera of Hindus, Id-ul-Fiter, Id-ul-Juha and Barawafat of Muslims, Christmas of Christians, Lohari or Baisakhi of Punjabis or Pongal of South Bharat.

Similarly, the birth-days of great persons and various jubilees are also celebrated by all groups together. Arrival of fresh crops marks jubillance everywhere, whether in the form of Baisakhi or Pongal in northern and southern Bharat respectively. It is characterized by jocund dances, cultural programmes and sports with the participation of all.

5. Language and Literature – Bharat is among those countries where many languages and dialects are spoken. Despite such diversities, an

element of unity is present in the form of Sanskrit. Whether the Aryan group of languages like Hindi, Gujarati, Punjabi, Marathi, Bangla etc. or the

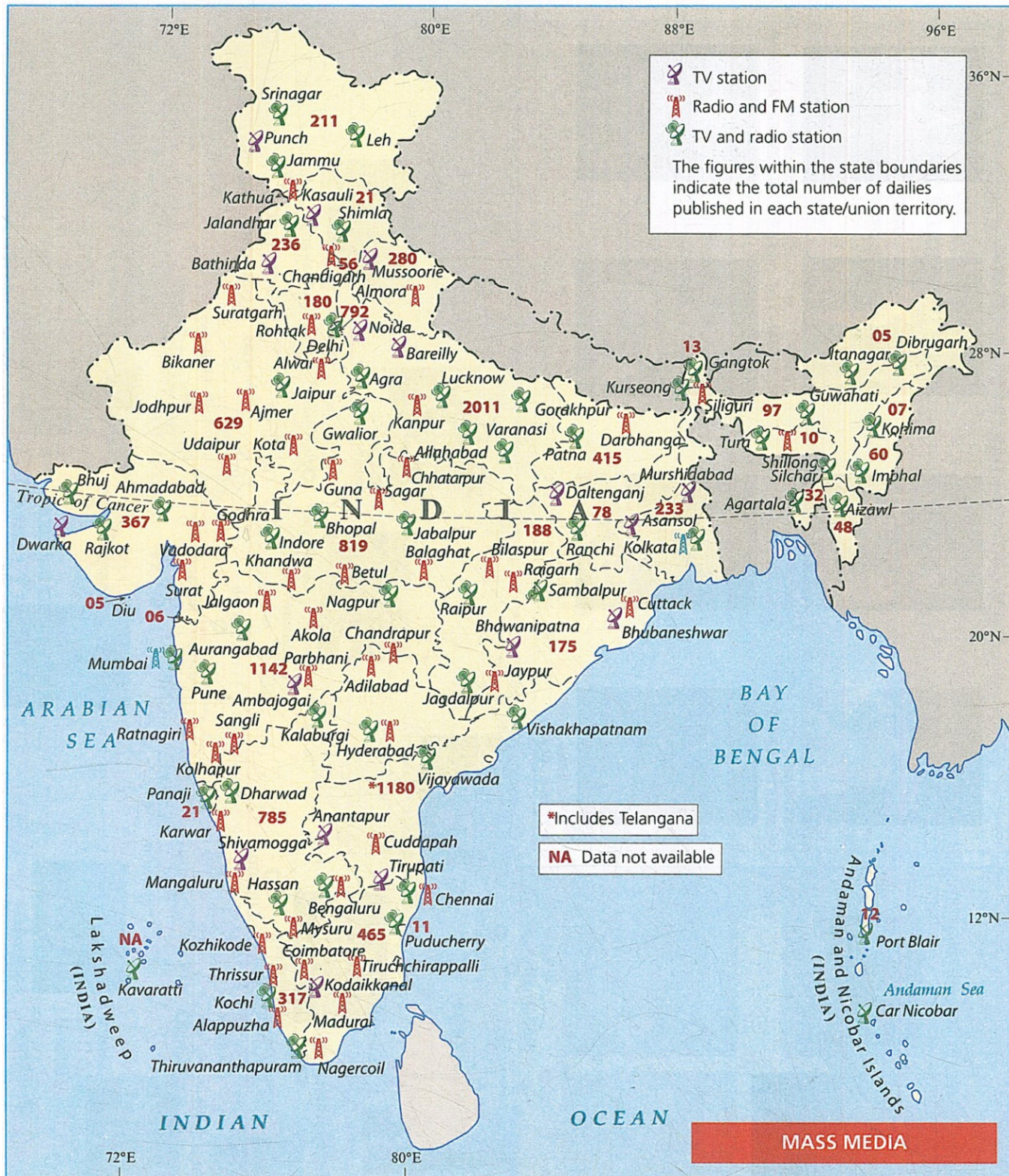


Fig.3.2 : India : Mass Media

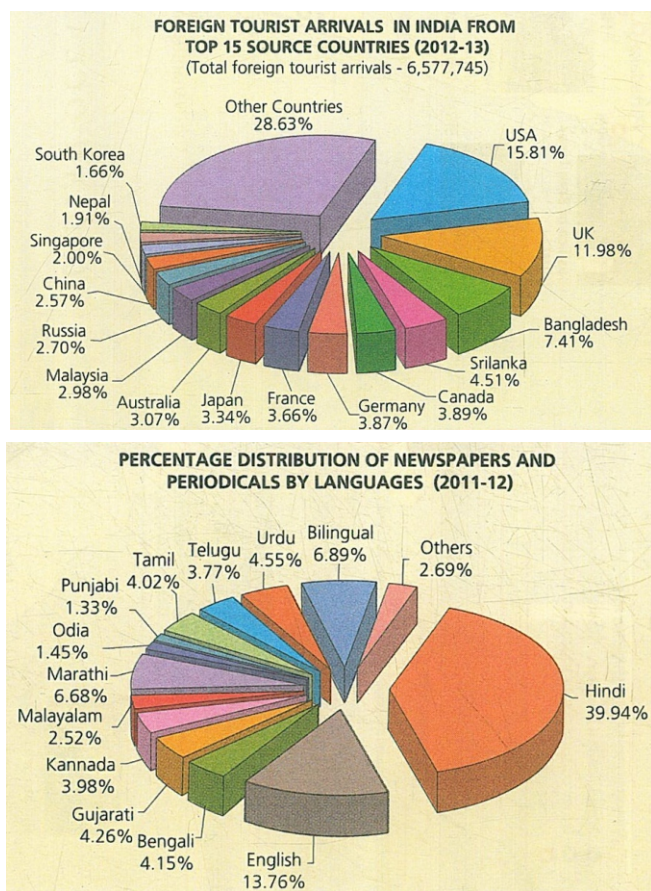


Fig.3.3 : India : Tourism and Literature

Dravidian languages like Kannad, Telugu, Tamil, Malyalam etc., Sanskrit words are present in them. In some of these languages, Sanskrit component exceeds 50 per cent.

Time spirited and eternal treaties of Bhartiya culture - Vedas, Puranas and Upanishads are written in Sanskrit, These are being read and understood throughout the country even today. The fact that many countries are translating the treatise in their languages to provide the knowledge, contained therein, to their young generation, shows their importance. Germany is leading the process.

Bhartiya literature also prospered with the development of Sanskrit and other languages. Despite the use of different languages, Ram, Krishna and Shiva remained main ideals in the literature.

Eternal treatise like Ramayan, Mahabharat and Gita have become identifications of Bhartiya culture. Presentations are being made on the contexts taken from Ramayan, Mahabharat and Gita through plays, folk dances and other folk arts for

providing the knowledge and sacraments. Meera, Raidas, Dadu, Kabir Nanak, Soordas and Tulsi have enriched and unified Bhartiya culture with their contributions.

6. Religion and Pilgrimage – Bharat is known as the land of religions. Maximum number of religions and sects of the world have originated on this land. Geographical environment of Bharat and its diversities have influenced thinkers, so that their thoughts are diverse and modest. The influence of geography, therefore, is obvious on Bhartiya religions and philosophy. Five basic elements (Panch Mahabhoota) have been recognized in our culture. These have been considered as the basic components of cosmos and human body. Thinkers have observed generation and destruction of flora and fauna in nature. It led to the belief of rebirth in the philosophy of life.

Bhartiya populace have experienced the effects of natural powers like water, wind and insolation which have been given the status of gods and have been worshipped. The balanced receipt of these powers is the basic requirement for raising crops. Their adversities affects the agricultural production. Therefore, natural powers have been recognized as Gods. Rivers have been considered as life givers (because civilizations have prospered in river valleys) and have been given the status of mother. Hence, Ganga, Yamuna, Narmada, Shipra, Godavari, Krishna, Kaveri rivers etc. occupy special status in Bhartiya culture. The fairs and festivals celebrated on the banks of these rivers bear the testimony to this fact. Bhartiya populace have learnt to lead life with positive aptitude by experiencing positive effects of natural powers. Hence, he is theistic and pious. Consequently, he has many qualities of kindness, tolerance, harmonization and adoption.

The pilgrimage centres are important contributors of cultural unity in Bharat. The places related to any thinker's, saint's or a great person's birth, salvation or any other reason have become famous sacred or pious places. These places gradually become pilgrimage centres due to people's devotion and reverence.

Such pilgrimage centres are located on river banks, sea coasts, lake coasts, in mountainous areas and caves. Pilgrims from all over the country visit those places throughout the year and strengthen the

fabric of our cultural unity. A few important pilgrimage centres related to all religions of Bharat are given below (Fig. 3.2 & 3.3) –

Sapta Sindhu (Seven sacred rivers) – Ganga, Yamuna, Saraswati, Narmada, Godavari, Sindhu and Kaveri.

Five major ponds – Mansarovar (Himalaya), Kurukshetra (Punjab), Galtaji and Pushkar (Rajasthan) and Pampa pond (southern Bharat).

Major Caves – Ajanta-Ellora and Elephanta (Maharashtra), Bagh (Madhya Pradesh), Udaigiri-Khandgiri (Orissa).

Major Pilgrimage Towns – Varanasi, Haridwar, Ayodhya, Prayag, Ajmer (Pushkar), Ujjain, Mathura, Nasik, Amritsar, Patna, Dwarika, Sarnath, Nalanda, Sanchi etc.

Pilgrimage Centres in Hilly Areas – Kailash, Badrinath, Kedarnath, Jamunotri, Gangotri, Pawagarh, Palitana, Samed Shikhar, Girnar mountain, Pawapuri, Dilwara, Ranakpur etc.

Four Seats (Math) of Shankaracharya – Jyotirmath (Himalaya), Shringeri Math (Mysore), Sharda Math (Dwarika) and Gowardhan Math (Puri).

Char Dham – Badrinath, Dwarikapuri, Jagannathpuri and Rameshwaram.

Places of pilgrimage are the major fabric of Bhartiya cultural unity. Four Mathas are the symbols of strength of the four directions. The biggest advantage of the growth of the four Dhams is that people come here from all parts of the country throughout the year. The congregation symbolizes their feeling to have a glimpse (Darshan) of the Almighty and dedication towards His existence directly and strengthen the unified cultural identity of the country indirectly.

Pilgrimage centres of river banks, hilly areas and caves bring the people close to nature. The natural panorama generates positive thinking about nature and its creator in human minds. These thoughts help them in the adoption of positive attitude towards life, take for example - rivers. A person thinks that it is his river, so long he sees it near his village or town. When he observes its religious significance, then he starts thinking in

terms of our river or rivers. These become rivers of the country when he see it flowing across various regions and states. These thoughts orients a person to develop a feeling of devotion towards the country. Thus, the feeling of 'my' grows into 'our' and ultimately the country becomes important, e.g. 'my river' converts into 'our river' and 'my country' into 'our country'. The same feeling applies to mountains also.

The same feeling of 'I' germinating into 'we' is the feeling of unity in Bhartiya culture. With the strengthening of the feeling, subjects like river water disputes are automatically solved, because waters of the country's rivers are meant for the development all the citizens. As a mother nurtures all her children equally and lovingly, the same feeling develops towards rivers.

It may be concluded that Bharat encompasses a treasure of geographical diversities arising due to its huge size and specific situation. It has resulted into diverse ways of life, yet maintaining its identity as a nation in the world for centuries due to its unique culture. Bharat enjoys the place of World Guru due to its civilization-culture and philosophy.

Important Points

1. Geographical conditions influence both human structure and his thinking.
2. Geographical conditions of an area have a major contribution in determining the civilization and culture of a region.
3. Culture means to be cogent, refined, to do such deeds and to adopt such thoughts which are life-giving for self and others.
4. Bharat is identified as a vegetarian society.
5. The Ayurvedic system of treatment is age old and standard method.
6. Bharat is famous for different types of herbs and medicinal plants in the world.
7. Dhoti-kurta and Kurta-Pajama, and sarees are the traditional costumes of males and females respectively in Bharat.
8. Baisakhi is the main festival of Punjabis.
9. Words of Sanskrit language are found in almost all the languages of Bharat.
10. The vedas, Puranas, Upanishads, Ramayan,

Mahabharat, Gita etc. are the major treatise of Bhartiya culture.

11. The rivers are considered as mother and are worshipped in Bhartiya culture.
12. Four seats (Mathas) and four Dhams symbolize the cultural unity of the country.
13. The pilgrimage centres have indirectly unified Bharat, Bhartiyata and Bhartiya Cultural.
14. The trees have been considered as God in Bhartiya culture. Tree plantation and protection are considered as pious deeds.
15. Bharat is known as world teacher due to its sympathy, tolerance, kindness, co-ordination and spiritual knowledge.

Exercise

Multiple Choice Questions

1. Number of rivers included in Sapta-Sindhu, are-
(A) Seventeen (B) Hundred
(C) Eleven (D) Seven.
2. The original system of treatment of Bharat, is –
(A) Allopathy (B) Homeopathy
(C) Ayurvedic (D) Unani.
3. The state of which Baisakhi is the major festival, is –
(A) Madhya Pradesh (B) Bihar
(C) Andhra Pradesh (D) Punjab.

Very Short Answer Type

4. What is meant by culture?
5. In which language are Vedas-Puranas written?
6. Which are the four seats (Mathas) of Shankaracharya?

Short Answer Type

7. What are pilgrimage centres and how did they develop as such?
8. How geography influences the dietary system?
9. Name the Sapta Sindhu and five ponds.

Essay Type

10. Write an essay on 'Cultural Unity in Geographical Diversity'.
11. Explain the role of pilgrimage centres in cultural unity.

Answer Key

1. (D), 2. (C), 3. (D).

Lesson - 4

Bharat : Structure, Relief & Physiographic Regions**Structure**

It is necessary to have the knowledge of geological structure for developing better comprehension of relief and topographical features of Bharat. The rocks of our country have been formed in different eras and ages. Relief and topographical features of a country depend mainly upon geological structure. Not only this, mineral resources, soil resources, natural vegetation, underground water resources, etc. also depend upon geological structure. The geological history of Bharat extends from Archean Era to the present Quaternary Era. Therefore, Bharat possesses rocks of several systems which can be divided into four major groups -

1. Archean Era

The rocks of this era are mainly divided into two major groups (Fig. 4.1)–

Archean System - The rocks of this system are very old and crystalline in which there is an absence of fossils. There are three main regions of the rocks of this system - (a) Bengal Gneiss, (b) Bundelkhand Gneiss and (c) Nilgiri Gneiss.

Dharwar System - The rocks of Dharwar system have been deposited above the rocks of Archean Era. These are also found in conjunction with each other in some places. The rocks of the Archean era have been subjected to a long period of metamorphism and erosion. The eroded material was deposited to form sedimentary rocks. These are the oldest sedimentary rocks of Dharwar system. In

the long geological history, the rocks of Dharwar system had also undergone the process of metamorphism. These rocks are mainly found in (a) Mysore-Dharwar-Bellary region, (b) Chhota Nagpur Plateau region, (c) Aravalli region of Rajasthan, (d) Punjab and (e) some areas of sub-Himalayas. These rocks possess not only several metallic minerals but also metamorphosed rocks like marble.

2. Purana Era

The rocks of this era are also divided into two major groups –

Cudappah System - The long process of erosion and the deposition of eroded materials continued to be deposited in the form of sedimentary rocks which have undergone a long process of metamorphism. These have been termed as the rocks of Cudappah System. These include the deposits of slate, quartzite and limestone. Most of the rocks of this system are found in the ranges lying between Krishna and Pennar rivers, Cudappah (Papkani river) valley, Nallamalai and Veniconda ranges, Godawari valley, Delhi system and many parts of Kashmir.

Vindhyan System - Most of the rocks of this system are found along Vindhya mountain ranges. The rocks of this system are found above the rocks of Cudappah system. These rocks are spread from Sasaram and Rohtas regions of Bihar through Chittorgarh in the Aravalli range to Vindhya mountains. The main deposits in the system include sandstone, shale, quartzite and limestone. These rocks provide diamonds

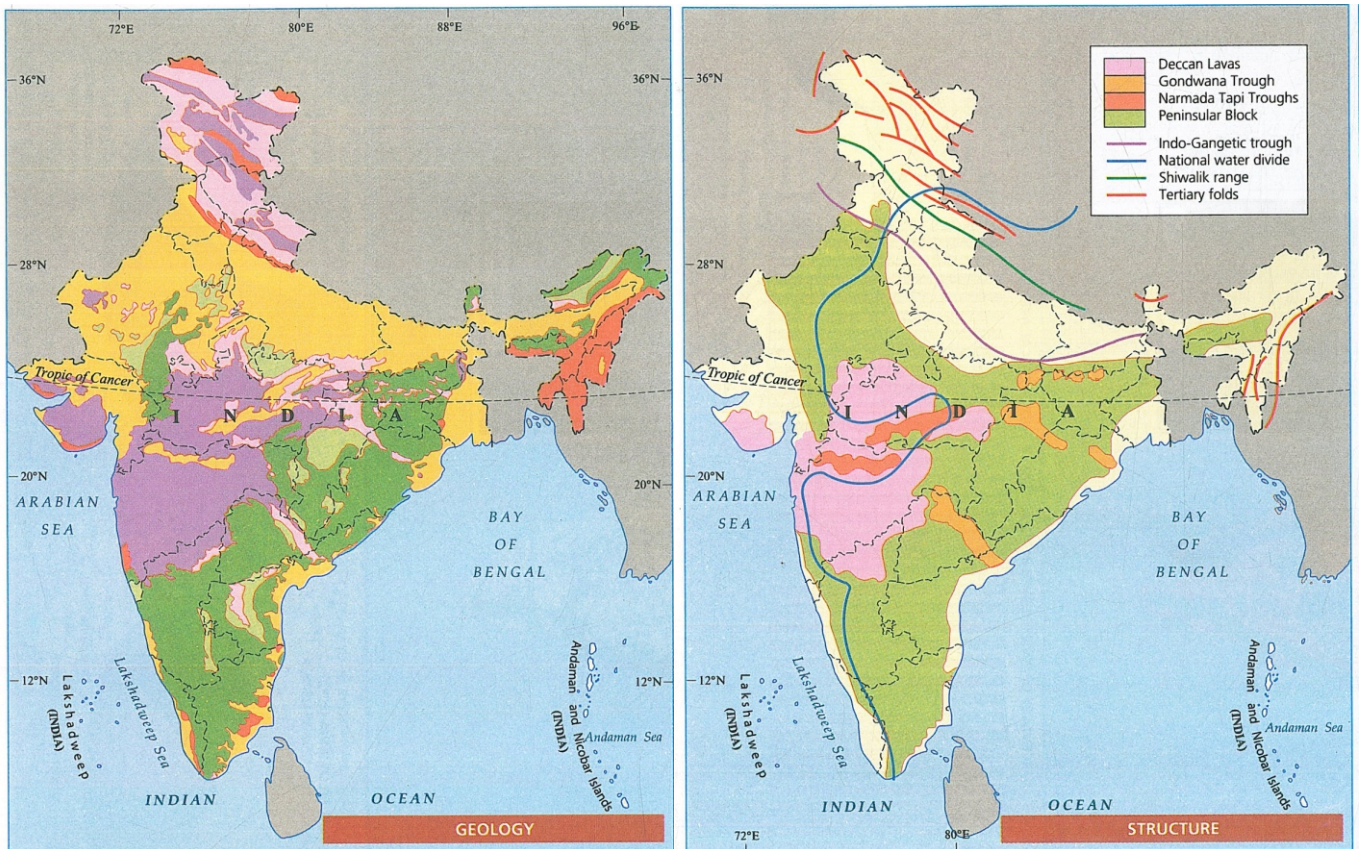


Fig.4.1 : India : Geological Structure

particularly in Panna, Anantpur and Golconda areas. The rocks of this system are also rich in the deposits of sandstone of various colours and the limestone, which is used in the cement industry.

3. Dravid Era

The rocks of this era belong to Gondwana system. These are mainly found in Damodar valley, Mahanadi valley, Godawari valley, Satpura ranges, Rajmahal hills, Kutch, Kathiyawad, Western Rajasthan, Kashmir, Spiti etc. Major extension of these rocks is in southern Bharat.

4. Aryan Era

The formation of the rocks of this era started in Carboniferous period. Therefore, these rocks are very important in terms of the carbonic minerals like coal, mineral oil and natural gas. These are the newest rocks of this system.

Relief

Bharat possesses many diversities of natural features. On one side these diversities make the

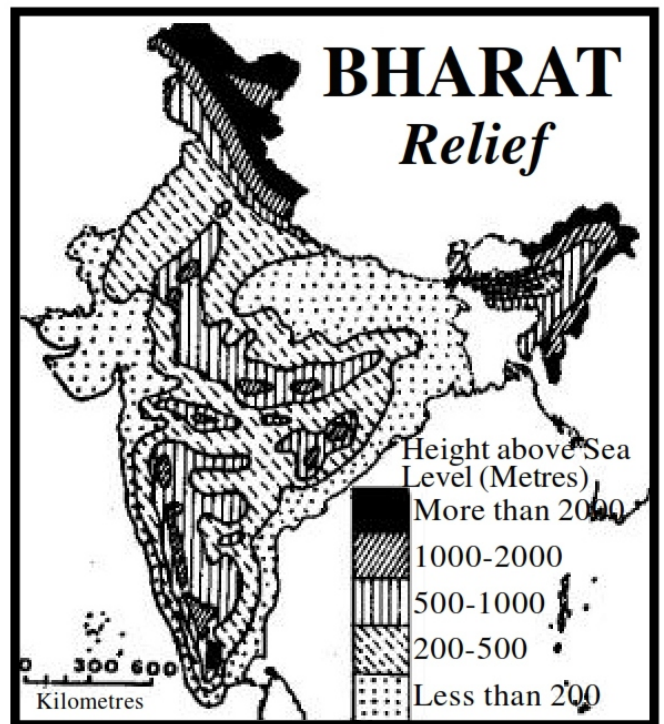


Fig.4.2 : Relief of India

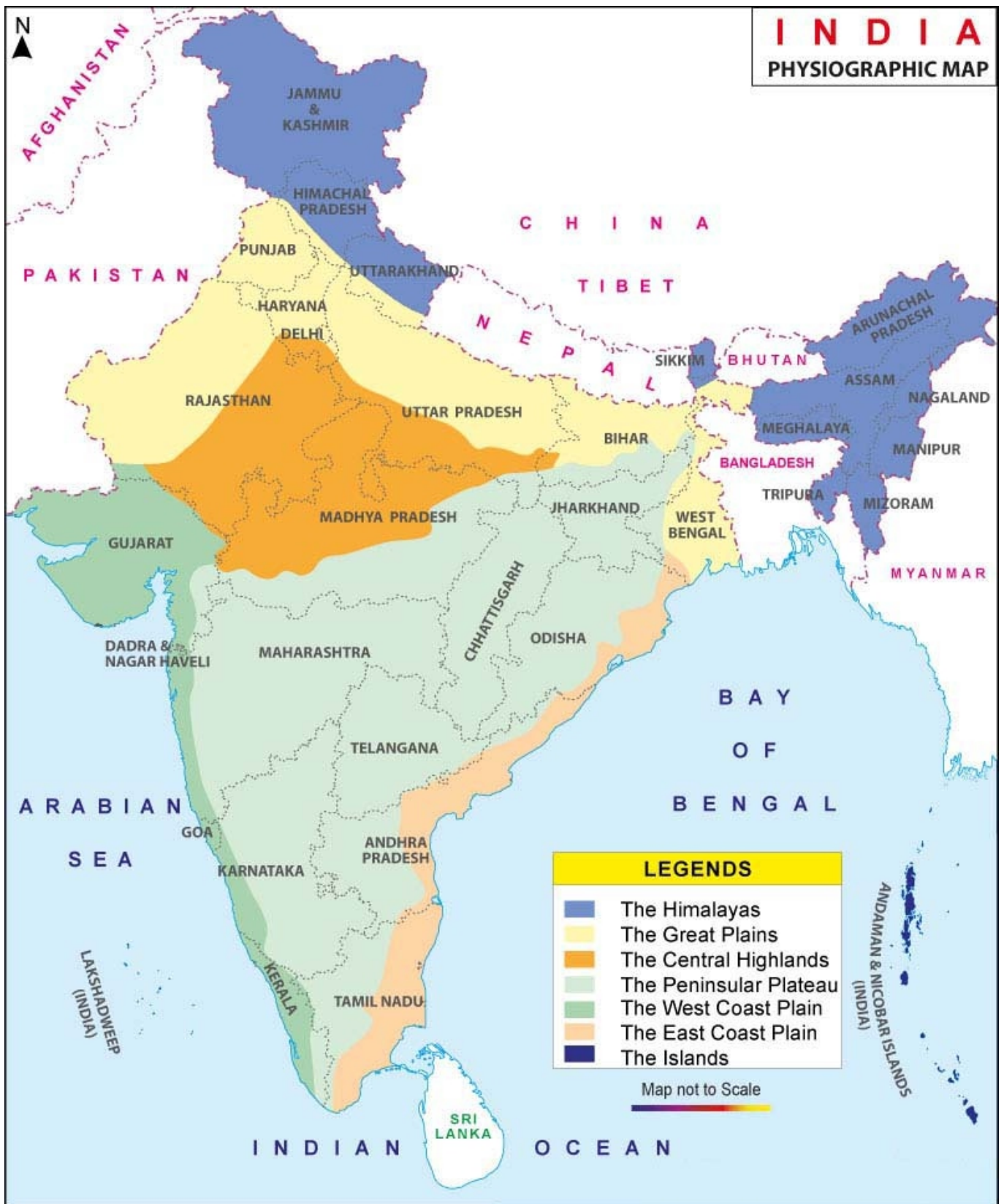


Fig.4.3 : Physiographic Regions of India

natural features lively by breaking their prosaism, while on the other hand these have contributed to the development of large and attractive but adjustable variations in the demographic, life-style, diet and food habits, dresses, languages, customs and traditions, availability of resources, stages of development etc. The diversities of climate, natural vegetation, fauna etc. have also been originated due to the diversities of relief (Fig. 4.2).

Despite large diversities of relief, most of the areas of Bharat are useful for the population. Approximately 33.4 per cent area of our country is less than 200 metres above the mean sea level. About one-third of the total area of our country possesses a slope of less than 5°. Such areas are mainly spread in the Ganga-Sutlej plain, Brahmaputra valley, most of the parts of Tripura and West Bengal and coastal areas of peninsular Bharat. There is a fall of only 200 metres in a length of about 1600 km long plain extending from Delhi to Bay of Bengal. Approximately two-third area of our country is less than 500 metres above mean sea level. This huge area is suitable and convenient for human habitations, agriculture and other economic activities. Approximately 28.3 per cent area of our country lies between 200 to 500 metres, 18.6 per cent from 500 to 1000 metres, 8.7 per cent from 1000 to 2000 metres and 11 per cent above 2000 metres from the mean sea level. Approximately 20 per cent area of our country has a slope exceeding 15°.

Physiographic Regions

The presence of the diverse geographical features in Bharat is natural due to vast expanse of the country. These diversities also include a variety of topographical features (Fig. 4.3).

In order to study topographical features of Bharat in detail, these can be grouped into six regions -

- (1) Northern Mountainous Region
- (2) Great Plains
- (3) Thar Desert
- (4) Deccan Plateau
- (5) Coastal Plains, and
- (6) Islands

(1) Northern Mountainous Region

Himalayas form our northern boundary from west to east in the form of an extensive mountainous arc. It covers an area of about five lakh

square kilometers. The region extends in a length of about 2400 kilometers and a width ranging from 250 to 400 kilometers. It is the highest mountain range of the world. The literal meaning of the Himalayas is the **abode of snow**. On an average, the slopes exceeding 5000 metres in elevation are always covered with snow. The height of snow-line in the western part of Himalayas is about 5700 metres while it is 4200 metres in the eastern section. Breadth of these newly folded mountains increases from east to west, but their height decreases in that direction. These mountains comprise several ranges. These mountain ranges circumscribe plateaus and valleys within them. The mountain ranges have a steeper slope towards Bharat and gentler slope towards Tibet. The eastern sections of Himalayas abruptly rise above the plains of Uttar Pradesh and West Bengal. Therefore, Everest and Kanchanjanga are visible from these plains because these peaks lie close to the plains. But western section of Himalayas rise gradually above the plains. Therefore, the mountain peaks are situated at a greater distance and therefore, Nanga Parbat, Badrinath, Nandadevi Peaks etc. are not visible from the plains.

Origin of Himalayas

Various hypothesis have been propounded about the origin of the newly folded mountains but the hypothesis conceiving the origin through geosynclines is more acceptable. This fact also applies to the origin of Himalayas. Geosynclines have been defined as elongated, narrow, shallow and weak bottomed water bodies by Haug, Hall, Dana, Steers etc. Millions of years ago, all the continents were joined together to form one huge landmass known as **Pangea**. Its northern part was named **Laurasia** and the southern section was named as **Gondwanaland**. Eurasian Laurasia was named as **Angaraland**. A long geosyncline named **Tethys sea** existed between Angaraland and Gondwanaland in the geological past at the place where Himalayas stand today. Rivers continued to bring and deposit large volume of sediments in the geosyncline from both sides. Although a geosyncline is defined as a shallow water body, its weak bottom continuously sinks due to the burden

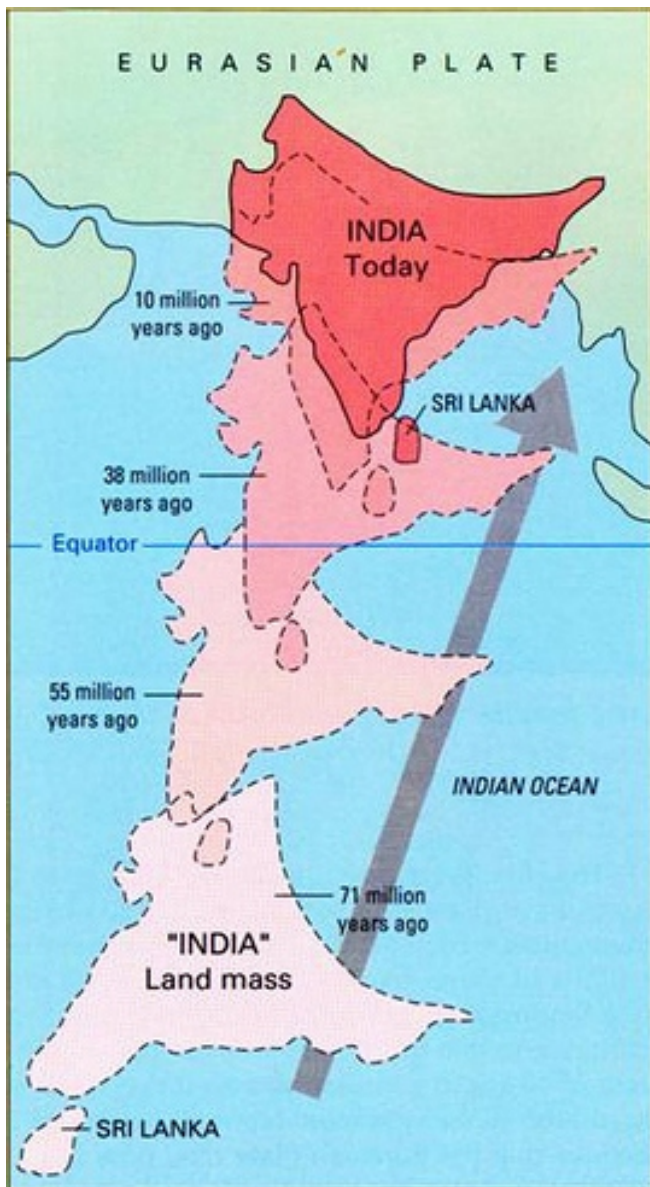


Fig.4.4 : The drifting of Gondwanaland

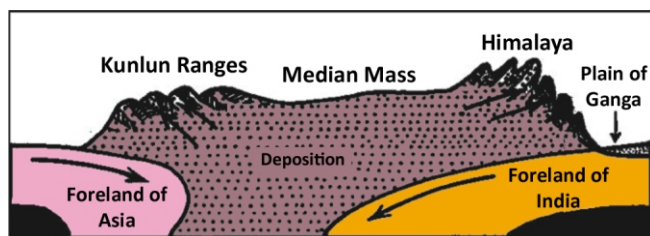


Fig.4.5 : Origin of Himalaya according to Kober

overlayed of sedimentation. Thus, the sediments were deposited in a thickness of thousands of feet in Tethys sea. Tectonic pressure on the sediments followed due to various reasons, resulting into the

rise of Himalayas by folding. There are differences of opinion about the direction and causes of the pressure (Fig. 4.4).

Kober believed that Himalayas originated due to the pressure levied from both sides on the sediments deposited in the geosyncline. The land masses levying pressure from both sides on the sediments were termed as **Foreland** by Kober. The pressure of forelands causes folding in the marginal areas of sediments, while its middle section remains unaffected by the tectonic force. Resultantly, the middle section stands as a flat highland, which was termed as **Median Mass** by Kober. In the context of the origin of Himalayas, Kober's view was that both Angaraland and Gondwanaland were Forelands and Tibet plateau is a Median Mass, as explained in Fig. 3.3. Although the hypothesizing of pressure coming from both sides was also accepted by Daly and Holmes, but they differed on the causes of pressure. Continental sliding from both sides was held responsible for causing pressure on the sediments by Daly. Holmes ascribed convectional currents causing the formation of geosyncline, its continuous sinking and pressure from both sides. The process has been shown in Fig. 4.5.

Some geologists have different views about the issue. They hypothesize that the pressure came from one side only. These geologists designate the landmass levying pressure as **Hinterland** and the stable landmass as **Foreland** as shown in Fig. 4.5. But these geologists also differ about the direction of the pressure on the sediments. Some geologists believe that the pressure came from northern (from Angaraland) side while others believe it to be coming from southern side (from Gondwanaland). Theoretically, Suess believes that the pressure from one side is enough for causing folds in the sediments. He also designates the moving landmass as Hinterland and the stable landmass resisting the pressure as Foreland. According to Suess, the Foreland resists the pressure. Argand and Wegner believe that a part of the Gondwanaland drifted towards Tethys sea and Angaraland remained stable. Australian geologists - Powell & Conaghan also held that Himalayas were folded due to resistance of Tibetan block against the drifting Bhartiya sub-continent. While Wadia's view was that Himalayas originated due to the forces coming

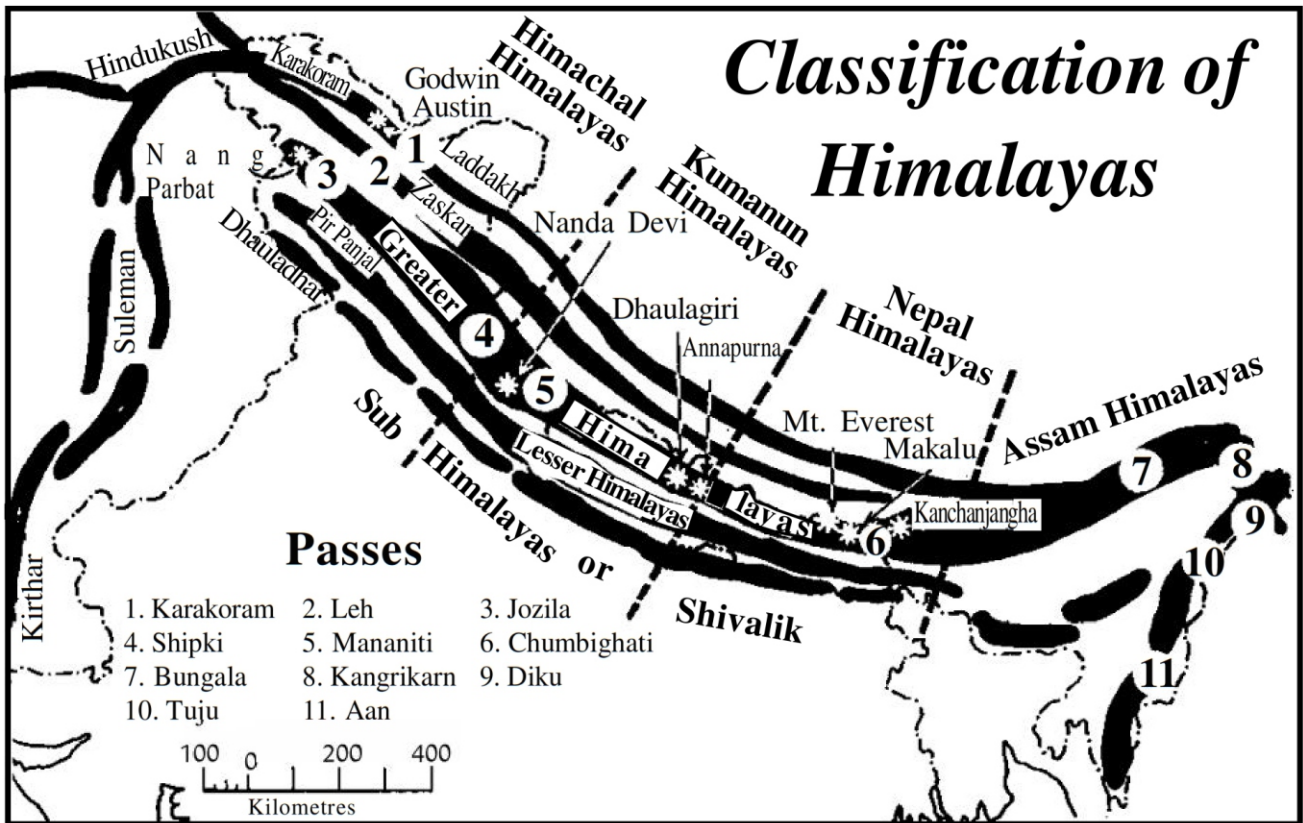


Fig. 4.7 : Classification of Himalaya

from the north and the resistance by Bhartiya sub-continent.

Geographical Classification of Himalayas

Himalayas consists of several mountain ranges. Geographically these are divided into three parts (Fig. 4.7) -

1. Greater Himalayas - It is the

northernmost mountain range of Himalayas. It is also known as the **Main Himalayas, Himadri, Inner Himalayas, Snowy Himalayas** etc. This range extends in a length of about 2500 kms. from the bend of Sindh river in the north-west to the bend of Brahmaputra river in the east. The range spreads in the form of an arc from 73° E. to 97°E longitude. It is the highest mountain range. Its average height is 6000 metres above mean sea level and width ranging from 100 to 200 kms. There are about 40 peaks which rise above 7000 metres in the range. The highest peaks of our country lie in this range. Mount Everest (8848 metres), Godwin Austin (8611 metres), Kanchanjanga (8585 metres), Makalu (8481 metres), Dhaulagiri (8172 metres), Nanga Parbat (8126 metres), Annapurna (8078 metres), Nanda Devi (7818 metres) etc. snow covered peaks lie in this range. This mountain range is tectonically active and is still rising. The rivers descending from the range towards Bharat make narrow, deep and vertical sided valleys because the range has steep slope towards Bharat. Sindh, Sutlej, Ganga,

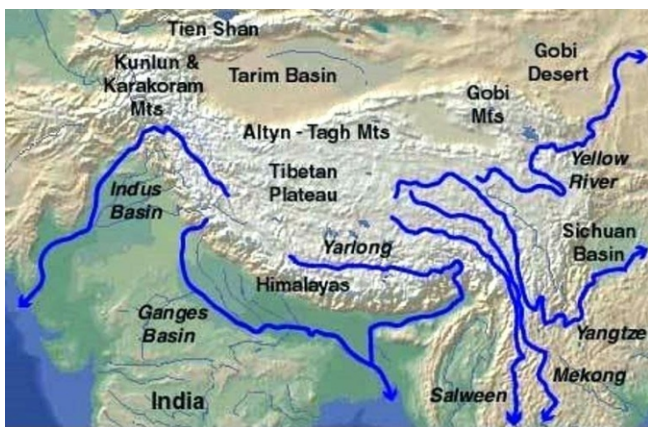


Fig. 4.6 : Himalaya, Indus, Ganga and Brahmaputra plain

Yamuna, Brahmaputra rivers etc. originate in this range. Although the range produces barrier in the movement due to its ruggedness and steep slopes, Jozila, Karakoram, Shipki, Mananiti passes etc. provide the facility for transportation routes.

South-eastern branch of the greater Himalayas makes the eastern boundary of Bharat and goes upto Myanmar (Burma). Garo, Khasi, Jayantia, Patkoi, Naga, Bum and Lushai hills etc. are the parts of this range. These hills are highly inaccessible and covered with dense forest. These ranges form the eastern boundary of Bharat.

The north-western branch of the greater Himalayas lie on the borders of Pakistan and Afghanistan. Suleman, Kirthar, Hindukush and Karakoram are its main ranges. Khyber, Gomal, Tochi, Bolan passes etc. provide the facility for international trade through the land routes.

2. Lesser Himalayas - These mountain ranges are situated south of the Greater Himalayas. These are also known as Middle Himalayas or Himachal Himalayas. These mountain ranges lie parallel to the Greater Himalayas and have a width ranging from 80 to 100 kms. The average elevation of these ranges is 3000 metres but the maximum elevation goes up to 5000 metres. There are many small mountain ranges in Lesser Himalayas. Dhauladhar, Pir Panjal, Nag Tiba, Mahabharat, Mussouri etc. are its main ranges. The ranges experience snowfall for 3-4 months in winter season, but the summer season remains very pleasant and healthy. Therefore, there are many tourist places and hill stations in these ranges e.g. Shimla, Mussouri, Nainital, Darjeeling, Ranikhet etc. The higher slopes of these ranges are covered with coniferous forests and lower slopes are covered with grasslands which are known as **Marg in Kashmir** (e.g. Gulmarg, Sonmarg etc.) and as **Bugyal** and **Payar** in Uttarakhand. Lesser Himalayas are isostatically more stable and balanced. There are many examples of **river capture** in these ranges.

3. Sub-Himalayas - It is the southernmost range of the Himalayan system. It is also known as **Outer Himalayas** or **Shivalik range**. It is the newest formation in the Himalayan system. It extends from Potwar basin to Kosi river in the east. Its width varies from 10 to 50 kms. and its average height is 1000 metres above sea level. The range is

given different names in different regions eg. it is known as **Doondwa** near Gorakhpur and **Churiyan** and **Muriyan** towards the east. All the rivers flow through narrow valleys or gorges in Shivalik range before entering into the plains and make alluvial fans at the base of the range. These are locally known as **Bhabar**. The southern part of Bhabar region is marshy and is known as **Tarai**. The whole region is densely forested. High valley-plains, made up of river alluvium and sand, are found in its central sections lying between Himalayas and Shivalik range. These plains are known as **Dwar** (eg. Haridwar) in the east and **Doon** (eg. Dehradun) in the west.

Regional Classification of Himalayas

Regionally Himalayan mountain system is divided into four major groups (Fig. 4.6) -

1. Himachal Himalaya - It extends from Sindh river to Sutlej river. Its total length is approximately 570 kms. It mainly extends in Jammu-Kashmir and Himachal Pradesh. Pir Panjal, Dhauladhar, Zaskar and Laddakh are the main mountain ranges of this section. Northern slopes of these ranges are highly rugged, uninhabited and dry, while its southern slopes are densely forested. Kangra, Lahul and Spiti valleys, famous for fruit cultivation, extend in this region.

2. Kumaun Himalaya - It extends in a length of approximately 320 kms. between Sutlej and Kali rivers. It is higher than the Himachal Himalayas. Badrinath (7040 metres), Kedarnath (6831 metres), Trishul (6707 metres), Gangotri (6508 metres) etc. are the main mountain peaks of this section. Ganga, Yamuna rivers etc. originate in this section. The famous places of pilgrimage like Badrinath, Kedarnath, Gangotri, Jamnotri etc. are located in this section.

3. Nepal Himalayas - It stretches in a length of about 800 kms. from Kali river to Tista river. Since most of this section extends in Nepal, it is also known as **Nepal Himalayas** and elsewhere in Sikkim it is known as **Sikkim Himalayas**, in West Bengal as **Darjeeling Himalayas** and in Bhutan as **Bhutan Himalayas**. It is the highest section of Himalayan system where snow-capped peaks of Everest, Kanchanjangha, Makalu, Dhaulagiri, Annapurna etc. are located.

4. Assam Himalayas - This section extends in a length of about 740 kms. between Tista and Brahmaputra rivers. Kabru, Chumalhari, Jaang Sangla, Kula Kangdi, Pauhuni etc. are the major peaks of this section. Naga Hills of this section function as a water divide between Bharat and Myanmar (Burma). It is a densely forested region inhabiting many tribes.

Importance of Himalayas

Great Poet Kalidas has described Himalayas as the King of Mountains and abode of Gods. The physical features, location, extension and structure of Himalayas are very important and useful to our country, because -

1. They form natural boundary in the north and east.
2. Traditionally, Himalayas have been our northern sentry because of the unique location due to which Bharat had been conceived as safe from external aggressions. But these are no more inaccessible because of modern technological achievements. Hence, we have to be very cautious about our security on northern and eastern borders.
3. The high Himalayan wall protects Bharat from the cold polar winds.
4. The weather conditions of Bharat remain stable and experience a rhythmic change because the cold polar winds are effectively checked by the Himalayan wall.
5. Himalayas also intercept the rain bearing monsoons in Bharat itself and hence the benefit of these humid winds is received by our country.
6. It is the source of many perennial rivers which are fed by snow melted water. These rivers help in providing irrigational facilities to the extensive Ganga-Sindh plain.
7. Various waterfalls in the Himalayas are important sources of hydroelectric power generation.
8. Ganga-Sutlej plains are made up of fine alluvium deposited by the rivers descending from the Himalayas. These are extremely important economically for Bharat. Not only this, these rivers naturally rejuvenate the soil layer in these plains by flooding.
9. Different types of forests are found on varying heights of the Himalayas. These forests provide a large variety of vegetation, wood, rhizome-fruits, gum, lac and medicinal herbs etc.

10. Many Bharatiya industries are dependent on these raw materials obtained from the Himalayas.

11. Large variety of flora in the Himalayas provide congenial ecological conditions for various wild animals like lions, tigers, elephants, Bhartiya antelope, deer, bear, panthers, monkeys etc.

12. Saffron, tea, potatoes and various fruits are grown on the slopes of Himalayas and cattle rearing is also done.

13. Himalayas are storehouse of a variety of minerals. The oilyferous nature of Himalayan rocks render the possibility of mineral oil.

14. Himalayas have a tremendous tourist importance due to the beautiful natural lakes, and wholesome and charming places. Shimla, Mussoorie, Nainital, Bhimtal, Garudtal, Ranikhet, Almorah, Kasauli, Chamba, Kullu, Mukteshwar, Amarnath, Bhuwali, Kalimpong, Sheshnag, Pahalgam, Gulmarg, Sonmarg etc. attract many native and foreign tourists.

15. Besides the above mentioned materialistic advantages, Himalayas carry Pauranik spiritual importance. These have been conceived as the abode of Gods. Badrinath, Kedarnath, Amarnath, Kailash, Mansarovar, Vishnuprayag, Devprayag, Karnprayag, Haridwar, Uttarkashi, Joshimath, Gangotri, Yamnotri etc. are important places of pilgrimage in the Himalayas. Swayambhunath, Tabang, Hemis, Dhyagboche etc. are famous Baudh Monasteries in the region.

16. Himalayas are very important from the point of view of mountaineering.

17. The inhabitants of this region are stout, healthy and brave, hence they are important constituents of Bharatiya Army.

2. Great Plains

Great plains extend between Himalayas in the north and the peninsular plateau in the south. Before the partition of Bharat, it was known as Ganga-Sindh plain, but because of the partition, Sindh with its tributaries - Jhelum, Chenab and Ravi have gone to Pakistan. Therefore, now the portion of the plain remaining in Bharat is known as the Sutlej-Ganga-Brahmaputra plain because it is made by the alluvium deposited by these rivers. The arc-shaped plain extends in a length of about 2400 kms. and a breadth of 150 to 480 kms. It is a gently sloping fertile plain. It has a slope of only 10 cms. per

kilometre between Varanasi and the Delta of Ganga river. Aravalli ranges function as a water-divide in the region. Excepting Aravallis, its maximum elevation is 185 metres above sea level. There is a difference of opinion about the thickness of alluvium found in the plains, but at several places the thickness of alluvium layer exceeds 3000 metres. It is one of the most extensive, fertile and densely populated plains of the world.

Geographical Classification

Although it is popularly known as a **featureless plain**, geographically it can be divided into four groups -

1. Bhabar Region - This region extends in a belt of 8 to 16 kms wide strip between Sutlej and Tista rivers at the foot hills of Shivaliks. Rivers deposit most of the heavy debris at the foot hills when they leave the mountain stage and enter into the plain stage (because of the sudden change in the nature of slope). Most of the rivers have underground flow in the region. Long rooted trees are found in this agriculturally unsuitable region.

2. Tarai Region - It is that region lying to the south of Bhabar, where the underground drainage of rivers reappears over the surface. It is mostly covered by marshes because of the indeterminate drainage system. Dense forest, tall grasses (like Kans, elephant grass etc.) and wild animals are characteristic features of the region. Tarai characteristics are absent in its western section due to scarcity of rains. Successful attempts have been made to convert the area into agriculturally useful region for growing different crops and jute etc. by clearing the region and properly managing the drainage system of Tarai in Uttar Pradesh.

3. Bangar Region - It is that higher section of the plain which is made up of older alluvium and where the flood water is unable to reach. These are mostly found in the north-western section of Uttar Pradesh.

4. Khadar Region - These low lying plains are made up of newer alluvium. A fresh layer of soil is spread every year by flood water in this section. Such low lying plains are known as Khadar. These are mostly found in Uttar Pradesh, Jharkhand, Bihar and West Bengal.

Regional Classification

Regionally, the plain extending between Sutlej and Brahmaputra river valleys is divided into four sections -

1. The Plains of Punjab-Haryana - This section of the great plains extends in Punjab and Haryana. Its north-western section is made up by the alluvium deposited by Sindh and its tributary rivers - Sutlej, Beas, Ravi, Chenab and Jhelum. The plain lying between two rivers is locally known as **Doab**. **Bist Doab** extends between Beas and Sutlej, **Bari Doab** between Ravi and Beas, **Rechna Doab** between Chenab and Ravi, **Chaj Doab** between Jhelum and Chenab and **Sindhu Sagar Doab** between Sindh and Jhelum. Out of these only **Bist-Bari Doab** is in Bharat and the rest have gone to Pakistan as a result of the partition. Approximately 10 to 20 kms wide area on both sides of these rivers is khadar or flood prone area. Such areas are locally known as **Bet**. Several depressions have been made by the erosional process of small rivers in the plains adjoining Shivalik hills. These depressions are locally known as **Cho**. There are many such Chos in Hoshiyarpur district. The south-eastern section extending upto Ghagghar river is known as Haryana plain. The importance of Haryana plain has rapidly increased with the availability of irrigational facilities.

2. Ganga Plain - This huge, level and a very fertile plain is made up by fertile alluvium deposited by Ganga and its tributary rivers Yamuna, Gomti, Ghaghara, Gandak, Kosi, Betwa, Ken, Chambal, Son etc. It extends from Aravalli ranges eastwards upto West Bengal. It mainly spreads over eastern Rajasthan, Uttaranchal, Uttar Pradesh, Jharkhand, Bihar and West Bengal. The general slope of this section is towards the east and south-east. It mainly consists of Khadar and Bangar areas. Bangar region or the dry higher plains are covered with low knolls, which are locally known as **Bhoor**. Its eastern part is known as **Ganga-Yamuna Doab**, north-central part as **Ruhelkhand Plain** and its north-eastern part as **Awadh Plain** in Uttar Pradesh. The plain region extending on both sides of Ganga river in Bihar is known as **Jharkhand Plain** and **Bihar Plain** respectively. Jharkhand Plain is drained by Ghaghara, Gandak, Kosi rivers etc. It slopes south-eastwards. Son and its tributaries originate from Chhota Nagpur Plateau and join river Ganga after draining through Bihar Plain northwards and north-

eastwards. North Bengal Plain extends between Himalayan foot hills and Ganga Delta in West Bengal. This section is drained by Ganga and Brahmaputra rivers. The piedmont section of this region is known as **Duar**, where there are many tea plantations.

3. Brahmaputra Plain - It is a narrow and elongated plain extending between Himalaya mountains and Garo hills in Assam. It is mainly made up of the alluvium deposited by Brahmaputra river. It is approximately 650 kms long and 100 kms wide and stretches between Dhubri and Sadiya. Brahmaputra river transports large volume of alluvium which tends to be deposited by any obstacle in the flow. It causes the formation of several islands in Brahmaputra river.

4. Ganga-Brahmaputra Delta - It is an extremely level plain which does not have much height above sea level. It is a marshy area because tidal water usually spreads throughout the region. The high area lying beyond the reach of tidal water is locally known as **Char**, where settlements are found. The low area is locally known as **Bill**, where enough water is available for washing jute.

Importance of the Great Plains

1. This plain is made up of river brought alluvium, hence it is extremely fertile.

2. The soils are rejuvenated every year naturally by the spread of fresh layer of alluvium during floods.

3. The plains have a dense network of rivers. Their water is utilized for irrigation, water transport, generation of hydroelectric power and in industries.

4. Because of being level plain, it is less expensive to construct canals and dig wells. Therefore, the means of irrigation are cheap and easily available.

5. It is an important producer of sugarcane, tea and rice in its eastern section, and wheat, cotton etc. in its western section.

6. Approximately 45 per cent of the country's population lives in these plains.

7. There is a dense network of all means of transportation due to its levelness.

8. Most of the big cities, commercial and industrial centres of Bharat are situated in this region.

9. Ample various means of livelihood are available in the plains.

10. Trade facilities are easily available in this region.

11. Industrial development has also been promoted in the plains because of the availability of various facilities.

12. The plains have many tourist centres.

3. Thar Desert

Thar desert covers the whole of western Rajasthan. Some geographers include it in the study of the peninsular Bharat because the basal rocks of the desert are considered as the continuation of the rocks of Deccan plateau. Other geographers consider it logical to study the desert with the plains because of its continuity with the latter. But in reality this region possesses its own characteristics and the problems as well, therefore, it has been included as a separate geographical region.

Origin of Thar Desert

There are various views regarding the origin of Thar Desert. Some experts believe that the presence of sand in the region owes its existence due to the disintegration of local rocks. But there are indications of erosion of surface rocks by running water. Therefore, other experts believe that formerly the climate of the region would have been humid but gradually it became dry and the region was converted into a desert. Wood Fossil Park in Aakal near Jaisalmer bears the testimony to this fact. Millions of years old fossils of huge trees have been excavated in Aakal. Many geologists believe that formerly it was a very fertile region drained by many big rivers. The region was uplifted due to tectonic activities. Resultantly, the drainage of the region was diverted towards Ganga and Sindh river systems, causing dry conditions in the region. La Touche was of the view that the prevailing south-western storms in the region continuously brought sand with them and it was deposited in the region. However, the hypothesis of climatic drought is generally more acceptable.

Geographical Characteristics

The desert extends to the west and north-west of the Aravallis upto Sindh plain. International boundary between Bharat and Pakistan passes through it. Thar desert is generally a lowland area. It averages from 150 to 300 metres in elevation, 640

kms. in length and 160 kms. in width. Sanddunes are formed by the prevailing fast blowing winds in the region. These sanddunes frequently migrate in the direction of the prevailing winds. Occasionally, the sanddunes surround low lying areas between them. Such low lying areas are locally known as **Talli**. These tallies are converted into small lakes by the accumulation of rain water. Such lakes are locally known as **Dhandh** or **Rann**. Sambhar, Lunkaransar, Deedwana, Pachpadra etc are the salt water lakes in this region. Salt is prepared from the brackish water of these lakes.

The migrating sanddunes and blowing sand enable us to conjecture that Thar Desert is spreading eastwards at the rate of one kilometre per year. A row of trees and other semi-arid vegetation has been developed to check its expansion. Central Arid Zone Research Institute (CAZRI) is also taking other steps for its containment. Transformation of the desert is expected by irrigation facilities to be made available after completion of Indira Gandhi Canal. The construction work of canal is gradually progressing with the objective of taking advantage of this possibility.

Importance of Thar Desert

1. Excessive summer heating in the region develops intense low pressure which attracts south-west monsoon.

2. Cattle rearing and herding is the main occupation in the drier parts of the desert.

3. Various minerals are found in this region. Mica, Gypsum, Asbestos, Coal, Copper, Soapstone, Marble, Building Stones, Rock Phosphate, Felspar, Mineral Oil, Natural Gas etc. are the main minerals found in this region.

4. There are large possibilities of agricultural development through irrigational facilities because the soils of the region are fertile.

5. It attracts tourists due to its physiographic peculiarities. Yearly held Desert Festival of Jaisalmer bears the testimony to this fact.

6. The region has strategic importance due to its location on the international border with Pakistan.

4. Deccan Plateau

It is one of the oldest massifs of the world. The plateau extends in an area over about 1.6 million square kilometres. It is a triangular plateau

extending to the south of the great plains of Bharat. It has oceans on three sides - Bay of Bengal in the east, Arabian Sea in the west and the Indian Ocean in the south. The triangular plateau has its base in the north near Vindhya mountains and its apex in the south near Cape Comorin (Kumari). From the highlands of the south-eastern Rajasthan upto Kanyakumari, it extends in a maximum length of 1800 kms. and its width measures about 1400 kms. The plateau averages 600 metres in elevation above mean sea level. It covers south-eastern Rajasthan, Gujarat, Chhattisgarh, Madhya Pradesh, Jharkhand, Orissa, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu and partially Kerala. It is an old plateau consisting of extremely hard and crystalline rocks. The plateau slopes towards the east. Therefore, all the rivers, except Narmada and Tapti, flow eastwards and drop out in the Bay of Bengal. These rivers have dissected the plateau in many parts. There are many old residual mountain ranges in this plateau (Fig. 4.8).

Origin of Deccan Plateau

Millions of years ago, it was a part of Gondwanaland lying south of the Tethys Sea. In the course of geological history, Gondwanaland was fractured and fragmented. Its various fragmented parts took the shape of the continents of southern hemisphere. Peninsular Bharat came in its present situation by drifting north-eastwards from the fragmented Gondwanaland.

Classification of Deccan Plateau

The Deccan plateau can be divided into the following three parts -

1. **Western Ghats** - The western margin of the Deccan plateau rises as Western Ghats, which are also known as **Sahayadri**. Western Ghats have steep slope towards Arabian Sea and gentle slope towards the east. The Sahayadri has an average elevation of about 1000 metres above mean sea level and extends continuously from Tapti Valley to Cape Comorin. There are three major passes in the Western Ghats - **Bhor Ghat, Thal Ghat** and **Pal Ghat**. Sahayadri merges with eastern ghats in the southern section of the Deccan Plateau, where Dodabeta (2637 metres) is the highest peak in Nilgiri mountains. Annamalai, Ilaichi and Palni ranges converge in this section. Famous tourist

centres - Utakmund, Kodaikanal etc. are located in this section. Mahabaleshwar (1438 metres) in Maharashtra is also an important tourist centre. The northern section of Sahayadri is covered with lava and its southern section is made up of gneiss, schist and chernokite rocks. Most of the rivers originating from the Western Ghats flow eastwards and drain their waters into Bay of Bengal. These rivers include Godawari, Bhima, Krishna, Tungbhadra, Pennar, Kaveri, Tamraparni, Periyar, Waigai etc. These rivers make waterfalls while descending from

Sahayadri. Yena falls (183 metres) near Mahabaleshwar, Shivsamudram falls (100 metres) of Kaveri and Pappanasam falls of Tamraparni rivers are the major falls. There are few rivers flowing westwards and draining their waters into the Arabian Sea but these rivers also make water falls. Jirsappa (Shri Mahatma Gandhi) falls (250 metres) of Sharawati river besides the falls of Narmada and Tapti are the major water falls. All these water falls are unique natural gifts for the production of cheap hydroelectric power.

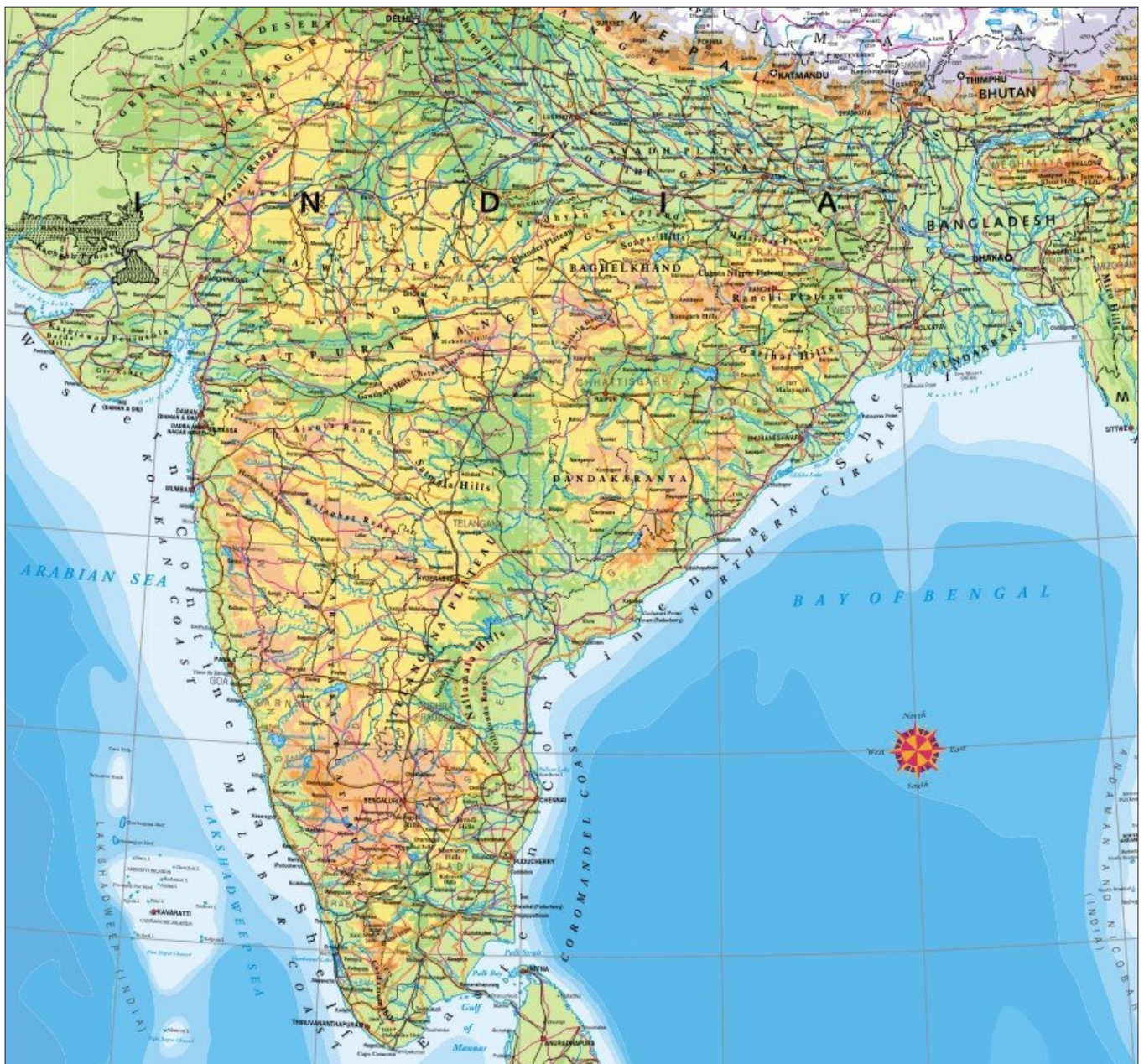


Fig. 4.8 : Deccan Plateau and Coastal Plain

2. Eastern Ghats - These ghats spread parallel to the eastern coast in a total length of about 800 kms. These are different from the Western Ghats because these are relatively low, discontinuous and lie far off from the eastern coast. Eastern Ghats spread from Mahanadi Valley in the north to Nilgiri mountains in the south. All east bound rivers have dissected the Eastern Ghats tremendously. Although the average height of the eastern ghats is 600 metres above mean sea level, Nilgiri peak rises to an elevation of 1516 metres and Mahendragiri peak to 1501 metres. Schist, gneiss, chernokite, khondlite etc. of sedimentary origin and igneous rocks have contributed to the constitution of eastern ghats.

3. Southern Plateau - The plateau is made up of very old, hard and metamorphosed igneous rocks, sandstone, limestone and metamorphosed rocks of Dharwar and Gondwana systems (including coal seams). It is an **old massif**. Huge part of the plateau surface was covered with lava by volcanic eruption. Approximately 5 lakh sq.km. area of the plateau surface is covered with black soil disintegrated from the lava deposits. This soil spreads over some parts of south-eastern Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka. Some parts of the plateau are covered with leached laterite soil which is red in colour. The average elevation of the plateau is 600 metres above mean sea level. The plateau is tilted eastwards, therefore, most of the rivers of the plateau flow in this direction. These rivers have dissected the plateau in various parts like Chhattisgarh, Mysore plateau, Railseema plateau, Telangana plateau etc. Chhattisgarh is a high, flat plateau region rising to an elevation of 300 metres. Some geologists believe that Shillong plateau is the distant most north-eastern extension of this plateau.

Importance of the Deccan Plateau

1. It is a stable block because it is an old massif related to Gondwanaland. Hence, it is almost free from seismic activities like earthquakes and volcanoes.

2. It enjoys equable climate because it is surrounded by oceans on three sides.

3. The plateau is rich in various minerals because it consists of old rocks.

4. In its major north-western section, it is

covered with black soils which is very fertile. The soil is highly suitable for growing cotton and groundnuts.

5. Areas of laterite soils are suitable for growing tea, coffee and rubber.

6. It possesses valuable forest resources of Sal, teak (Sagwan), rosewood (Shisham) and Sandalwood.

7. There are ample favourable and natural conditions available for the generation of cheap hydroelectric power as the rivers make waterfalls.

8. The region has a dense network of roads because of hard surface and easy availability of stones.

9. Many basic industries like iron and steel, aluminium, ship building, arms and ammunition manufacturing etc. have been developed in the region because of easy availability of raw materials, power resources, labour and market facilities.

5. Coastal Plains

Coastal plains flank the Deccan plateau on both sides. Both the coastal plains have been formed by either the upliftment of the continental shelves or by the deposit of river brought alluvium. These coastal plain are divided into two parts (Fig. 4.8) -

(A) Western Coastal Plains & (B) Eastern Coastal Plains

(A) Western Coastal Plains - These coastal plains extend from Bay of Cambay to Cape Comorin. Their average width is 64 kms and the maximum height of the plains is about 180 metres above mean sea level. The rivers flowing in this region are short and swift. Therefore, no deposition is made by them. Southern section of the coast is characterised by long and narrow lagoons. Kochin port is situated on one such lagoon. Mumbai and Mangalore are the major ports here. Its northern section is comparatively broad particularly from the mouths of Narmada and Tapti rivers upto northern Gujarat. Its northern section is known as **Konkan** and the southern section is known as **Malabar coast**. It is a densely populated area because of the facilities of good climate, fertile soil, rich rice cropping, industrial development and trade.

(B) Eastern Coastal Plains - The plain is located between the Eastern Ghats and Bay of Bengal. It extends from Orissa in the north to Cape

Comorin in the south. It is broader than the western coastal plains. Its width varies from 160 kms. to 480 kms. The plain is divided into two longitudinal sections - (1) The lower section consisting of river deltas. It is made up of the alluvium deposited by Mahanadi, Godawari, Krishna, Kaveri rivers etc descending from Deccan plateau. This section also possesses long chain of sandy knolls made by wave action. Chilka and Pulicut lakes are surrounded by such sandy knolls. These lakes are **lagoons**. (2) The upper section consists of the residual plains made up by alluvium. This section spreads in upper valleys. These plains are partially covered with river brought alluvium and elsewhere old rocks are exposed on the surface. The northern section of the eastern Coastal plain is known as **Northern Sarkar Coast** and its southern section as **Coromandel Coast**. Chennai and Vishakhapatnam are the major ports of these plains.

Importance of the Coastal Plains

1. Rice is cultivated widely in these plains. Coconut, cashewnut, beetalnut, rubber and palm plantations are also common in these fertile plains.
2. Large quantities of fish are caught on the Malabar coast and the deltaic coast of the east bound rivers.
3. Important ports of our country are situated in these coastal plains. These ports handle import and export trade of Bharat.
4. Salt is made on these coasts from the saline ocean water.
5. Valuable atomic mineral like monozite is found on the western coast of Kerala.
6. Large number of tourists come here to enjoy the scenic beauty of this coastal region, particularly in Panaji, Vasco-degama, Madgaon, Juhu, Chennai, Puri etc.

6. Islands

Although Bharatiya coasts are not indented, there are several islands found near the coasts. On the basis of the location of the island, these are divided into two parts -

(i) Coastal Islands

(A) Alluvial Islands - Such islands are found along the eastern coast. All the islands on the eastern coast except Bhasra-Mandla Islands (rocky) near Chilka Lake are made up of alluvial soil. Sagar

islands near the mouth of Hooghli, Short Islands in Mahanadi-Brahmani Delta and Wheeler Islands on their mouth, Adam's Bridge between Bharat and Sri Lanka, Pamban Islands of Rameshwaram, Crocodile, Anda and Kota islands in Bay of Mannar are made up of alluvium.

(B) Rocky Islands - Such islands are mostly found on the western coast. Henre, Kenre, Boocher, Elephanta, Pegion Islands near Mumbai and Peeram, Bhensla Islands etc. on Kathiawar coast are rocky islands.

(ii) Distant Islands

The islands situated away from the coast are included in this category. These islands are also divided into two parts on the basis of their structure -

(A) Hilly Islands - Higher parts of the submerged mountain ranges stand in the form of the islands. These are called as hilly islands. Andaman-Nicobar islands situated in Bay of Bengal are the best examples of this group. Southern extension of Arakan Yoma range of Myanmar (Burma) is submerged under the waters of Bay of Bengal. The portions of the range which stand higher than the sea level stand as Andaman-Nicobar islands. Some of the islands in this category are formed by volcanic eruptions. Approximately 200 islands of different size are included in this category, which are spread upto 350 kms. away from the Bharatiya coast. Andaman islands have been separated from the Nicobar islands by Ten Degree Channel.

(B) Coral Islands - Laksha Dweep situated in the Arabian Sea, off the west coast of Kerala, are such islands. Covering an area of about 21 square kilometres, this group includes Laksha Dweep, Amindivi, Minicoy, Kavaratti, Ilayachi islands etc. All these coral islands are centres of tourist attraction due to their natural beauty.

Importance of Islands

1. Their climate remains equable due to maritime effect.
2. These are the centres of tourist attraction because of their scenic beauty.
3. They have specific biotic characteristics because of their separation from the main land.
4. They have a special contribution in providing fuel and safe harbour to the commercial ships in emergency.

5. They carry a specific strategic importance because of their location in the Indian ocean. In the light of some near and distant foreign powers intending to increase their undue influence in the Indian ocean, their naval importance has further increased.

Important Points

1. The rock structure of Bharat is geologically divided into Archean Era, Purana Era, Dravid Era and Aryan Era.
2. Many diversities of relief and topographical features - Northern Mountainous Region, Great Plains, Thar Desert, Deccan Plateau, Coastal Plains and Islands.
3. Northern Mountainous Region - extends in an area of about 5 lakh sq.kms., 2400 kms long and 150 to 400 kms. broad.
4. Geographical classification of Himalayas - Greater Himalayas, Lesser Himalayas and Sub-Himalayas. Regional classification - Himachal, Kumaun, Nepal and Assam Himalayas.
5. Many advantages of Himalayas.
6. Great plains - Sutlej-Ganga-Brahmaputra plains; the arc shaped plains are 2400 kms long and 150 to 480 kms broad. Geographical classification - Bhabar, Tarai, Bangar and Khadar regions. Regional classification - Punjab-Haryana plains, Ganga-Brahmaputra plain and delta of Ganga-Brahmaputra, importance of the great plains.
7. Thar desert - Vast dry desert covered with sanddunes; Indira Gandhi Canal carries special importance considering the prevailing dry conditions in the region; importance of Thar desert.
8. Deccan plateau - Covering an area of about 16 lakh sq.kms., it is 1800 kms. long and 1400 kms. broad, it is one of the oldest plateaus of the world. (A) Central Foreland - Aravalli range, uplands of eastern Rajasthan, Malwa plateau, Bundelkhand plateau, Baghelkhand plateau, Chhota Nagpur Plateau, Vindhya-Chhota Nagpur ranges. (B) Peninsular plateau - Western ghats, Eastern ghats and southern plateau. Importance of Deccan Plateau.

8. Coastal plains - Western coastal plains are relatively narrow, its northern section is known as Konkan and southern section as Malabar coast. Eastern coastal plains relatively broad and continuous, its northern section is known as North Sarkar Coast and southern section as Coromandel Coast, importance of coastal plains.
9. Islands - Coastal-alluvial and rocky islands. Distant islands - mountainous and coral islands.

Exercise

Multiple Choice Questions

1. The physiographic region extending between Sutlej and Kali rivers, is –
(A) Himachal Himalayas (B) Sub Himalayas
(C) Kumaun Himalayas (D) Nepal Himalayas
2. Wheeler islands are -
(A) Distant islands (B) Alluvial islands
(C) Rocky islands (D) Coral islands.
3. The region where natural rejuvenation of soil occurs every year, is -
(A) Bhabar (B) Tarai
(C) Bangar (D) Khadar.

Very Short Answer Type

4. What is meant by Talli?
5. Where are Margs found?
6. Which is Konkan Coast?

Short Answer Type

7. Distinguish between Dhandh and Talli.
8. Distinguish between Eastern and Western Ghats.
9. Which are the rocky islands of Bharat?

Essay Type

10. Divide Bharat into physiographic regions and give a detailed description of Himalayan region.
11. Divide Bharat into physiographic regions and give a detailed description of great plains.
12. Divide Bharat into physiographic regions and give a detailed description of Deccan Plateau.

Skill

13. Mark the major physiographic regions in an outline map of Bharat.
14. Draw a sketch of Deccan plateau showing its sub-divisions.

Answer Key

1. (C), 2. (B), 3. (D).

Lesson - 5

Drainage System of Bharat

Bhartiya civilization and culture has developed in river valleys. Rivers occupy a very important place in Bharat particularly because of the monsoonal character of its climate. Most of the historical and religious centres of Bharat are situated along river coasts. Even the major industrial and commercial centres of today have riverine location. Rivers have an important contribution in the economic development of Bharat because of various facilities provided by them like ample supply of fresh water, hydro-electric power, irrigation, inland water transport and water for industrial use. Brief knowledge of some of the related concepts is necessary before studying the drainage system of Bharat.

Change of Course

Geologists believe that there had been changes in the course of rivers in Bharat from time to time. The most interesting example is of Sindh-Brahmputra system. This river system, which has also been termed or Shiwalik river, drained into Arabian Sea after originating from Assam in the north-east and flowing parallel to Himalayas westwards upto Suleman-Kirthar ranges. From here it turns southwards to drain into Arabian Sea. Subsequent geological events bifurcated the Indo-Brahm or Shiwalik river system. Its north-western part separated as Sindhu system and the eastern section as Brahmputra and other river systems. Similarly Saraswati drainage system also disappeared in course of time. Brahmputra, Ganga, Kosi etc. have changed their courses several times

during past two decades.

Water Divide

The area which divides the drainage of a region in different directions is known as **water divide**. The dotted line shown in Fig. 5.1 is a water divide, which divides the drainage system of Bharat into three drainage regions - (1) Arabian Sea drainage, (2) Bay of Bengal drainage and (3) Inland

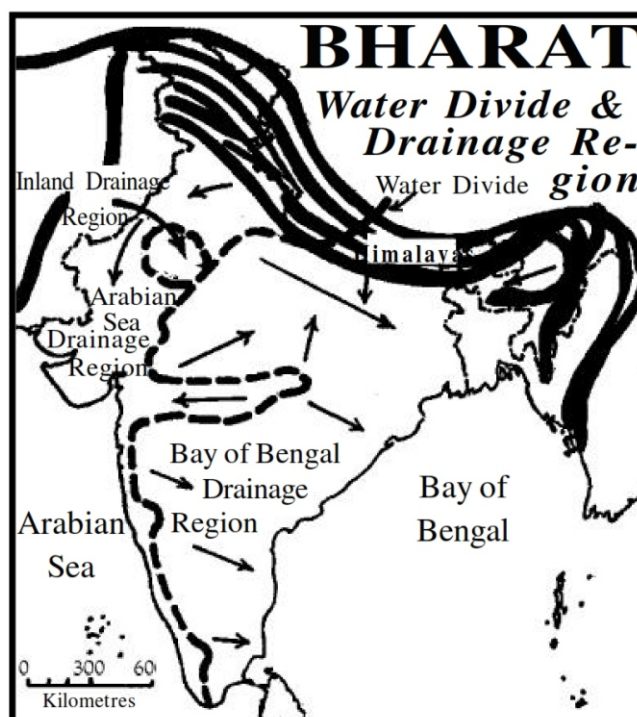


Fig.5.1 : India : Water Divide & Drainage System



Fig. 5.2 : India : Drainage System

drainage system. This line of water divide originates from Himalayas near Mansarovar lake and goes upto Udaipur passing through Kamet mountains, east of Shimla and then following Aravallis, it further extends southwards from Udaipur through Indore, Western Ghats upto Kanyakumari, after taking a bend to include Narmada and Tapti valleys into Arabian Sea drainage. The area whose waters drain into Arabian Sea, is known as **Arabian Sea drainage region**. Similarly, rivers of **Bay of Bengal drainage region** drain into Bay of Bengal. There is a small area in the north-western part of Rajasthan, from where no river channel drains into any open

ocean. Therefore, it is known as **inland drainage region** (Fig. 5.2).

Geographically, drainage system of Bharat is divided into three parts -

- (1) Himalayan drainage system or the rivers of northern Bharat,
- (2) Peninsular drainage system or the rivers of southern Bharat and
- (3) Inland drainage system.

Himalayan Drainage System or the Rivers of Northern Bharat

Most of the rivers of northern Bharat

originate from the Himalayas. The rivers originating from the Himalayas are perennial because these are fed with snow-melted water even in dry period. These rivers are divided into three drainage systems - (1) Sindh drainage, (2) Ganga drainage and (3) Brahmaputra drainage.

1. Sindh Drainage

It comprises Sindh (Indus) and its tributaries - Sutlej, Vyas, Ravi, Chenab and Jhelum. Its catchment area spreads over 11.5 lakh square kms., out of which 3.25 lakh square kms. is in Bharat and rest has gone to Pakistan. Under an agreement with Pakistan, Bharat can use 42 lakh cubic metres water of this drainage system. Its upper drainage is in Bharat and lower drainage is in Pakistan. All the rivers of the system make gorges in their upper valleys. Sutlej river originates from Rakshas Tal near lake Mansarovar and enters into the plain near Ropar in Punjab after crossing mountainous region. Bhakhra dam has been constructed at that site.

2. Ganga Drainage

Its total drainage area spreads over about 8.6 lakh square kms. River Ganga originates from Gangotri glacier. Alaknanda and Bhagirathi channels join to form Ganga near Dev Prayag. It enters into the plains near Haridwar. Chambal, Betwa, Kain etc. with their tributaries join Yamuna river after originating from Vindhyaachal mountains. Yamuna meets river Ganga near Allahabad at a place known as **Sangam** or **Prayag**. Ramganga, Gomti, Ghaghra (Saryu), Gandak, Kosi and Mahananda meet Ganga from the north and river Son from the south. Then Ganga river enters into Bangla Desh near Farakkha. Here it is known as river Padma which forms a delta with Brahmaputra before draining into Bay of Bengal. River Kosi causes heavy losses of life and property due to frequent change in its course and floods. Hence, it is known as **Sorrow of Bihar**.

3. Brahmaputra Drainage

River Brahmaputra originates from Kailash Parbat near lake Mansarovar. It, then, goes upto the eastern tip of Himalayas in its eastward journey. Here it is known as **Tsan Po**. From here, it turns southwards and then flows westwards through

Assam and Bangla Desh where it joins river Ganga. Its tributaries like Divang, Luhit etc. flow in a direction opposite to that of Brahmaputra river before joining the latter. Tributaries like Bhareli, Sabansiri, Manas etc. join Brahmaputra from its right. Besides Divang and Luhit, other tributaries like Kapili, Dhansiri, Buri Dihing etc. join Brahmaputra on its left bank. Huge quantity of alluvium is transported through the drainage. In their delta region, Ganga-Brahmaputra rivers are divided into numerous distributaries like Madhumati, Padma, Saraswati, Hooghli, Bhagirathi channels etc.

Peninsular Drainage or Rivers of Southern Bharat

1. Rivers draining into Bay of Bengal

Damodar, Swarnrekha, Brahmani, Mahanadi, Godavari, Bhima, Krishna, Tungbhadra, Pennar, Palar, Kaveri, Waigai rivers etc. are included in the system. These rivers flow eastwards to join Bay of Bengal due to the tilting of peninsular plateau in that direction. Most of the rivers of the peninsular plateau originate in the Western Ghats and make waterfalls. River Damodar is ill-famed for frequently changing its course and for causing flood havoc. Therefore, it is known as **Sorrow of Bengal**. Mahanadi, Godavari, Krishna and Kaveri rivers make deltas on the eastern coast.

2. Rivers draining into Arabian Sea

Narmada and Tapti are the longest and main rivers of the system. River Narmada originates from Amar Katak peak in Maikal range and makes several waterfalls in its narrow rift valley. Kapil Dhara, Doodh Dhara, Sahastra Dhara, Dhuandhar, Ghaghri and Hiran falls are famous. Tapti flows parallel to and south of Narmada river. Besides, Luni, Sabarmati, Mahi, Sukri, Bandi, Sharavati rivers etc. also drain into Arabian sea.

Inland Drainage

Inland drainage area is not very extensive in Bharat. It extends from Sambhar lake in Rajasthan to Ghagghar flow in Haryana. All the rivers of the region are seasonal which either drain into Sambhar and other smaller lakes or disappear in the desert.

Important Points

1. Rivers have special importance in Bharat in the light of the monsoon climate.
2. Many Bhartiya rivers have been changing their course.
3. Bhartiya drainage is classified into three groups by water divide - Himalayan, Peninsular and Inland drainage system.
4. Major components of Himalayan drainage - Sindh drainage, Ganga drainage and Brahmaputra drainage.
5. Major components of Peninsular drainage - Bay of Bengal drainage, Arabian Sea drainage.
6. Inland drainage system - Sambhar-Ghagghar region.

Exercise

Multiple Choice Questions

1. The aspect in which the effect of the tilting of peninsular plateau is visible, is –
(A) Structure
(B) Age of the plateau
(C) Direction of drainage
(D) Relief
2. Choose the group of which all the rivers drain into Bay of Bengal -
(A) Mahanadi, Krishna, Kaveri and Narmada
(B) Ganga, Brahmaputra, Krishna and Tapti
(C) Ganga, Brahmaputra, Krishna and Kaveri
(D) Ganga, Godavari, Krishna and Sabarmati.
3. Choose the group of which all the rivers make delta–
(A) Kaveri, Krishna, Narmada and Tapti
(B) Godavari, Krishna, Kaveri and Ganga
(C) Mahanadi, Krishna, Kaveri and Narmada
(D) Ganga, Godavari, Krishna and Narmada.

Very Short Answer Type

4. Tapti is a part of which drainage system?
5. What is a water-divide?
6. Ghagghar river is a part of which drainage system?

Short Answer Type

7. Name the tributary rivers that joins Ganga on its left bank.
8. Why are Himalayan rivers more useful?
9. Explain the meaning of inland drainage with the help of an example.

Essay Type

10. Give a detailed description of Bhartiya drainage system.
11. Give a comparative explanation of the Himalayan and peninsular drainage systems.

Skill

12. Mark the courses of major rivers in an outline map of Bharat.

Answer Key

1. (C), 2. (C), 3. (B).

Lesson - 6

Climate of Bharat

Bharat is characterized by climatic diversities due to its vast expansion and variations of relief. But despite climatic diversities, unity is apparent in the country due to monsoonal effect everywhere. Therefore, climate of Bharat is called as **Monsoon Climate**.

Various geographical factors affect the climate of Bharat. It is necessary to have a detailed study of these factors to better comprehend the climate of our country.

Factors Affecting Climate

1. Elevation above Sea Level - Temperature is negatively correlated with it. Normally there is a decrease of 1°C. per 165 metres height. It explains why the higher slopes of Himalayas are snow covered. Despite the location on the same latitude, variations in temperature are observed due to difference in heights of Mussourie with 24°C., Dehradun 32°C. and Ambala with 40°C.

2. Distance from Sea - Maritime effect is humid and equable. Its effect can be observed in the form of minimum range of temperature and humid climate of coastal cities. Extremities, range of temperature and aridity increases with increasing distance from sea. Annual rainfall averages 200 cms. in western coastal areas, while it diminishes to only 5 cms. in Jaisalmer.

3. Distance from Equator - It is the basic factor affecting temperature. It decreases with higher latitudes due to increasing obliquity of sun's rays. It affects the amount of insolation. For this reason, height of snow line is more on the southern

slopes of Himalayas and lesser on the northern slopes or towards Tibet. Tropic of cancer passes through the middle of Bharat. Hence, northern Bharat is included in the temperate zone and southern Bharat in the torrid zone.

4. Location of Mountains - It is also an important factor affecting the climate. Western Ghat is located close to the western coast. Therefore, its western slopes receive plentiful rain from south-west monsoon, while its leeward slopes and peninsular plateau come under rain shadow effect.

5. Direction of Mountains - Climate of Bharat is moderate only due to the location and direction of Himalayas. Himalayas protect Bharat from the cold Siberian winds. Besides, the mountains also effectively check the summer monsoon and force it provide rain in Bharat. Similarly, the main reason for scanty rain in western Rajasthan is the parallelism of south-western monsoon with Aravallis. Hence, Aravallis are not effective barriers in the way of these winds.

6. Direction of Winds - Winds bring with them the characteristics of their source region and their path of travel. Summer monsoon is warm and humid because its source region is Indian Ocean. Source region of winter monsoon is continental and cold, hence, it is cold and dry.

7. Upper Air Circulation - Latest researches have proved that upper air circulation and monsoon are deeply related. Monsoonal climate of Bharat is greatly affected by the movements in the troposphere. Uncertainties of monsoonal period

and quantity of rain also depend upon the conditions of upper air circulation.

Besides, amount of cloudiness, vegetative cover, ocean currents etc. also affect the climate of Bharat partially.

Climatic Conditions

Meteorological department of Government of Bharat has divided the year into the following seasons keeping in view the monsoon period -

- (A) North-eastern or Winter Monsoon period -
 1. Winter season - December to February
 2. Summer season - March to mid-June.
- (B) South-western or Summer Monsoon period-
 3. Rainy season - mid-June to mid-September.
 4. Autumn season - mid-September to December.

(A) North-Eastern or Winter Monsoon Period

1. Winter Season

Winter season prevails from December to February in Bharat. Sky remains clear in this season. Main characteristics of the season are that winds blow slowly and bear little moisture.

Temperature - Temperature increases from north to south in this season. Average temperature ranges from 8°C to 21°C in northern Bharat and from 21°C to 26°C in the south. There is a speedy loss of temperature during nights due to terrestrial radiation in western Rajasthan, hence, temperature drops below freezing point in its various parts. Lowest winter temperatures are recorded on the higher slopes of Himalayas, in Jammu-Kashmir, Punjab and Himachal Pradesh.

Pressure - Intense high pressure develops over land due to the prevailing very low temperatures on the Bhartiya sub-continent in winters. Considering the pressure system over the whole of Asia, the highest pressure is observed near Lake Baikal. Second centre of high pressure prevails near Peshawar in Pakistan and the third one in western Rajasthan. Oceanic areas in this season remain warmer, hence low pressure prevails over Indian Ocean.

Winds - Winds blow from high pressure to low pressure. Therefore, winds blow from land to

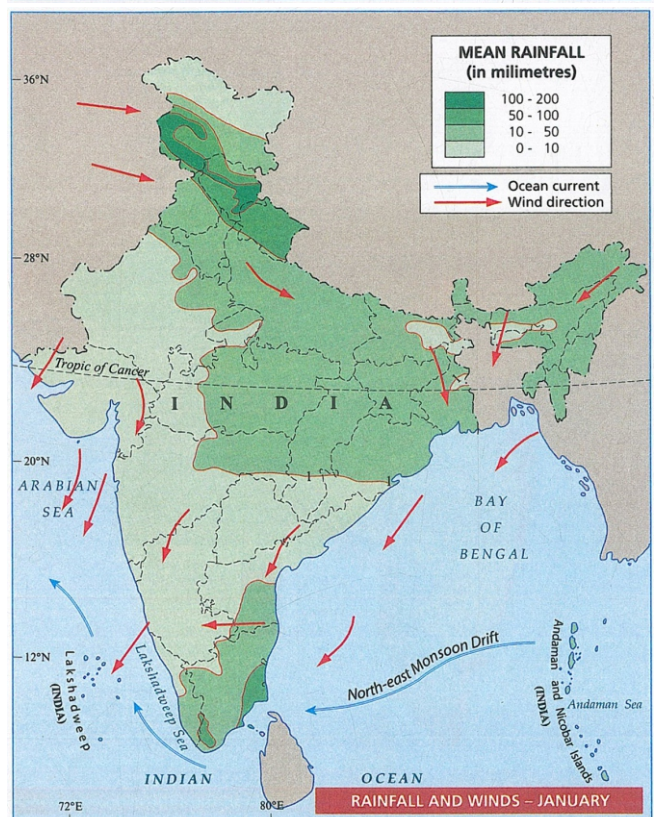
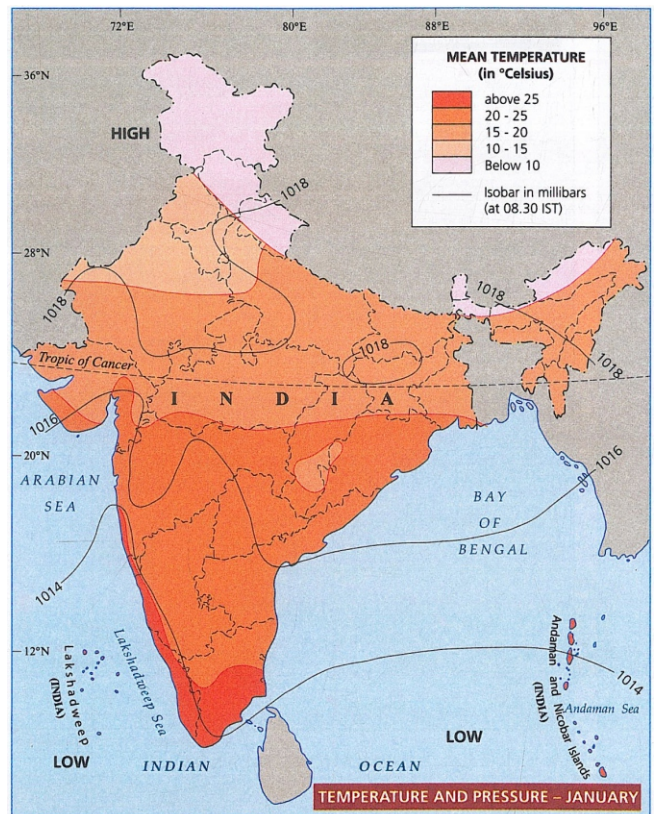


Fig. 6.1 : India : Temperature, Rainfall and Pressure (January)

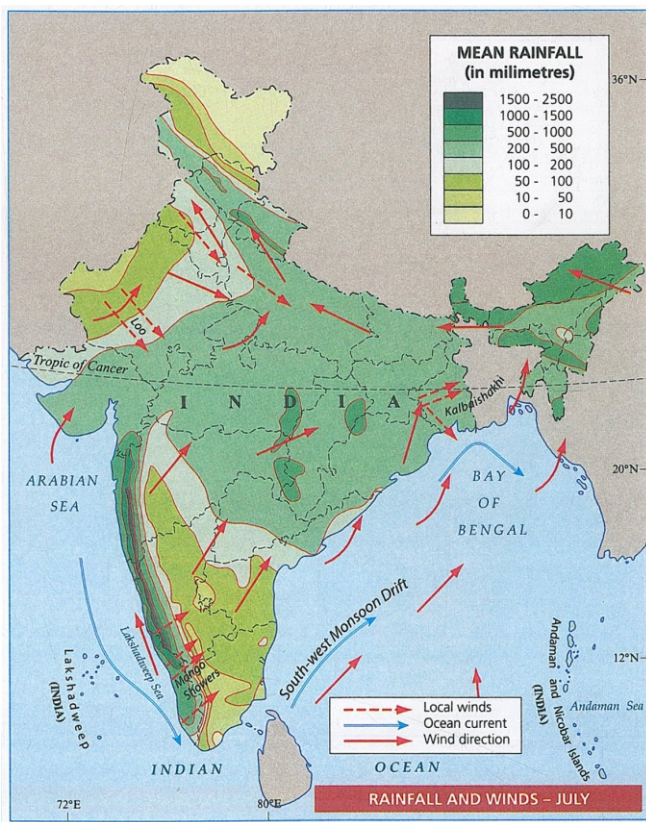
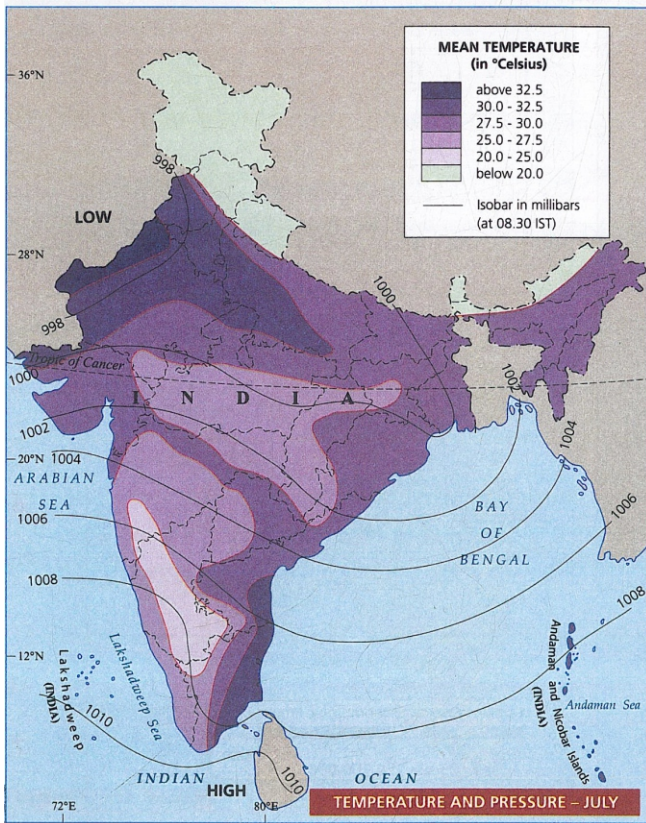


Fig. 6.2 : India : Temperature, Rainfall and Pressure (July)

sea in this season in Bharat. These winds blow from the north-west towards Ganga-Sutlej plain. After crossing the plain, the winds start blowing from the north-east. These winds are known as North-East Monsoon. In this season, a tongue-shaped high pressure area develops over Europe, where prevailing planetary winds are westerlies. The tongue shaped high pressure area bifurcates the westerlies and related cyclonic depressions. One of the branches reaches north-western part of Bharat after travelling over Mediterranean Sea, Israel, Syria, Jordan, Iraq, Iran, Afghanistan and Pakistan.

Rainfall - Winds in this season are mostly dry because their movement is from land to sea. Therefore, very little rain is provided by these winds in Bharat. A little precipitation is provided by Mediterranean cyclones in Jammu-Kashmir, Himachal Pradesh, Punjab, Haryana, Uttaranchal, Rajasthan and Uttar Pradesh in this season. The rain is locally known as **mawat**. It is very beneficial for the crop. A little rain is also provided by north-east monsoon in the hilly areas of north-eastern Bharat. The winds become drier as these proceed ahead. But these are recharged with moisture while travelling over Bay of Bengal. Tamilnadu is benefitted in the process in the form of winter rains. Hence, the largest part of winter rains is received by Tamilnadu. These conditions have been represented in Fig. 6.1.

2. Summer Season

Its duration is from March to mid-June. May and June are the hottest months of this season. This season is hot and dry. It is characterized by frequent duststorms. These hot and dry winds are known as **Loo**. The volume of wind blown sand and dust is so much that the sky becomes yellowish many times. In northern and western Rajasthan, the duststorms are almost a daily phenomena.

Temperature - Temperature over Bharat starts increasing after March when the sun begins shifting northwards. Increasing trend of temperature tends to reach above 45°C at several places in north-western Bharat. Great plains of northern Bharat also experience very high temperature conditions. Temperatures remain relatively low and mild towards coastal areas. Therefore, southern Bharat experiences lower temperatures due to maritime effect in comparison to the north. Temperatures also remain low in the

Himalayas due elevation above sea level. It has led to the growth and development of several hill stations like Shimla, Mussourie, Nainital, Darjeeling etc. and Mt. Abu in Aravalli hills.

Pressure - High summer temperatures lead to the development of low pressure over northern Bharat. An intense low pressure system develops over Thar desert due to the highest temperatures prevailing there. Pressure increases towards southern Bharat due to lowering of temperatures in that direction. Hence, low pressure prevails over Indian Ocean.

Winds - Temperature rises rapidly in this season as a result of which pressure decreases. The low pressure attracts winds from all sides causing the inset of dust-laden, hot and dry winds, which are known as **Loo**. Maximum effects of the duststorms are observed in Rajasthan, Haryana and Punjab. The duststorms occasionally provide local rains. Winds start blowing from sea to land in coastal regions and southern Bharat. This reversal of winds also causes a little rain in southern Bharat, where it is known as **Mango Showers** and particularly in coffee producing regions as **Blossom Showers**.

(B) South-Western or Summer Monsoon Period

3. Rainy Season

The period of this season extends from mid-June to mid-September. This season is specially important and significant, particularly in an agricultural country like Bharat. It is because wide spread rains occur throughout the country in this season (Fig.6.2 and 6.3).

Pressure, Winds & Rainfall - Pattern of temperature, pressure and winds was explained under the heading of summer season. These conditions become the basis of the inception of winds blowing from sea to land in Bharat. The low pressure of north-western Bharat is so intense that even the south-east trade winds, whose domain lies south of equator, are attracted towards it. After crossing the equator, these winds are deflected towards their right according Ferrel's law. Therefore, these winds become south-westerlies and hence, are known as **South-west Monsoons**. These are humid winds because they blow from sea

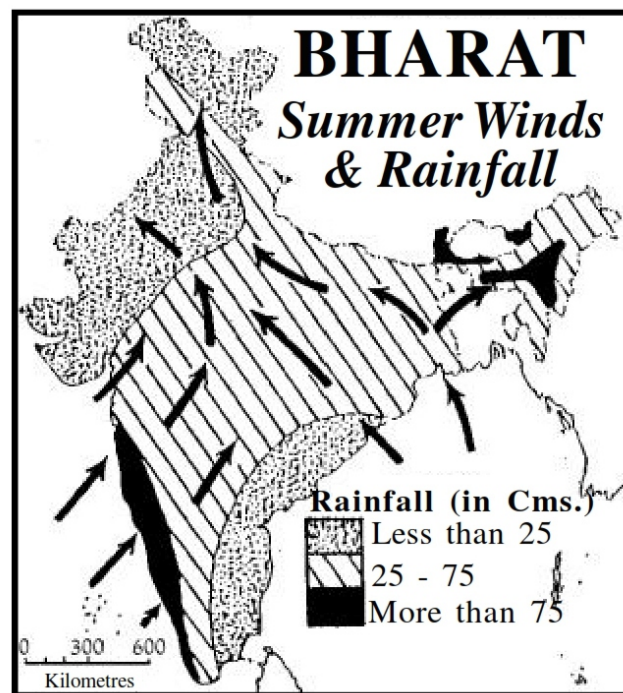


Fig.6.3 : India : Summer Monsoon and Rainfall

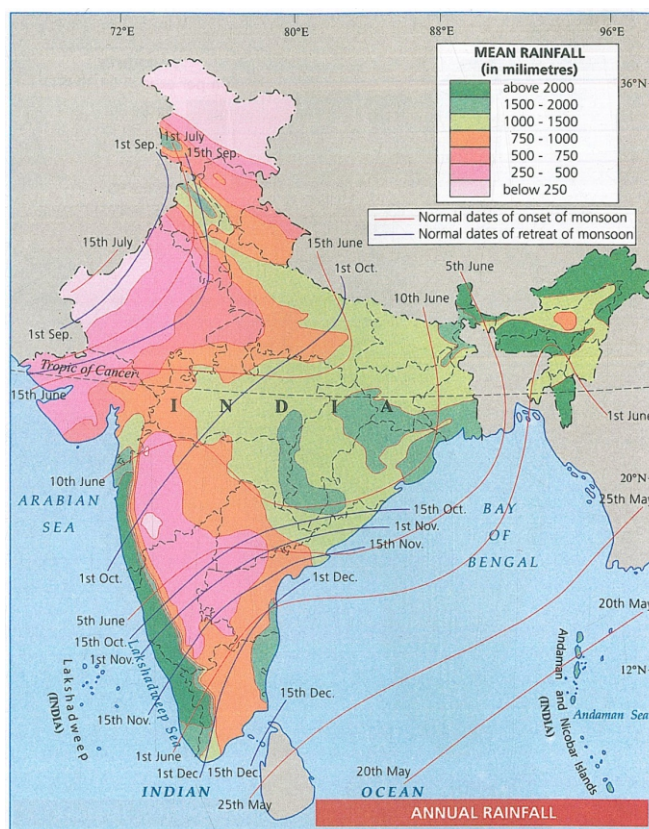


Fig.6.4 : India : Annual Rainfall

to land and provide widespread rains in Bharat. About 90% of the total rains received in Bharat comes in this season. Summer monsoonal winds are bifurcated in two branches due to the shape and location of peninsular Bharat (Fig.6.4) -

- (A) Arabian Sea Monsoon and
- (B) Bay of Bengal Monsoon.

(A) Arabian Sea Monsoon - Velocity of this branch of monsoon is very high. Therefore, the on-set of monsoonal rain on the Western Ghats occurs very heavily. The heavy on-set of rain is termed as the **Burst of Monsoon**. Velocity of the monsoon is limited only to the western coastal plain and the western slopes of the Western Ghats. The average rainfall is about 250 cms. on the western coast and 500 cms. on the higher windward slopes of the Western Ghats. On crossing the Western Ghats, not only the humidity content in the winds decreases but while descending on the eastern slopes, these winds become warm and dry also. Hence, very less rain is received on the eastern slopes of the Western Ghats and Deccan plateau under rain shadow effect. The average decreases to less than 38 cms. upto Chennai in the east. Thus, the rain shadow effect is apparent in the Deccan Plateau east of Western Ghats (see Fig. 6.5)

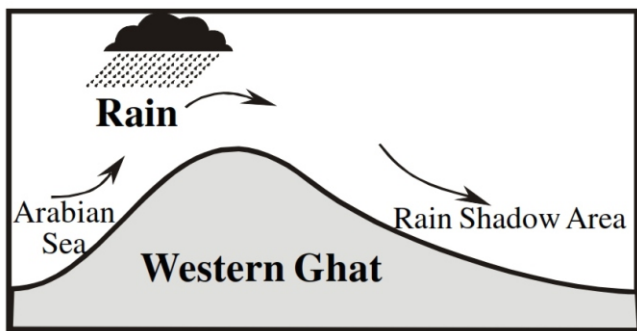


Fig.6.5 : Effect of the Location of Mountains

After crossing the Western Ghats, one branch of Arabian Sea monsoon goes towards Chennai and second branch goes upto Chhota Nagpur plateau following a course between Vindhyachal and Satpura ranges. Rainfall average begins at 150 cms. on this track and diminishes to 100 cms. with increasing distance. The third branch of the monsoon provides rain upto Himachal Pradesh in Western Himalayas by following a route through Kutch, Rajasthan, Haryana and Punjab.

Rajasthan is not benefitted much by this branch because of its **parallelism with Aravallis**. Rainfall average on this route begins with 50 cms. near Bay of Cambay and diminishes with increasing distance.

(B) Bay of Bengal Monsoon - After originating from Bay of Bengal, its one branch provides very heavy rain in the eastern section of Himalayas. Mousinram, situated in Khasi hills in this section of Himalayas, receive more than 1300 cms. of rainfall. It is the highest rainfall in the world. Another branch goes towards Assam in the east via Brahmaputra river valley where it provides plenty of rain. It averages more than 200 cms. The third branch of the monsoon travels westwards parallel to Himalayas through Bihar, Jharkhand, Uttar Pradesh, Uttaranchal, Punjab, Haryana and Rajasthan. Rainfall from this branch decreases with increasing distance from the sea. For example, the average is 170 cms. in Kolkata and it gradually decreases to 120 cms. in Patna, 85 cms. in Allahabad, 70 cms. in Agra, 65 cms. in Delhi, 28 cms. in Bikaner and 5 cms. in Jaisalmer. One more branch of the Bay of Bengal monsoon advances towards Chhota Nagpur plateau and meets with the Arabian sea monsoon branch. Rainfall average rises to 100 cms. in the region due to the meeting of the two branches of monsoons.

4. Autumn Season

The duration of the season is from mid-September to December. It is the season of retreating monsoon.

Temperature - The sun starts shifting southwards in this season, as a result of which temperatures gradually decline in Bharat. Maximum temperatures in the season range between 30° to 35°C which gradually decline to 25°C in coastal and southern Bharat and to 5°C in many parts of northern Bharat. Higher mountainous areas experience temperatures below freezing point.

Pressure & Winds - Pressure also changes in accordance with temperatures. Uncertain state of pressure prevails for some time due to slow decline in temperatures. Gradually, the pressure system reverses from that of the summer season. These conditions lead to the retreat of monsoons.

Rainfall - Amount and areal distribution of rainfall remains limited in this season. A little rain

occurs in Tamil Nadu and a few coastal areas due to retreating monsoon.

Distribution of Rainfall in Bharat

There are widespread variations of rainfall in Bharat, e.g. 1300 cms. in Mausinram and only 5 cms. in Jaisalmer while the average for the country is 110 cms. According to the distributional pattern, Bharat can be divided into four major rainfall regions –

1. Areas with abundant rainfall - The region includes the area receiving rainfall more than 200 cms. Western coastal plain, western/windward slopes of the Western Ghats, eastern Uttar Pradesh, eastern Bihar and Jharkhand, northern part of West Bengal, Assam, Meghalaya etc. are included in this category.

2. Areas with moderate rainfall - The areas receiving rainfall between 100 to 200 cms. are included in this category. The region spreads over the eastern slopes of the Western Ghats, southern part of West Bengal, Orissa, interior areas of Bihar, Chhattisgarh, south-eastern Uttar Pradesh, Haryana and a narrow belt of Himachal Pradesh. These are also termed as **areas with medium rainfall**.

3. Areas with scanty rainfall - Areas receiving 50 to 100 cms. rainfall are included in this category. Deccan plateau, Madhya Pradesh, north-western Andhra Pradesh, Karnataka, eastern Rajasthan, southern Punjab, Haryana and southern Uttar Pradesh are included in the region. The amount of rainfall is scanty with high variability.

4. Areas of insignificant rainfall - The areas receiving less than 50 cms. rainfall are included in this region. It comprises western Rajasthan, western Punjab, Railseema region of Tamil Nadu, Kutch, Laddakh etc.

Characteristics of Bhartiya Rainfall

1. About 90% rainfall in Bharat is received by south-west monsoon in summer season.

2. Monsoonal rain is uncertain in time and period of occurrence. The rain sometimes comes early and sometimes starts late. Sometimes it starts early and ends early or it may stay longer.

3. Spatial distribution is also highly unequal in Bharat.

4. Monsoonal rain does not occur continuously. But it occurs intermittently with a gap of a few days. Occasionally, the gap becomes longer during which crops are dried.

5. In some areas, monsoonal rain occurs in heavy downpours while in some other areas it is received in the form of showers. Heavy rains usually cause soil erosion, leaving the land infertile.

6. Winter season is almost dry. About 10% of the country's rain is received by winter monsoon and cyclones.

7. Number of rainy days in Bharat are few, e.g. 118 days in Kolkata, 55 days in Chennai, 75 days in Mumbai etc. Therefore, irrigation is necessary.

8. The rainfall variability is very high. The areas of Rajasthan, receiving 12 cms. rainfall, have 30% variability. But the variability is 20% in Kanpur and 11% in Kolkata.

Important Points

1. Bharat has monsoon climate.
2. Factors affecting climate of Bharat - elevation above sea-level, distance from sea, distance from equator, location of mountains, direction of mountains, direction of winds, upper air circulation etc.
3. Climatic conditions - (A) North-eastern or Winter monsoon period (winter and summer seasons), (B) South-western or Summer monsoon period (rainy and autumn season).
4. Rainfall distribution is highly unequal; major rainfall regions according to distribution - (i) Areas with abundant rain, (ii) Areas with moderate rain, (iii) Areas with scanty rain and (iv) Areas with insignificant rain.
5. There are many characteristics of monsoonal rain.

Exercise

Multiple Choice Questions

1. Had the equator passed through the middle Bharat, its climate would have been –
(A) Hot & humid (B) Hot & dry
(C) Cold & humid (D) Cold & dry

2. In the absence of Western Ghats, the amount of rain in the western coastal region would have been –
(A) More (B) Lesser
(C) Nil (D) Uncertain.
3. The group of states having annual rainfall more than 200 cms. is –
(A) Nagaland, Meghalaya, Manipur & Arunachal Pradesh
(B) Meghalaya, Manipur, Uttar Pradesh & Madhya Pradesh
(C) Nagaland, Tamil Nadu, Arunachal Pradesh & West Bengal
(D) Madhya Pradesh, Manipur, Uttar Pradesh & Meghalaya.

Very Short Answer Type

4. Where is low pressure located in Bharat in summer season?
5. Which winds causes mawat?
6. What is Loo?

Short Answer Type

7. What are the main factors affecting climate of Bharat?
8. How do Mediterranean cyclones originate?
9. How does winter rains occur in Tamil Nadu?

Essay Type

10. Compare summer and winter seasons on the basis of temperature, pressure and rainfall.
11. Describe the distributional pattern of rainfall and its characteristics in Bharat.

Skill

12. Show the annual distribution of rainfall in an outline map of Bharat.
13. Show the pressure conditions and winds of summer season in an outline map of Bharat.

Answer Key

1. (A), 2. (B), 3. (A).

Lesson - 7

Monsoon System of Bharat

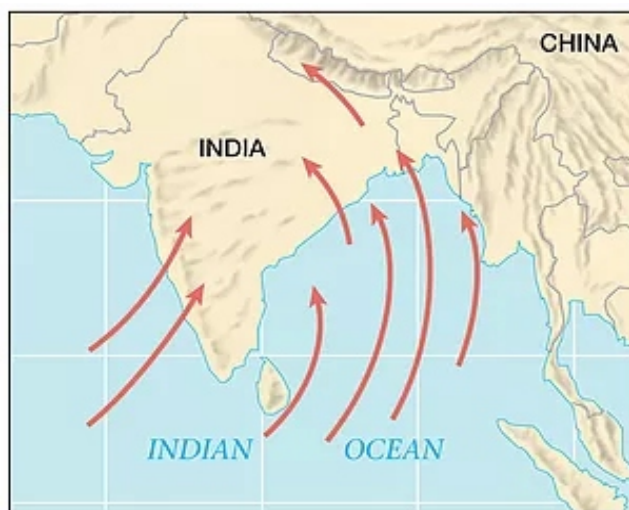
Climate of Bharat is termed as monsoon climate because monsoons play a major role in its climate. Due to its dominant role, attempts are always made to predict about monsoons. Since the economy of our country depends upon monsoons, its prediction is necessary too. But it is essential to make predictions on unanimously acceptable and logical base, so that it may be accurate. Various hypothesis about the origin of monsoons have come up from time to time. It is pertinent to understand them.

Concept of Monsoon

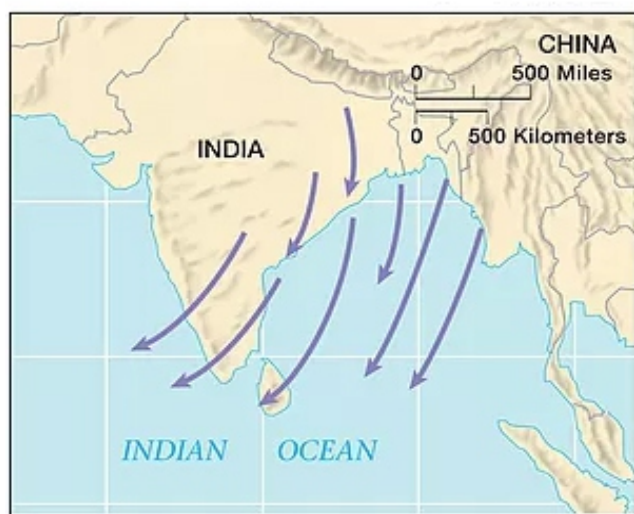
The word monsoon has originated from the arabic word **Mausim**, meaning weather or season. As a matter of fact monsoons are seasonal winds. These winds blow from land for six months and from ocean for another six months. Our country remains under the effect of monsoonal winds throughout the year. Therefore, its climatic conditions are mainly determined by these winds. Our agriculture, agro-based industries and other related economic aspects depend upon climate. Hence economy of Bharat is a **Gamble in Monsoons**. There are various hypothesis about the origin of monsoons -

1. Classical Hypothesis

This hypothesis is related to the distribution of land and sea and their variable characteristics of grasping and loosing heat. Land areas are heated and cooled rapid by, while water is heated and cooled slowly. Low pressure develops over land due to rapid heating in summer season, while water



Summer



Winter

Fig.7.1 : Origin of Monsoon in Summer & Winter

remains cooler due to slow heating which creates, high pressure there. Consequently, winds start blowing from ocean towards land. These winds are humid because they originate from oceanic areas. Therefore, these winds provide widespread rains.

Wind direction turns opposite due to the reversal of the mechanism in winter season. High pressure develops over land due to its fast cooling and low pressure develops over oceanic areas which remain warmer due to longer retention of heat. Therefore winds start blowing from land towards ocean. These winds are dry because they originate over land. Therefore, usually these winds do not provide rains.

Thus **summer monsoon** and **winter monsoon** originate due to the reversal of weather conditions according to seasons.

2. Inter-tropical Convergence Hypothesis

German climatologists **Flohn** hypothesized that a **Front** is generated by the meeting of both the trade winds which blow towards equatorial low pressure. The **front** is the basis of the genesis of monsoons. The front shifts northwards in summer season. The resulting cyclonic movement provides rainfall in the form of summer monsoon. In winter season, not only the front shifts southwards but the influence of sub-tropical high pressure also increases in Bharat due to southward shifting of the pressure belts. Consequential anticyclonic conditions create north-east monsoon. Thus, according to Flohn, the seasonal reversal in the direction of monsoonal winds is not due to seasonal reversal of thermal conditions but it is due to the

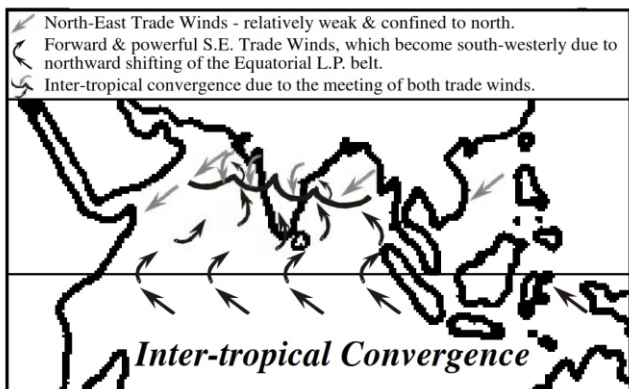


Fig.7.2 : Inter-tropical Convergence According to Flohn

resetting of trade winds as part of the global wind system. This view about the origin of monsoons is also known as **Flohn's Hypothesis** (Fig. 7.2).

3. Cyclonic Hypothesis of Spate

Australian geographer Spate believed that monsoonal winds result from the origin of cyclones. The cyclones originate by frontogenesis resulting from the meeting of different air masses. He held that the process of frontogenesis is very powerful in summer season. The fronts attract moist winds from oceanic areas. Contrarily, Spate held that these fronts happen to be weak and shallow in winter season.

4. Jet Stream Hypothesis

There are many geographical facts inherent in the hypothesis. In this hypothesis, monsoonal origin is ascribed more to the air circulation

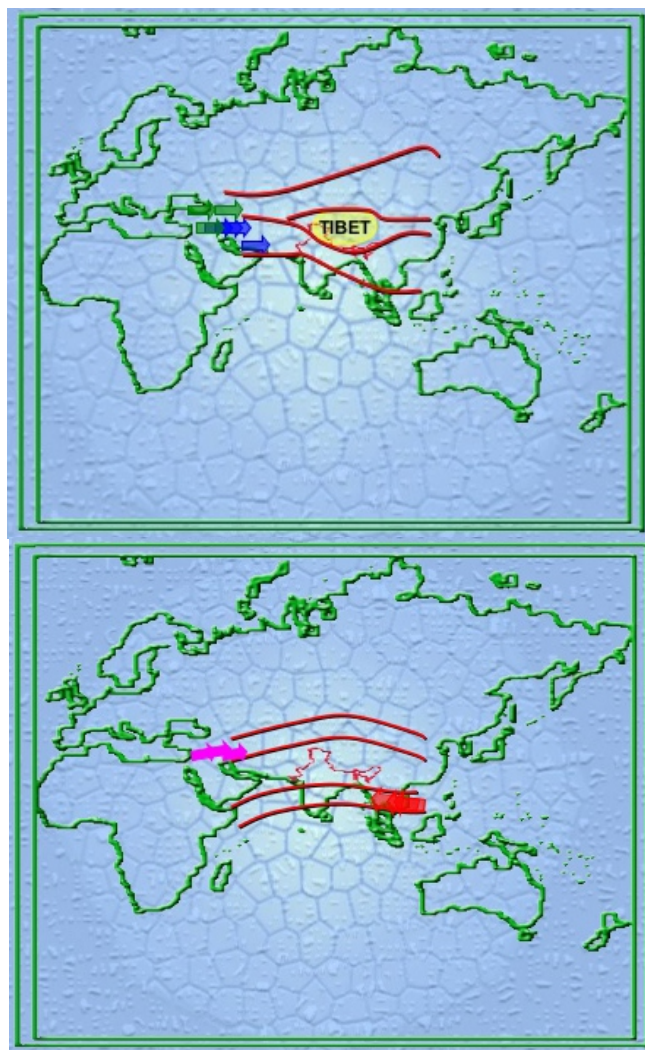


Fig.7.3 : Summer and Winter Jet Stream

prevalent in the **Troposphere** than only to the surface climatic conditions. Tropospheric air movement is also known as **Upper Air Circulation**. A fast speed air current, known as **Jet Stream**, exists in the upper air circulatory system. Jet stream is an important component of the upper air circulation prevailing over Himalayan and Tibetan region. Scientists such as Koteswaram, Pant, Ramamurthy, Ramaswami, Flohn, Hamilton etc. have assumed a strong relationship of Jet stream with the monsoons. Hamilton established the correlation between conditions of the entire troposphere and monsoons, while other scientists relate it with only the lower troposphere.

As a part of the upper air circulation, Jet Stream **blows from west to east**. Its track fluctuates with seasons. In summer season, its entire path is limited to the north of Tibet plateau (Fig. 7.3). With the shifting of pressure belts and winds belts southwards in winter season, the track of Jet Stream also shifts southwards. But due to the presence of plateau of Tibet, the Jet Stream is bifurcated. One branch blows north of Tibet plateau and the other branch blows south of it (Fig. 7.1).

In winter season, the sun shifts southwards and shines vertically over the Tropic of Capricorn. Resultantly, all the pressure belts and correspondingly all the wind belts shift southwards. The track of Jet Stream also shifts southwards in this season. Southwardly shifted track of Jet Stream is bifurcated due to the situation of Tibet plateau. Its northern branch blows to the north of the plateau. This branch is relatively feeble. Second branch blows south of Tibet plateau. The southerly track shifts between 20° to 25° north latitudes due to southward shifting of the wind belts in this season. Climatologists are of the view that this branch is responsible for the genesis of winter monsoons. This branch of Jet Stream also facilitates the arrival of the cyclonic disturbances from the north-west in Bharat in winters.

In summer season, the sun shifts northwards or it shines vertically over the Tropic of Cancer. Resultantly, all the pressure belts and correspondingly all the wind belts also shift northwards. Hence, the entire flow of Jet stream starts blowing to the north of Tibet plateau in a single path. The gap created by the northward shift of Jet Stream is filled by the winds blowing

northwards from Indian Ocean. This is the process of the genesis of summer monsoons.

5. El Nino - La Nina Hypothesis

Some climatologists have hypothesized that the **oceanic temperature condition near Peruvian coast in southern Pacific Ocean** is an important determinant factor in the genesis of Bhartiya monsoon. These scientists are of the view that ocean water temperature condition near Peruvian coast in southern Pacific Ocean **during Christmas** plays an important role. The situations arise when this temperature fluctuates between 2° to 4°C above or below the normal. The condition of **fluctuation above the normal** is known as **El Nino Effect**. Contrarily, temperature condition **below the normal** is known as **La Nina Effect**. Since these abnormal conditions occur around Christmas, these have been termed as **Children of Christ** by the climatologists.

It has been hypothesized that **El Nino conditions weaken the process of the genesis of Bhartiya monsoon**. Contrarily, **La Nina conditions strengthens the monsoonal genesis in Bharat**.

Mechanics of El Nino Effect - Pressure conditions are affected by the increase of temperature above the normal near Peruvian coast in southern Pacific Ocean. Pressure becomes lower than the normal due to rise in temperature. It has been assumed that it affects the global pressure system and the wind system. The **push factor** for the south-east trade winds weakens near Peruvian coast due to the pressure lowered below the normal. Instead, the pull factor (to attract the south-east trade winds) become effective. Resultantly, the flow of the south-east trade winds towards Asia also weakens. This, in turn, creates the probabilities of

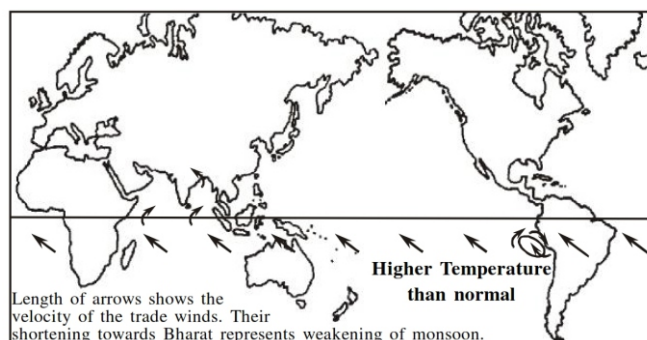


Fig.7.4 : Weak Monsoons During El Nino

delay or weakening of the summer monsoons in Bharat. The process has been explained in figure 7.4.

Mechanics of La Nina Effect - Pressure rises above the normal when the temperature decreases below the normal near Peruvian coast in southern Pacific Ocean. Resultant high pressure strengthens the **push factor**, so that the probabilities of early and/or powerful genesis of the summer monsoons increase. The process has been explained in figure 7.5

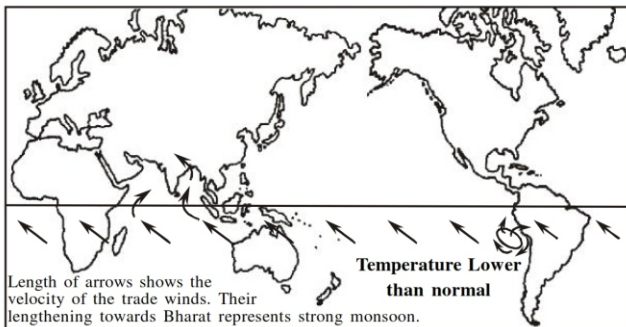


Fig.7.5 : Strong Monsoons During La Nina

Bharat is an agricultural country, hence monsoons carry special significance for us. Several types of uncertainties are inherent in the process of monsoons. Sometimes it sets-in too late and sometimes too early. Sometimes it weakens too soon and sometimes it remains effective for long. Sometimes it is very powerful and sometimes it remains very weak. The rainfall pattern of our country is affected by these uncertainties. It affects the agricultural production directly and the entire economy indirectly. Hence, Bhartiya economy is called as **gamble of monsoons**. Scientists are attempting to gain more and more knowledge about the genesis of monsoons. In the process of such attempts, many hypothesis have come forward from time to time, but no hypothesis is capable of providing unanimously acceptable explanation till now.

Important Points

1. The word monsoon owes its origin from Arabic word **mausim**.
2. Various hypothesis are prevalent about the origin of monsoons.
3. Classical hypothesis is based on the variable

thermal conditions developing on water-bodies and land.

4. Inter-tropical Convergence hypothesis was propounded by Flohn. He hypothesized that monsoons originate due to the convergence of the two trade winds.
5. Spate's hypothesis about the origin of monsoons is based on the frontogenesis due to the meeting of different air masses.
6. Many scientists hold the Jet Stream flow as the part of upper air circulation and deviations in its track responsible for the genesis of monsoons.
7. In the upper air circulation, Jet Stream blows from west to east.
8. The flow of Jet Stream remains totally confined to the north of Tibet plateau in summers. In winters, its track is bifurcated due to the presence of Tibet plateau when it shifts southwards. The two tracks spread north and south of the plateau.
9. The condition of temperature higher than the normal near Peruvian coast in south Pacific Ocean is known as El Nino and lower than the normal is known as La Nina. Since these conditions develop around Christmas, these are called as **Child of Christ**.
10. Late arrival and weak monsoons are imagined under El Nino effect.
11. Early arrival and strong monsoons are imagined under La Nina effect.

Exercise

Multiple Choice Questions

1. Jet Stream is the part of –
 (A) Various air-masses
 (B) Fronts
 (C) Cyclones
 (D) Upper air circulation
2. Traditional hypothesis about the origin of monsoons is –
 (A) Jet Stream hypothesis
 (B) Inter-tropical Convergence hypothesis
 (C) Classical hypothesis
 (D) El Nino - La Nina effect.

3. The scientist who propagated the origin of monsoons from frontogenesis is –
(A) Spate (B) Flohn
(C) Hamilton (D) Koteswaram.

Very Short Answer Type

4. Which of the winds combine to form inter-tropical convergence?
5. Jet Stream is the part of which circulation?
6. What is meant by Child of Christ?

Short Answer Type

7. What is formed by the meeting of various air-masses?
8. Why is Jet Stream bifurcated during winter season?
9. What is La Nina effect?

Essay Type

10. Explain in detail the Jet Stream hypothesis about the origin of monsoons.
11. Give a detailed explanation of the role of El-Nino and La Nina in the genesis of monsoons.

Skill

12. Draw labelled sketches to show the tracks of Jet Stream during different seasons.

Answer Key

1. (D), 2. (C), 3. (A).

Lesson - 8

Natural Vegetation of Bharat

Bharat is a large country with variations of temperature, rainfall, soils, topographical features, winds and the patterns of sunlight. Therefore, the presence of a variety of vegetation in Bharat is natural. The main types of forests found in Bharat are (Fig. 8.1) –

1. Evergreen Forests

These are found in the areas having an average rainfall exceeding 200 cms. and an annual average temperature of 24°C. There are three important areas of this category - (1) Western slopes of the Western Ghats (2) Andman-Nicobar Islands and (3) West Bengal, Assam, Meghalaya and Tarai regions of north-eastern Bharat. Rubber, Mahogany, Abony, Iron Wood, Mango, Palm etc. are the important trees in these forests. Bamboos and many kinds of creepers also grow in these areas. Variety of dense trees of different heights grow in these regions. Usually these trees attain the height of 30 to 45 metres. These trees have umbrella like canopy. In many of these forest areas, the growth is so dense that even sunlight cannot reach upto the ground.

The utilization of these forests is slow due to many reasons -

(1) The trees have hard wood.

(2) The trees are not gregarious. It means that in any region a large variety of trees are found. This renders the commercial exploitation of the forests difficult, because for lumbering of a particular variety of wood, one has to search it in a large area.

(3) Lumbering is difficult due to denseness of trees, creepers and small bushes.

(4) Means of transportation are not developed in these regions because of the density of forests and rugged topography of mountains. Hence, their economic use is very limited.

2. Deciduous or Monsoon Forests

In these forests, trees shed their leaves in dry season. These forests are found in the areas where rainfall averages between 100 to 200 cms. There are four main areas of these forests - (1) Lower slopes of the northern mountainous region (2) Vindhya and Satpura ranges, Chhota Nagpur plateau and the hills of Assam, (3) Southern section of Eastern Ghats and (4) Leeward eastern slopes of the Western Ghats. The trees in these forests are not as dense and as high compared with the trees of evergreen forests. These forests include Sal, Teak (Sagwan), Neem, Sandlewood, Rosewood (Sheesham), Abony, Mango, Bamboos, etc. Their wood is not very hard, therefore, these trees can be cut easily. Their wood is durable, therefore, it is used in making railway sleepers, boats & ships and furniture. There had been rapid exploitation of these forests due to developed means of transportation in their areas.

3. Dry Forests

These forests are found in the areas having rainfall average of 50 to 100 cms. annually. Forests of this category are mainly found in south-western Punjab, Haryana, eastern Rajasthan and in south-western Uttar Pradesh. The major trees of this forest are Bargad, Keekar, Babool, Neem, Mango, Mahua, Kareel, Khejra etc. These trees are characterised by having long roots. The trees are stunted because of

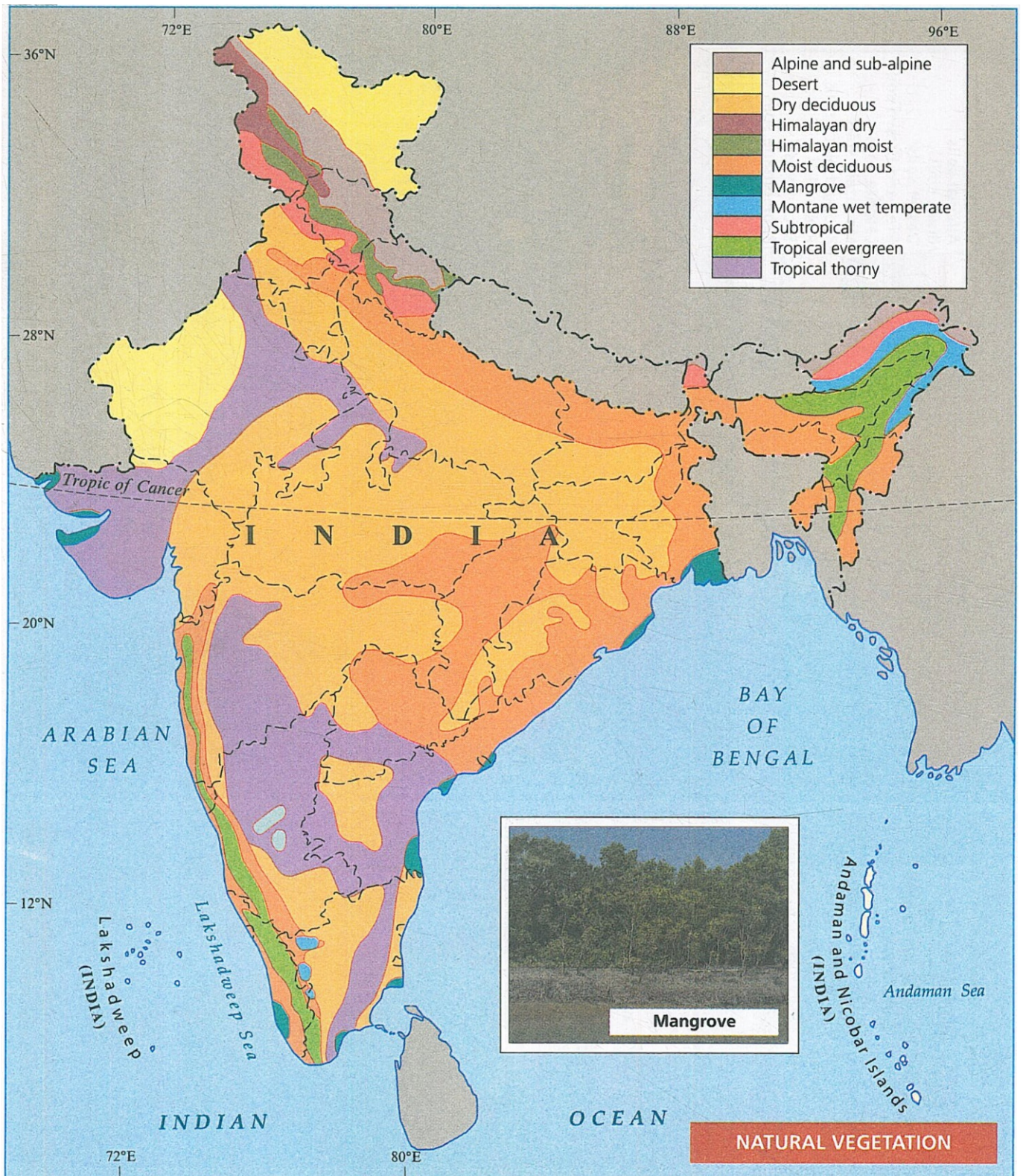


Fig.8.1 : India : Natural Vegetation

less rainfall. The trees have an average height ranging from 6 to 9 metres. These trees are locally very important.

4. Desert Forests

These forests are found in the areas where annual average of rainfall is less than 50 cms. These trees have small and thin leaves which are mostly thorny. These characteristics minimize the loss of water through evapotranspiration. The roots of these trees are long and thick which fetch the required quantity of water for the tree from huge areas. Babool is the most popular variety of this biome. Other trees of the region are Nagfani, Rambas, Khejra, Ker, Khajur etc. These are mostly found in south-western Punjab, western Rajasthan, Gujarat, Madhya Pradesh etc. The trees are locally important. Farmers use them for providing shade in their fields, for deriving nutrient leaves for feeding animals, for adding fertile humus content in the soil and controlling soil erosion.

5. Tidal Forests

These forests are found at the mouths of peninsular rivers like Mahanadi, Godavari, Krishna, Kaveri etc. and in the deltaic areas of Ganga-Brahmaputra where the oceanic water advanced into the land during tides and reaches upto the roots of these trees. These areas are characterised by mud and marshes. Sundri trees of Ganga-Brahmaputra delta and mangrove trees in Hugli delta are characteristic of this group. Other trees include palm, coconut, herotera, rizophora, sonerita etc. These trees have soft wood.

6. Mountain Forests

These forests are found at the height of 1500 metres above sea level in Mahabaleshwar of Maharashtra, Pachmarhi of Madhya Pradesh. These trees are 15-18 metres high. The trees have a thick stem supporting dense bushes beneath them. Dense and evergreen foliage is the characteristic of these forests. Creepers usually climb over these trees. Ugenia, Michenia and Rodendrons trees are found at higher elevations. These forests are also found in the western Himalayas and Assam hills in north Bharat at the height of 1800 metres to 2800 metres. The trees include pine, sanowar, devdar, spruce, birch, larch, elm, mapple and chestnut mainly.

Administrative Classification

Forest Department of the Government of India looks after the forests. Indian forests are

divided into three major categories for their proper management, control and security -

1. Reserved Forests - Cutting of wood and animal grazing are banned in these forests of great significance. These forests extend over about 5 lakh Sq.Kms. area in India. They are very important as controllers of floods, soil erosion and desert expansion.

2. Protected Forests - Only government licenced people can cut wood and graze their animals in these forests. These forests extend over about 3 lakh sq.Kms. area.

3. Unclassified Forests - There is no ban from the government for wood cutting and animal grazing in these forests. But the user has to pay tax for it. Usually, the work of wood cutting is given to contractors. These forests extend over 2 lakh sq.Kms. area.

New Classification

Now, a different administrative classification of forests have been adopted -

1. State Forests - Approximately 95% forests of Bharat are of this category. Their control, maintenance, development and security is totally in the hands of the government. Most of the forests of Bharat have now been included in this category in the light of the continuous reduction of forest areas.

2. Community Forests - In this category are included the forests over which municipal corporations, councils, municipalities, Zila Parishads etc. enjoy the control and bear the responsibility of their maintenance, development and security. Approximately 3% forests of Bharat are included in this category.

3. Individual Forests - Individually controlled forest areas are included in this category. Considering the need to expand forest area in Bharat, this new category has been introduced to encourage afforestation in individually owned areas. About 2% forests of Bharat belong to this group.

Forest Resources

Of all the valuable resources of India, forest resources occupy an important place. The resource has a major contribution in the economic progress and developmental projects of our country. Earlier Bharat had a vast stretch of forests. But in order to procure more agricultural land, additional

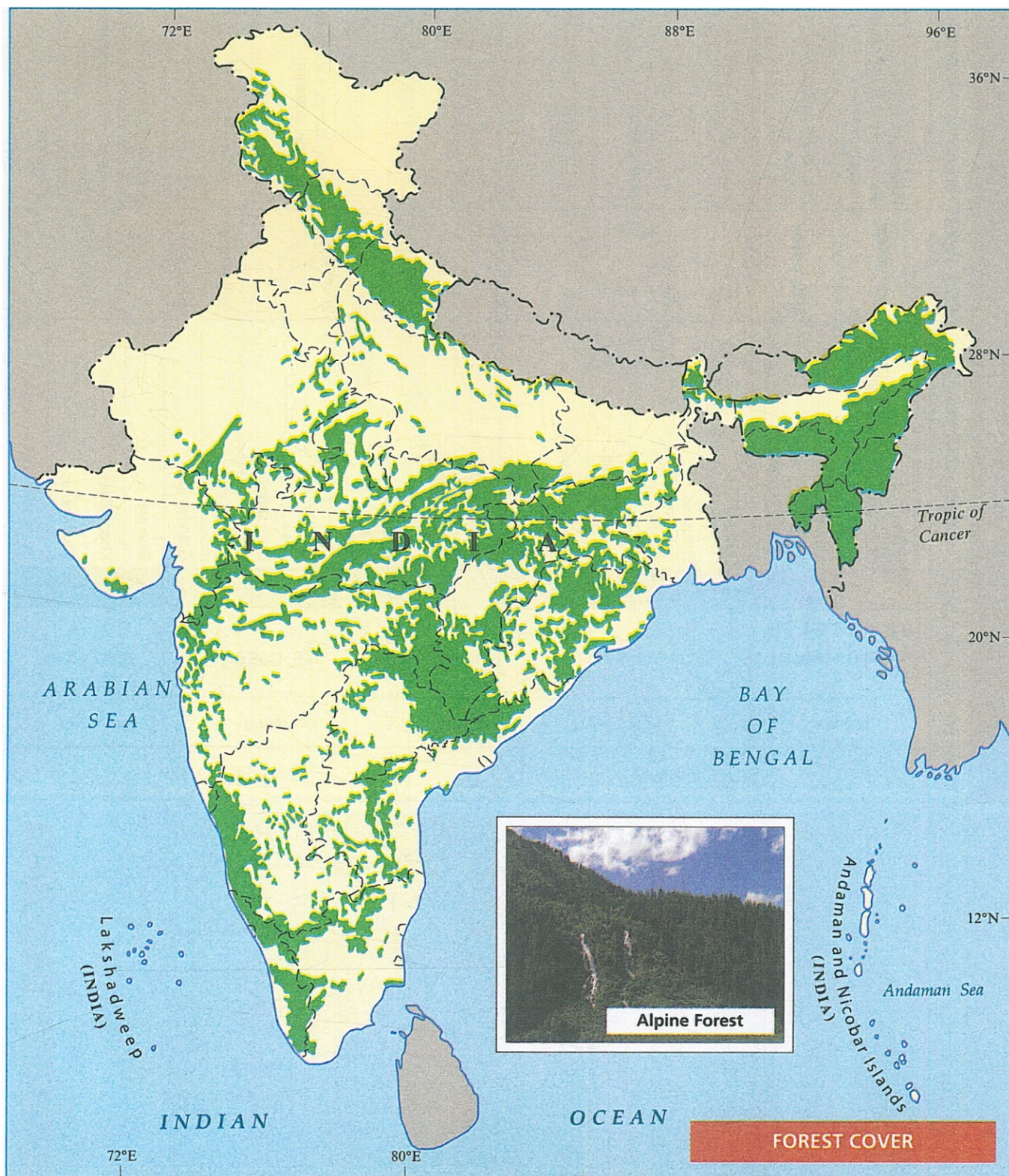


Fig. 8.2 : India : Forest Cover

requirements for settlement and rise in the demand for wood led to uncontrolled and illogical cutting of forests which led to their speedy shrinking. At present only 24.39% area of Bharat is covered under forest and tree cover: (2017, Forest Report). This area has to be increased to 33% as decided by the Government of India. Government has initiated social forestry plan to achieve this objective (Fig. 8.2).

Benefits of Forests

(A) Direct Benefits

1. Wood for agricultural implements, furnitures and buildings is obtained from forests.
2. Fodder for animals is available in forests.
3. Forests provide fuel wood.
4. Raw materials for paper, matches, sport goods, rubber and dye industries are obtained.
5. Forests are the sources of daily means of livelihood for many people. Wood cutting, wood sawing, boat, rope, van, cart making, gum, lac, fruits, vegetable-herbs, ral collection and transporting these materials to the market areas, are the activities which provide employment to many people.
6. Forests provide wood coal which is used as a source of power besides household fuel used in rural areas.
7. Forests provide many herbs for the preparation of useful medicines.
8. Forests are the source of silk through silk worm rearing particularly on Arandi and mulberry trees.
9. Government receives income from forests.

(B) Indirect Benefits

1. Forests keep the climate equable and humid.
2. Forests help in providing higher rainfall by attracting clouds towards them and helping in the condensation process.
3. Forests reduce the severity of storms and cyclones.
4. Forests reduce severity of floods.
5. Forests check soil erosion and desert expansion.
6. Soil fertility is increased by the mixture of tree leaves, the decay of which adds humus content.
7. Forests help in raising underground water

level by promoting seepage of water.

8. Forests, when burried in the sub-soil for a very long period, are converted into a valuable mineral like coal.

9. Forests provide shelter to wild life.

10. Forests provide hunting ground for entertainment.

11. Forests are symbol of natural beauty.

12. Forests help in maintaining biotic equilibrium.

13. Forests control environmental pollution.

14. Forests also help in controlling noise pollution.

15. Forests help in moderating green house effect which is increasing due to environmental pollution.

16. Forests have a special importance in Bhartiya culture. These are characterized as grounds sanctified by austerities, philosophical thinking and learning.

Environmental pollution is continuously increasing with the pace of industrial development in this modern era. The smoke emitted by the industrial chimneys, the large amount of smoke ejaculated by vehicles on roads, urban waste etc. are the major sources of environmental pollution. There has been a worldwide awakening for controlling the increasing environmental pollution. Natural vegetation helps in maintaining gaseous balance in the atmosphere. Afforestation programme undertaken in Bharat is also intended to control environmental pollution. It is our national and social duty to preserve this unique natural gift. Some selfish elements are destroying the valuable resource for their short term gains. We have to be cautious against these enemies of our society and help in the conservation of our valuable forest resources.

Forest Products

Indian forests are very important economically. Forest products can be divided into two groups - (A) main products and (B) secondary products.

(A) Main Products

Woods of Himalayan Region

1. Devdar - It is an evergreen needle leaved tree which attains an elevation of about 30 metres. It is mainly found in Kashmir, Punjab hills and

Garhwal region at the height of about 2500 metres. Wood of this tree is medium hard, yellow brown, durable and valuable. Its wood is used as building material as well as in making railway sleepers and bridges. The wood has a pleasant smell, therefore, a kind of fragrant oil is also extracted from it. These trees extend over an area of about 5,000 Sq.Kms.

2. Pine - This is also a needle leaved evergreen tree which is found at an elevation of 1000 to 2000 metres in the mountainous areas of Kashmir, Punjab, Uttar Pradesh and Uttaranchal. These trees usually grow to a height ranging from 18-30 metres. The tree cover spreads over an area of 8,000 Sq.Kms. The wood of this tree is light and therefore, it can float in water. Its wood is mostly used in making packing boxes, boats and cheap furniture. Turpentine oil is extracted from its wood.

3. White Sanowar - It is also a needle leaved evergreen tree which is mostly found in the western Himalayas over the height ranging from 2000-3000 metres above sea level. These trees can be as much as 50 metres high. Their wood is white, soft and durable. It is mainly used in preparing pulp for paper, matches, light boxes, packing boxes and floor boards.

Woods of Monsoonal Trees

1. Saal - It is a deciduous tree which is mostly found in the tarai area near the lower slopes of Himalayas and also extending in Uttaranchal, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar and Orissa. Its wood is hard and of brown colour. It is a durable wood which is mainly utilized in the preparation of railway coaches and sleepers, bridges and in buildings. These trees cover an area of about 1 lakh Sq.Kms.

2. Teak (Sagwan) - These trees cover an area of about 60,000 sq.kms. The trees of this durable wood are mostly found in southern Rajasthan, Madhya Pradesh, Chhattisgarh, Maharashtra, Kerala, Tamil Nadu and Orissa. Because of its durability, its woods is used in ships, railway coaches and for furniture.

3. Rosewood (Sheesham) - This wood is of dark brown colour and is very hard and solid. Its wood is used as building material, in furniture making and in railway wagons. These trees are mainly found in the drier areas of Uttaranchal, Uttar Pradesh, Punjab, Tamil Nadu and Andhra Pradesh. Some trees are also found in Madhya Pradesh,

Chhattisgarh, Assam and West Bengal.

Woods of Dry Forests

1. Acacia (Babool) - This tree is wide spread throughout India. There are atleast 20 varieties of this tree found in our country. The bark and gum of this tree is very useful. Its bark is used for colouring leather. Good quality of gum procured from this tree is edible. Other varieties of gum are used for various purposes. Many types of indigenous medicines are prepared from the roots, bark and gum of this tree.

2. Catechu (Kher) - This tree is also found in a large area of our country. It is usually 3-6 metres tall. Its wood is hard and cannot be destroyed by termites. Pillars in houses, indigenous oil crushers (Ghanies), ploughs and many other agricultural implements are prepared from this wood. This tree also provides catechu (kattha) and kuch. Catechu (kattha) is popularly used in beetles and in the preparation of many medicines. Kuch is used for dyeing-printing purposes.

(B) Secondary Products

1. Lac - India enjoys monopoly in the production of lac. An insect named **lecifer lacca** sucks juice of the soft branches of the trees of palash, kusum, bargad, kher, ghont, pipal, gular etc. This insect continuously ejaculate sticky material which is known as lac. Lac is mainly collected in Gujarat, Madhya Pradesh, Chhattisgarh, Orissa, Uttar Pradesh, Jharkhand, Bihar, Meghalaya and West Bengal. Lac is a bad conductor of electricity. It is used in the making of gramophone records, polish, toys, tubes of radio and televisions etc. About 90% of the production of lac in Bharat is exported to the United States of America, Russia, Germany, Britain, Australia etc.

2. Materials for dyeing leather - These materials are obtained from barks, leaves and fruits of many trees. The trees producing such materials are harad, baheda, amla, tarwood, mangrow, kuch, gambier etc.

3. Gum - The sticky material (Raal) ejaculated from the bark of neem, peepal, khejra, keekar, babool trees etc. is refined into various qualities of gum which is used for eating as well as for sticking. Many other varieties of gums, from which indigenous medicines are prepared, are also procured from the trees.

4. Grasses - Many types of grasses are found in forested areas. Famous products in this

category are khaskhas grass, rosha grass, agni grass, moonj and elephant (Hathi) grass.

Besides these products, forests also provide rubber, fruits, honey, wax, herbs etc. Bharat earns about rupees 600 crores annually from these secondary products of forests.

Causes of the Backwardness of Forestry

1. Forest area in Bharat is very limited. It is only 0.2 hectare per person in our country.
2. Forested area is unequally distributed.
3. Lumbering is done by old and traditional methods.
4. Most of the trees are not gregarious hence their economic importance is considerably reduced.
5. Most of the forest cover is found on higher elevations where their cutting is not easy.
6. There is a lack of means of transportation in forested areas.
7. There is a lack of coordination among different departments responsible for the conservation and protection of forests. Therefore, afforestation as well as the protection of existing forests cannot be done effectively.

8. There is an absence of scientific researches about forest management and the utilization of forest products.

Suggestions for the development of forests

1. Illegal and illogical cutting of forest should be strictly banned.
2. Minimum area under forest cover should be determined in each region.
3. Reserved forests should be well managed.
4. Means of transportation should be developed in forest areas.
5. More attention is required towards the commercial aspects of forestry. This will not only increase income of the government but will help in generating employment opportunities in the country.
6. Forest research should be accelerated.
7. Public awareness programmes should be started for highlighting use and importance of forests.
8. A better coordination must be managed among different government and non-government departments for the conservation and protection of forests.

Development of Forests in India

According to Forest Report, 2015, the total forest cover is 7,08,273 sq. Km, which is 22.02 of the geographical area of the country. The percentage of forested land in India is too small as compared to other countries. The forested area has been planned to be increased to 33% under the forest policy of 1952 as declared by the Government of India. Of this projected forest cover, about 60% has been planned to be developed in hilly areas and the rest in the plains.

Afforestation of fast growing trees along the roads and railways and at other places with a view to control floods and expansion of desert is being done under five year plans. Illegal forest cutting has been banned. Forest education and researches are also being promoted.

Important Points

1. Forests have cultural importance in Bharat; different types of forests are found in Bharat due to geographical diversities.
2. Types of forests - evergreen, deciduous or monsoonal, dry, desert, tidal and mountain forests.
3. Administrative classification - reserved, protected and unclassified forests; new basis - state, community and individual forests.
4. Many direct and indirect advantages of forests.
5. Forest products - main products (devdar, pine, white sanowar, sal, teak, rosewood, acacia, catechu, kuch etc.), secondary products (lac, materials for dyeing leather, gum, grasses, mahua, tung, bamboos, canes, rubber, fruits, honey, wax, herbs etc.).
6. Many factors responsible for the backwardness of forestry, measures for its development are necessary; many efforts are being made for forest development in Bharat.

Exercise

Multiple Choice Questions

1. The state in which Teak (Sagwan) trees are not found, is -
(A) Jammu-Kashmir (B) Rajasthan

(C) Madhya Pradesh. (D) Chhattisgarh.

2. The forest found in the areas of less than 50 cms. rainfall is-
(A) Dry (B) Desert
(C) Monsoon (D) Evergreen.
3. The group of trees belonging to mountain forest is -
(A) Pine, Devdar, Larch
(B) Mango, Bamboo, Acacia
(C) Acacia, Peepal, Pine
(D) Coconut, Rosewood, Devdar

Very Short Answer Type

4. In which type of forests Mangrove trees are found?
5. Which agency controls community forests?
6. How much percentage of land has been planned to be forested by the Government of India?

Short Answer Type

7. What are state forests?
8. Where are dry forests found?
9. Which type of trees are included in monsoon forests?

Essay Type

10. Write an essay on the forest products of Bharat.
11. Write an essay on the distributional pattern of forests in Bharat.

Skill

12. Show the areas of dry forests in an outline map of Bharat.
13. Show the areas of tidal forests in an outline map of Bharat.

Answer Key

1. (A), 2. (B), 3. (A)

Lesson - 9

Soils of Bharat

Soil plays a major role in the economic life of a country. It is still more important in a country like Bharat which has agricultural base and where more than 70 per cent of its population depends upon agriculture as the means of their livelihood. Soil is that layer of land surface which is *made up of the disintegrated materials of rocks and decomposed matter of vegetation and fossils*. Soil has the capacity to grow various types of trees and plants. Soil formation and characteristics depend upon the rocks, climate and the vegetation of a region.

Depending upon the process of formation, soil is of two types - *Local and Transported*. Due to the effect of weathering process the rock debris stay in its own areas or their movement is insignificant, then of rock disintegration leads to the formation of the soils known as *local soils*. Most of the Deccan plateau is covered by the soils of this type. Such soils bear the characteristics of their parental rocks. Consequently, the soils formed by the disintegration of the local crystalline metamorphosed rocks are stony, rough structured, red coloured and infertile. Disintegration of lava rocks leads to the formation of black soil which is very fertile.

Rivers, glaciers, winds etc. are the major agents of denudation which not only disintegrate the rocks to convert them into soils but also transport them to long distances. Hence, these soils are

deposited by the agents of denudation in the areas far away from their source region. These are known as *transported soils*. The soils of the great plains and the coastal plains of Bharat are of this category. These soils are very fertile.

Due to the vast expansion of our country, topographical, climatic and vegetational variations, it is natural that a variety of soils are found in Bharat. The economic significance of soils lie in their utility of supporting crops. Ploughing, irrigation, choice of the appropriate crops, methods of cultivation etc are important aspects of raising crops. These aspects mostly depend upon the type of soil. On the basis of formation and their characteristics, Bhartiya soils are classified into the following categories (Fig. 9.1)

1. Alluvial Soil

Great plains of Bharat and the coastal plains are made by thick deposits of alluvium. It has been deposited by various rivers. This type of soil covers about 8 lakh square kilometers area in Bharat. According to geographical conditions the soil can be sub-divided into three categories -

(a) Older Alluvium - It is found in the areas where flood water of rivers cannot reach. Such areas are known as *Bangar* in Bharat. Bangar areas are very fertile and are subjected to the intensive cultivation growing two crops in a year. These soils require irrigation.

(b) Newer Alluvium - This type of soil is

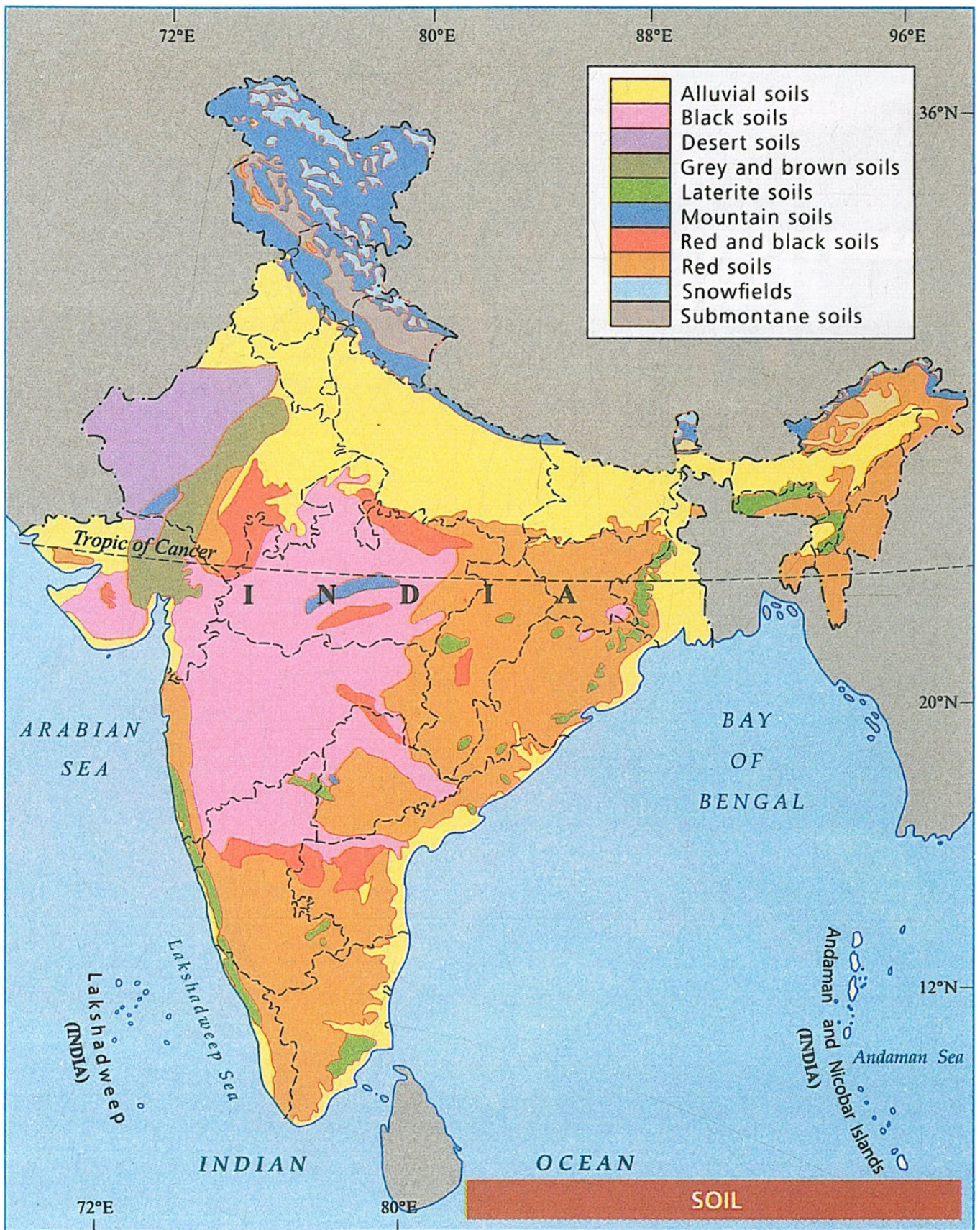


Fig. 9.1 : Soils of India

found to the extent upto which the flood water of rivers can reach. It is designated as **newer** because a new or a fresh layer of soil is deposited in such areas every year by flooding. Such areas are known as **Khadar** in Bharat. The soils of khadar have a larger clay content. It does not require irrigation.

(c) Newest Alluvium - It is found in Ganga-Brahmaputra Delta. It is highly rich in calcium, magnesium, potash, phosphorus and humus due to which it is a very fertile soil for cultivation. This type of soil is also found in some of the coastal plains of Bharat.

Characteristics of Alluvial Soils

1. Such soils are found in level plains which have tremendous facilities for the construction of canals, digging wells and performing various agricultural activities.

2. These soils can retain moisture for a longer time.

3. These are fine textured friable soils in which it is easy to grow crops. Plants can also procure their food easily from such soils.

4. Such soils are rich in humus content because vegetative materials fall into river water and ultimately degenerate and decomposed to form humus.

5. Such soils are naturally rejuvenated every year by flooding. Therefore, these soils don't require manures or fertilizers.

6. These are transported soils which are very fertile.

2. Black or Lava Soil

Black soil is found in lava regions of Bharat covering Maharashtra, western Madhya Pradesh, western Andhra Pradesh, northern Karnataka, Gujarat and south-eastern Rajasthan. This soil covers an area of about 5 lakh square kilometers in Bharat. It possesses a unique quality of moisture retention. It appears similar to the black soil of Prairie region of north America and to the Chernozem of Russia but black soil of Bharat is structurally different from them. In those regions, the soil is black because of its richness in humus and fossil content. But the black soil of Bharat owes its colour to the disintegrated lava deposits. It is rich in iron and aluminium contents. It also contains potash

and calcium. It is very fertile soil and is highly suitable for growing cotton. That is why this soil is also popularly known as **Black Cotton Soil**. Black soil of Bharat is also named **Regur soil**. It needs little irrigation and the requirement for fertilizers is also limited. It becomes hard when it is dry and its surface is marked by several cracks. It is almost 7 metres thick in the valleys of Narmada, Tapi, Godawari and Krishna rivers. Besides cotton, groundnut and sugarcane cultivation has also been introduced in the black soil regions. Introduction of irrigation facilities in the region has led to an unexpected rise in agricultural production.

3. Red Soil

It is a rough textured soil and is highly porous. It lacks moisture retaining capacity. Therefore, it requires irrigational facilities. It is not a fertile soil. Use of fertilizers and manures compensate lower fertility of this soil. Its colour is brown and red because it is rich in iron content. It lacks nitrogen, phosphorous and humus content. Calcium content is also less. It is found in a thin layer. Its thickness is higher only in river valleys. This type of soil is found in Chhatisgarh, Chhota Nagpur, Orissa, eastern Andhra Pradesh, Tamil Nadu and Karnataka.

4. Laterite Soil

Its colour is red like that of a brick. It consists of granules of large size. It is usually formed by disintegration of old rocks rich in iron and aluminium content. It lacks calcium, phosphorus, nitrogen, potash and fossils. This soil is found in hot and humid regions. Rain water washes away silica, chemical salts and fertile ions of soil. It becomes hard like a rock when it is dry. This type of soil is found in the Western Ghat region, in eastern ghat region from Rajmahal hills to Assam, extending in a continuous narrow belt through west Bengal. This soil is suitable for growing tea. It supports thin cover of hard wood trees which provide building wood.

5. Sandy Soil

It extends over western Rajasthan, Saurashtra and Rann of Kutch. Alkaline content is higher in this type of soil while nitrogen and humus

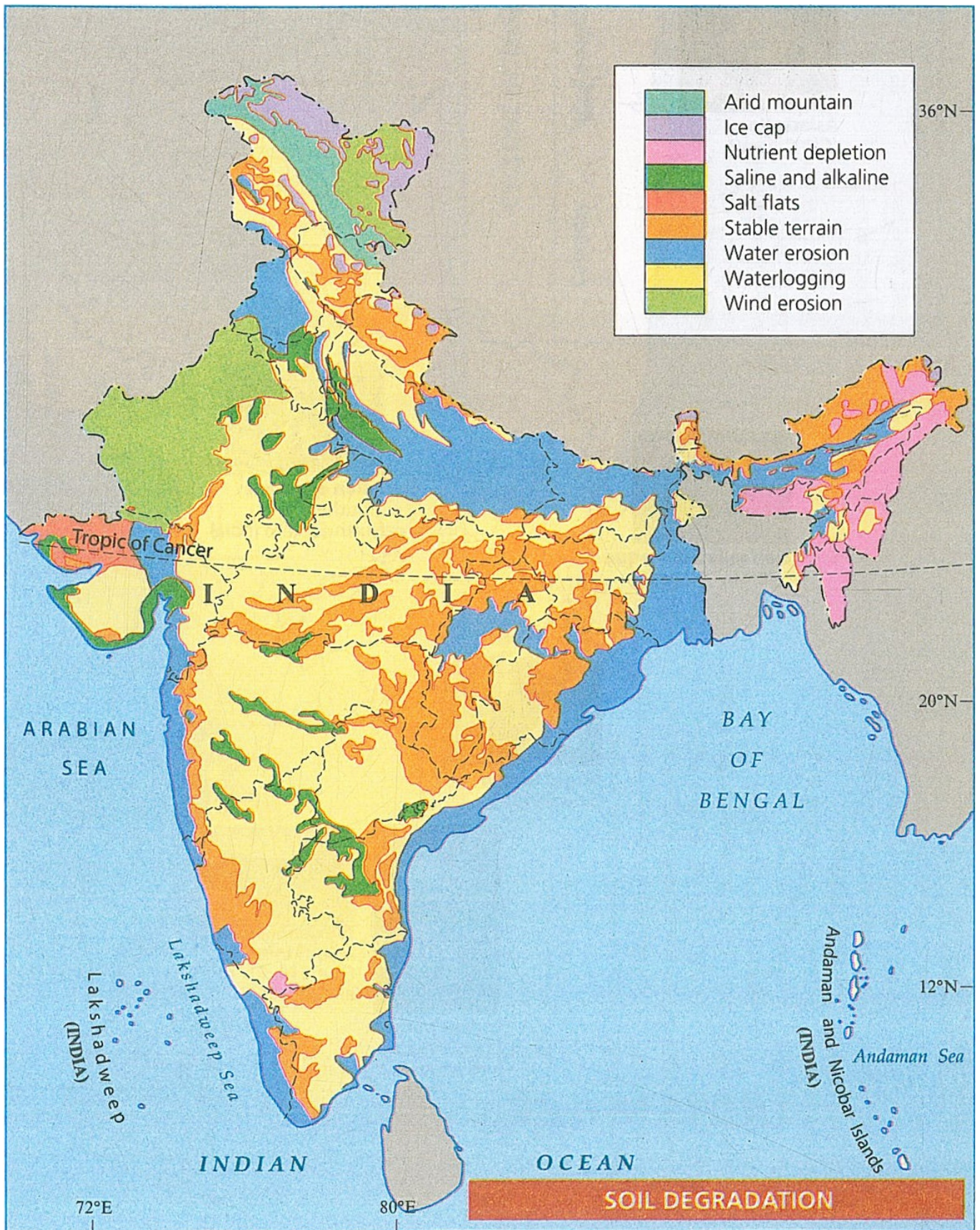


Fig. 9.2 : Soil Degradation in India

content is lower. It can easily be transported by winds because it is dry and porous soil. This soil proves to be very fertile when irrigation facilities are made available to it. Agricultural prosperity of Hanumangarh, Ganganagar and Bikaner districts prove this fact. Work on Indira Gandhi Canal is progressing very fast. It has reached ahead of Mohangarh near Jaisalmer. When completed, it is expected that the desert will become green and agriculturally prosperous.

6. Mountain Soil

It is found in Himalayan mountain region. It is a rough textured soil consisting of stones and pebbles and hence it is known as immature soil. This soil is found in a thin layer. This soil lacks humus and calcium. It is acidic soil. Where the layer of this soil is thicker, tea and potato cultivation is done. In the areas where the granular structure is fine, terraced farming is done to raise rice crop. Pastures are found on the slopes with less fertile soils.

Soil Problems & Conservation

Problems

Of a variety of soil problems, **soil erosion** is a major one. Agricultural land becomes infertile due to soil erosion. Soil erosion refers to an act of movement of soil to distant places. It is mainly done by running water and winds. It is a major problem in many parts of Bharat. According to an estimate, about $\frac{1}{4}$ of the area of our country is under the aggression of soil erosion. Rajasthan, Haryana, Uttaranchal, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Jharkhand and Bihar suffer from the serious problem of soil erosion. The problem is also acute in Yamuna, Chambal, Damodar and Mahanadi river valleys. In these regions soil erosion of both types - **sheet erosion** and **gully erosion** are common. Deep ravines have been created by the gully erosion of Yamuna and Chambal (Fig. 9.2).

There are many reasons of soil erosion in Bharat - (1) Bharat receives torrential monsoonal rains which erode soils fastly. (2) Heavy monsoonal rains cause flooding due to which soil layers become loose. (3) There have been deforestation on the mountain slopes so that the nude slopes bear the blunt of soil erosion by rain water and winds. (4) Animal grazing is practiced unsystematically or the

pastures of hill slopes have been converted into farms. (5) Farms are left uncultivated during summers. Hence, summer winds drift away surface soil layer fastly and easily.

Conservation

Soil conservation is extremely necessary. Special measures are required to be taken to control the problem of soil erosion. These measures should be based on the principle that the velocity of running water should be reduced and soils should not become loose. Several steps can be taken to control soil erosion - (1) Afforestation, (2) bunding and barricading of the channels, (3) development of terraced farming on mountain slopes, (4) bunding of farms, (5) proper management of animal grazing, (6) contour ploughing on the slopes of the hills and (7) Damming of rivers. Many important projects have been undertaken in Bharat. Government has also opened research centres in Dehradun, Kota, Jodhpur, Bellari and Utakmand for controlling soil erosion. Trees have been planted to check the expansion of deserts. Pastures have been developed, Babool and Aak plantation has been done by spreading seeds through aeroplanes in order to check sand drift in Rajasthan. Forest festivals (Van Mahotsav) and multipurpose projects have been taken up in hand to solve this problem. But the most important effort in this direction can be the awareness and cooperation of the farmers.

Second major problem related to soil is the depletion of fertility. It means that crop production is decreasing due to depletion of fertility. It happens when we deprive soils of fertile elements by procuring higher yields and no effort is being made to recover soil fertility by natural or artificial methods. In order to face the problem of the depletion of soil fertility, animal dung compost and the chemical fertilizers should be used. Crop rotation and the use of green manures can also check the loss of soil fertility. Natural way of replenishing the soil fertility is to leave the land fallow for sometime.

Important Points

1. Soils are formed by the disintegration of rocks and the decomposition of vegetation and

fossils. It is an important resource for an agricultural country like Bharat.

2. Alluvial soil - It is a transported fertile soil, old, new and newer type.
3. Black soil - fertile, regur soil, suitable for growing cotton, groundnuts, sugarcane etc.
4. Red soil - Rough textured, greater need for irrigation, less fertile.
5. Laterite soil - leached and without humus, less fertile, suitable for growing tea and coffee.
6. Sandy soil - found in dry areas, become fertile when water is made available.
7. Mountain soil - Immature, rough textured, suitable for pastures and rice cultivation on terraced slopes.
8. Soil problems - Soil erosion, depletion of soil fertility, soil pollution; various factors responsible for it; measures to control soil problems are necessary in an agricultural country like Bharat.

Exercise

Multiple Choice Questions

1. Local soils in Bharat are -
(A) Mountain (B) Sand
(C) Transported (D) Black.
2. The best suitable soil for growing cotton in Bharat is -
(A) Mountain (B) Black
(C) Red (D) Laterite.
3. Black soil in Bharat is -
(A) Transported (B) Marshy
(C) Made from Lava (D) Leached.

Very Short Answer Type

4. What is the colour of laterite soil?
5. Where is old alluvium found in Bharat?
6. How does leaching occur?

Short Answer Type

7. What is meant by soil conservation?
8. Which type of soil is rejuvenated naturally?
9. What is meant by soil erosion?

Essay Type

10. Explain the soil formation process and describe

various types of Bhartiya soils in detail.

Skill

11. Mark Red and sandy soil regions in an outline map of Bharat.
12. Mark black and mountain soil regions in an outline map of Bharat.

Answer Key

1. (A), 2. (B), 3. (C)

Lesson - 10

Natural Disasters and Management (Earthquakes and Landslides)

Natural Disasters

Change is a continuous process. Changes also occur continuously in nature. The changes which benefit the mankind are called as nature's boon. But the changes which play havoc in society are termed as natural disasters. For example, when it rains at suitable time and as per requirements of man, it is called a boon. When it rains heavily, it becomes a natural disaster in the form of flood. It is also known as excessive rain. When it rains scantily, it is a disaster in the form of a drought. The natural changes which have a negative effect on society, are termed as natural disasters.

Natural Disasters and Problems

There is a slight difference between natural disaster and problem. Natural disaster is a change which occur in nature within a short period of time. The adversities faced by the society as a consequence of the disasters are termed as problems.

In French language, **Dis** means bad and **Aster** denotes stars. Hence, the term disaster means bad or unfavourable stars. Natural disasters are also termed as natural hazards. In Bharat, it is perceived as wrath of nature. Natural hazards create several problematic and adverse situations. In ancient times, the natural disasters were considered as the punishment given by nature for disturbing it.

Causes of Natural Disasters

It is very difficult to determine the cause of natural disasters. As a matter of fact, combined

effect of several factors causes natural disasters. Indogenetic and exogenetic forces of the earth directly affect some of the natural disasters like earthquake and volcanoes. Man has continued illogical exploitation of natural resources. Land use pattern has been disturbed in order to fulfil the needs of increasing population. The resultant problems like deforestation, land degradation and water scarcity have created environmental imbalance. It is contributing to the problem of global warming, which ultimately causing natural hazards like excessive rains and droughts. Natural disasters like landslides and sea-storms have increasing incidences in Bharat also. Man's attitude of consumerism and blind pursuit of development is disrupting natural equilibrium. These activities of man are inviting natural disasters indirectly.

Classification of Natural Disasters

Natural disasters can be classified under the following heads on the basis of their origin –

1. Seasonal disasters – Those natural disasters are included in this category which occur due to seasonal changes, e.g. cyclones, excessive rains, drought and snowfall.

2. Geomorphological disasters – In this category, are included those natural hazards which take place due to sudden changes in landforms e.g. landslides, snowdrift, earthquakes and volcanoes. There are no active volcanoes in Bharat.

3. Biotic disasters – In this category, such natural disasters are included which are caused by

creatures and bacteria, e.g. attack by swarm of locust, epidemics, dead animals, plague, malaria etc.

Natural Disasters and Management

Management is a work which is undertaken to solve the problem of disasters and calamities. The country and society has to share the responsibility honestly to face the hours of difficulties. Management means to perform time bound relief operations at every level in accordance with the assigned responsibilities. The character of a nation and society is seen in the performance of humanitarian services rendered by people after the occurrence of natural disasters. The following factors affect management process –

1. Economic conditions
2. Man's positive thinking
3. Feeling of cooperation
4. Social honesty and integrity
5. Geographical conditions
6. The status of means of transportation and communication.
7. Density of population.

Earthquake

An earthquake is a vibration in any part of the earth caused by any phenomena occurring in the interior of the earth. In simple terms, vibration or tremor of any part of the earth is called earthquake. It is very damaging among natural disasters. It causes devastating changes in a few moments. It seems as if the earth is shaking or oscillating with the movement of earthquake waves.

The intensity of earthquake is measured by seismograph. It continuously records the earthquake waves. These waves are measured on Richter Scale. This was devised by Charles Richter, so that this scale is known by his name. Its intensity is measured between 1 to 12 on Richter Scale. When the intensity of earthquake waves is upto 5, it is termed as normal earthquake. As the intensity increases, the earthquake takes a very destructive form.

Causes of Earthquakes

Earthquakes are mainly caused due to the tectonic movements. Movement of plates causes tectonic upheavals. Its latest example is the earthquake which occurred on 26th December, 2004 in South-East Asia when the Indian plate drifted towards the north. Earthquakes are also caused during the continuous process of isostatic equilibrium on the earth. Folds and faults occur on the earth's surface during the process. The continuous release of heat from the earth causes its contraction. Although it is a long term process, but this contraction also causes earthquake. Irrational exploitation of minerals and construction of dams in the weaker zones of the earth's surface are such human acts which cause earthquakes.

Earthquake Prone Areas

Delimitation of earthquake prone areas in Bharat was treated to be very simple. But Latur earthquake of 30th September, 1993 demanded reconsideration of the delimitation. By reviewing the table of main earthquakes occurred in India, it becomes obvious that the maximum earthquakes have occurred in northern mountain region and its foothills (Table 13.1). Himalayas are newly folded mountains which are still in the stage of upliftment. The state of isostatic equilibrium is not yet attained in the Himalayan region, hence earthquakes occur frequently. In the northern plain region, the earthquakes of moderate intensity occur and their number of occurrence is also very small. Previously the Peninsular Plateau was considered to be a stable landmass, but after the Koyna and Latur earthquakes, this region is also considered to be earthquake prone. The continuous movement or drifting of the Indian plate towards north also causes earthquakes in this region. Based on the study of 1200 earthquakes occurred in Bharat, it has been divided into three earthquake zones. These have been shown in Fig. 10.1.

Earthquake - An Adversity

Earthquake is such a natural adversity that heart-shaking scenes are created within a few moments. It may cause loss of thousands of lives, buildings collapse and turn into heap of earth, the means of transportation are disrupted, bridges,

Table - 10.1
Major Earthquakes in India

Sr. No. ▼	Place	Deaths	Date, Time, and Year	Magnitude	Epicenter
1	Indian Ocean	> 283,106	08:50, December 26, 2004	9.1–9.3	West coast of Sumatra, Indonesia
2	Kashmir	130,000	08:50:38, October 8, 2005	7.6	Muzaffarabad, Pakistan-administered Kashmir
3	Bihar and Nepal	> 30,000	14 :13, January 15, 1934	8.7	South of Mount Everest
4	Gujarat	20,000	08:50:00, January 26, 2001	7.7	Kutch, Gujarat
5	Kangra	> 20,000	06:10, April 4, 1905	7.8	Himalayas
6	Latur	> 9,748	22:25, September 30, 1993	6.4	Killari, Latur
7	Assam	1,526	19:39, August 15, 1950	8.6	Rima, Tibet
8	Assam	1,500	17 :11, June 12, 1897	8.1	Exact location not known
9	Uttarkashi	>1,000	Unknown time, October 20, 1991	6.8	Garhwal, Uttarakhand
10	Koynanagar	180	04:21, December 11, 1967	6.5	Koyna

Source : Geological Survey of India.

dams and canals are damaged, faults are formed on the earth's surface, rivers change their courses due to landslides and lakes are also formed at many places. These changes increase the probabilities of flooding in future.

Nearly 3 lakh people died in the earthquake of 11th October, 1937 in Kolkata. Thousands of people died and rendered homeless due to landslides in the Kashmir caused by earthquake on 30th May, 1985. Morvi town was destroyed on 11th December, 1967 due to the earthquake which damaged Koyna dam. The Tsunami waves caused by an earthquake near Java in South-Eastern Asia on 26th December, 2004, took lives of about 5000 persons in the coastal regions of Bharat, situated thousands of kilometres away from the Tsunami

source area.

Relief Operations and Management

1. At Government and Social level – All governments provide relief and help immediately to overcome the problem arising out of natural disasters. In a country like Bharat, where the density of population is very high, such disasters cause heavy loss of human life and such probabilities always remain. Hence it is essential to install a network of seismographic centres in the country in order to enable to know about the tectonic movements of the earth's interior, so that people of the risk area may be timely alarmed through communication and media.

2. At individual level – When a person suspects the occurrence of earthquake, certain decisions should be taken immediately, e.g. ask everyone to vacate the house and go out in open space, and if it is not possible to go out one should stand on the door. Electric and gas supply should be switched off. Pets should be freed. If travelling by transport, vehicles should be stopped and the passengers should come out in the open. These steps are possible because prior to the occurrence of an earthquake of high magnitude, a few mild tremors are experienced. The mild tremors give an indication of a probable severe earthquake.

During such an emergency, people should be united. Physical, emotional and financial assistance should be extended on humanitarian grounds without any caste, creed or communal bias. Human bonds get stronger by such assistance. Whenever such critical situations have arisen in Bharat, the citizens, voluntary organizations, institutions and students have presented unique example of extending assistance to the victims.

Landslides

Creeping, sliding and falling of soil and rocks downslope is termed as landslide. If landslide occurs on a large scale, the rumbling sound starts in the beginning and gradually it increases with the falling of rock materials.

Causes of Landslides

A single cause cannot be attributed for landslide. As a matter of fact, several factors together give rise to disastrous landslides. The factors responsible for landslides can be classified

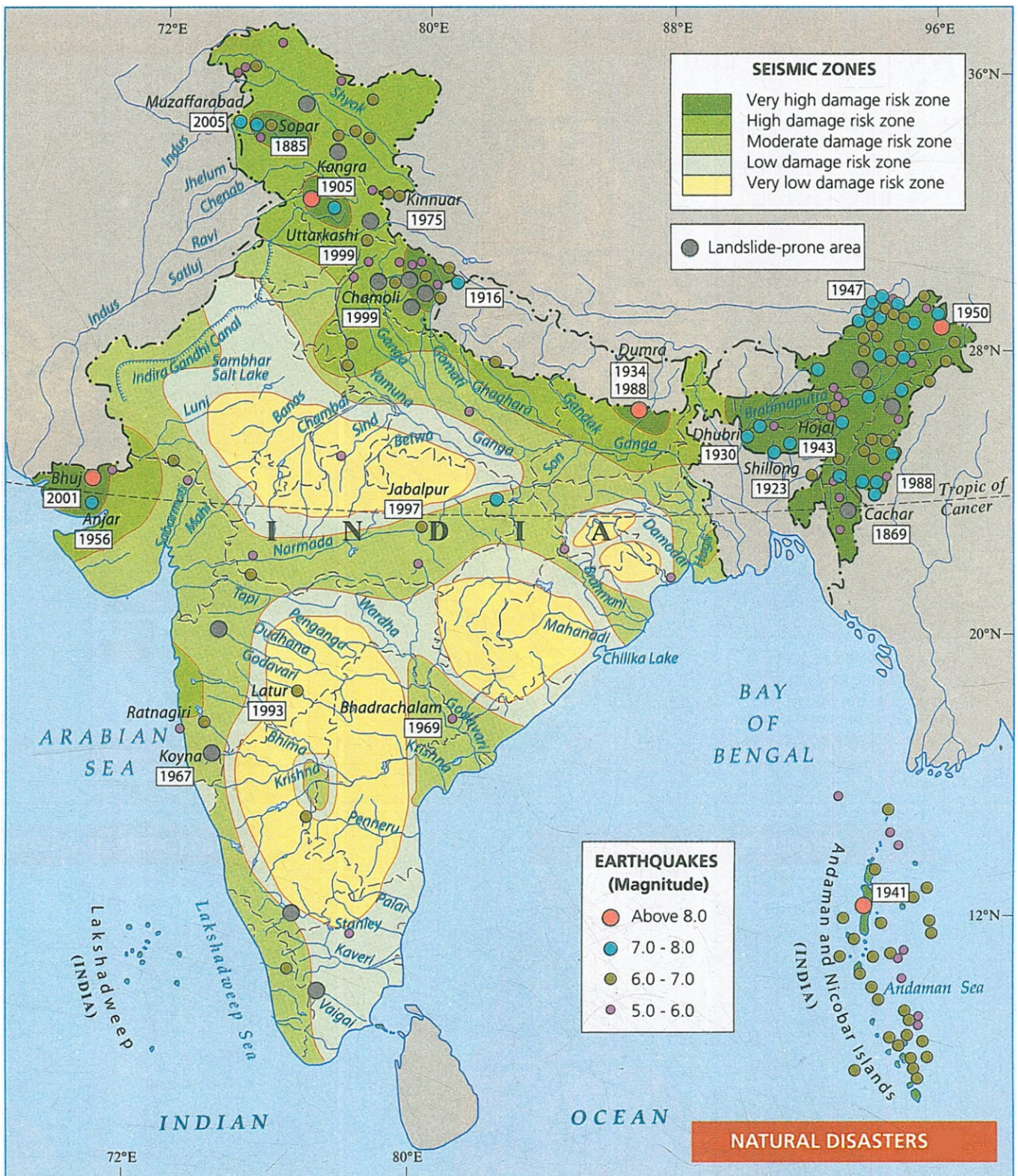


Fig.10.1 : India : Natural Disasters (Earthquake)

under two groups –

1. Natural Factors – Rock structure, gradient, folds and faults in rocks, amount of rainfall, vegetative cover are the main factors responsible for landslides. Incidence of landslides are frequent in folded mountain regions because continuous process of upliftment there weakens rock joints and the gradient is also steep. In such a situation, heavy rains act as additional powerful factor causing landslides. The rocks begin to slide down from weak joints with heavy flow of rain water. Gravitational force also enhances the process of landslides. Where the slope is steep, the force of gravity increases. Landslides are frequent where the gradient is more than 45° . This is experienced in the Western Ghats on Konkan railway route. Erosional capacity of rivers is higher in mountainous region. Lateral erosion causes landslides from higher slopes.

2. Human Factors – Man has increased the possibility of natural disasters like landslides by his endeavours for uncontrolled development. There has been speedy deforestation for obtaining raw material for pulp and paper, and timber. Due to speedy deforestation, tree roots loosen their grip over soils and rocks, so that soil erosion is enhanced. Continued soil erosion finally increases landslides. Man has also encouraged landslides by the construction of roads, railway tracks, tunnels and uncontrolled mining. Construction of transport routes in mountainous areas, require cutting of trees and removal of soils in huge quantity. The process increases possibilities of landslides.

Landslide Prone Areas

In Bharat, landslides are more frequent in the Himalayan region. Next in frequency comes western Ghats region. In these areas, landslides are more frequent where rivers flow. In the north-east Bharat and Jammu and Kashmir where new roads have been constructed, landslides are more frequent. Landslides also occur due to erosion by waves along the seacoast. This can be seen on the Konkan coast. The landslide prone areas in Bharat have been shown in Fig. 10.2.

Landslide - A Distress

Although not as damaging as an earthquake,

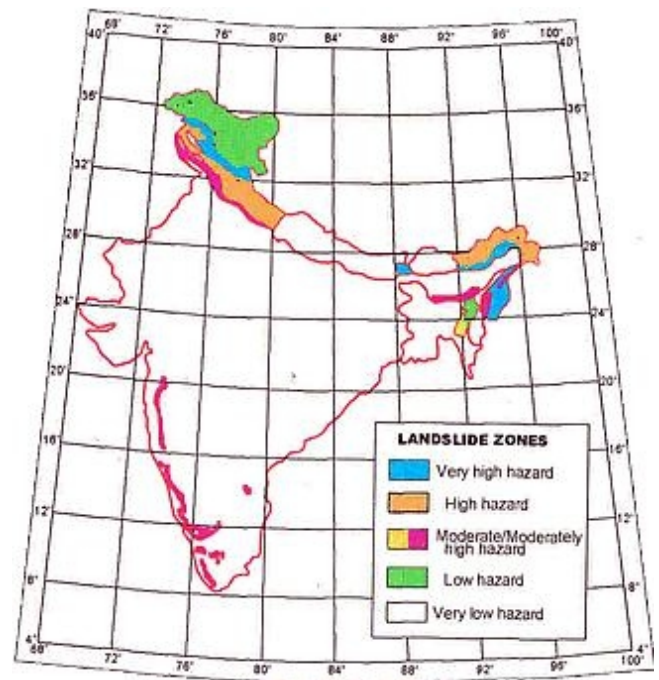


Fig.10.2 : India : Landslide Zones

yet it causes destruction. Sometimes it blocks river courses and sometimes transportation routes are blocked, which disturbs the normal life. It also disturbs the equilibrium of demand and supply of goods. Therefore, the transportation routes are opened with first priority to restore supplies and movement of traffic.

Whenever landslides occur in populated areas, there is a loss of life and property both. People are buried under debris of their homes. Landslides in Nilgiris in 1993 killed 40 persons. The roads and houses collapsed. During the same year, there was a heavy loss of life and property in Uttaranchal due to landslides.

Many a times, river courses are blocked due to landslides and temporary lakes are formed. Breaking of such lakes results into heavy loss of life and property by flooding. One such temporary lake was formed in the valley of Alaknanda river (Uttaranchal) by landslides in 1971. Whole of Belakuchi village was washed away when the lake broke. Table 10.2 represents the effects of main landslides occurred in Bharat.

Table - 10.2
Major Landslides in India

Guwahati landslide, Assam: The landslide took place on September 18, 1948 due to heavy rains. Over 500 people died in the landslide and according to the reports, the landslide buried an entire village

Darjeeling landslide, West Bengal: The landslide happened around October 4, 1968. The landslide was triggered by floods and the 60 km long highway was cut in 91 parts. As per reports, thousands of people died in the landslide

Malpa landslide, Uttarakhand: Consecutive landslides occurred between August 11 and August 17 in 1998 in the village of Malpa where over 380 people died as the entire village washed away in the landslide. The landslide is one of the worst landslides in India

Mumbai landslide, Maharashtra: The landslide was caused in July 2000. The landslide took place in the suburbs of Mumbai due heavy rains which was followed by land erosion. As per reports around 67 people died and the local trains were also stricken

Amboori landslide, Kerala: The landslide was known as the worst landslide in Kerala's history. The landslide occurred on November 9, 2001 due to heavy rains and around 40 people died in the incident

Kedarnath landslide, Uttarakhand: The landslide took place on June 16, 2013 and was the result of Uttarakhand floods. Over 5700 were reported dead and over 4,200 villages had been affected by the floods and post-floods landslide

Malin landslide, Maharashtra: The landslide occurred on July 30, 2014, in a village in Malin. The landslide occurred due to heavy rainfall and around 151 people died and 100 people went missing after the disaster.

Landslides and Management

1. At Government and Social level – While studying the occurrence of landslides in Bharat, it becomes clear that more than 90% of landslides

occur in rainy season. Therefore, in mountainous regions, there should be proper drainage for rain water on both sides of roads. The debris, with more than 45° gradient, should be removed simultaneously with the construction of roads. If its removal is not possible, a support wall should be constructed along side the debris. Villages should be developed in the areas which are free from the risk of landslides. Warning signals must be established along roadsides on the landslide prone spots.

2. At individual level – While travelling by own vehicles, if the rain starts in landslide prone areas, vehicles should be parked along road side. Houses must be constructed on firm grounds in mountainous regions. Houses should not be built along river sides in mountainous regions. During road blockades, full help should be extended to the held up people. Citizens should inform the concerned departments if the landslide has occurred along transportation routes.

Important Points

1. Changes in nature occur continuously. The natural changes which adversely affect human society are termed as natural disasters.
2. In Bharat, natural disasters are also known as wrath of nature.
3. Management here means the actions, decisions and responsibilities undertaken to ward off the severity of disasters and get ready to face the situation successfully.
4. The earth's tremors are termed as earthquake.
5. The intensity of earthquake is measured on Richter scale.
6. Earthquakes are more frequent in northern mountainous region of Bharat.
7. Seaquakes create the danger of Tsunami waves which bring disaster in coastal regions.
8. As soon as it appears that an earthquake is about to occur, we should come out in the open space.
9. The process of rocks and soil falling downwards is known as landslide.
10. Landslides are more frequent in rainy season. The rain water increases possibilities of landslides.
11. In Bharat, the incidence of landslides are more

- in the Himalayan and Western Ghats regions.
12. Landslides obstruct transportation routes and river courses.

16. Mark landslide prone areas on an outline map of Bharat.

Answer Key

1. (D), 2. (B), 3. (B).

**Exercise
Multiple Choice Questions**

1. The natural disaster not associated with Bharat, is—
(A) Earthquake (B) Flood
(C) Landslide (D) Volcano.
2. The region of Bharat where earthquakes occur more frequently is –
(A) Deccan Plateau (B) Himalaya
(C) Central Bharat (D) Coastal Bharat.
3. The mountainous region where landslides occur frequently in Bharat, is –
(A) Aravalli (B) Himalaya
(C) Satpura (D) Vindhyaachal.

Very Short Answer Type

4. What is meant by natural disaster?
5. What is an earthquake?
6. What do you understand by landslide?
7. In which season landslide occur more?

Short Answer Type

8. What is meant by management?
9. In which region of Bharat, earthquakes occur more frequently and why?
10. Explain about landslide management.

Essay Type

11. Explain the causes of an earthquake.
12. How can natural disaster of an earthquake be dealt with?
13. Which factors affect management?
14. Classify the factors that causes landslides.

Skill

15. Mark earthquake prone areas on an outline map of Bharat.

Lesson - 11

Natural Disasters and Management (Flood, Drought and Sea Storms)

Flood & Drought

Due to heavy or continued rains, when river water spreads in a large area by breaking levees, it is known as **flood**. When the rains are too scanty, not only for crops but also for the requirements of drinking water, it is termed as **drought**. Flood occurs due to excessive rains. Drought occurs due to lack of or scanty rains. Both type of extremities during rainy season in Bharat become the cause of these natural disasters. Occurrence of floods and droughts are repeated every year in one or the other part of Bharat. About 4 crore hectares area is considered as flood prone, while drought prone area is much larger.

Both the natural disasters affect Bharat due to its large size and monsoon climate. Bhartiya populace have been bearing the blunts of these disasters for centuries with ease due to their modest and contented nature.

Floods (Excessive Rains)

Causes of Floods

When the river water spreads all around by spilling over from its banks, it results into flood. But there are various factors responsible for floods. When it rains heavily in the catchment area of a river, the increased volume of water doesn't find enough space in the valley to flow, it begins to spill over in all directions. In rainy season, the sediments accumulate in the river bed making it shallow. As a result, the increased volume of water spills over to cause floods. Due to deforestation and destruction of pastures, the rain water flows swiftly to join the

main stream. When it increases beyond its capacity, it causes floods. Dense forests and pastures hinder the flow of water. It raises the underground water level and checks flooding.

Besides natural factors, man has also increased the possibilities of flooding by his illogical actions, e.g. development of settlements blocking water courses, irrational construction of transportation routes, destruction of traditional water harvesting areas and blocking natural flow of water by illegal constructions.

Flood-prone areas of Bharat

The flood prone areas of Bharat are determined by distribution of rains. More than 90% of the total loss in Bharat due to floods occurs in the northern and north-eastern regions. In northern Bharat, rainfall decreases from east to west. The same pattern emerges in Bharat in flood prone areas. The severity of floods is lesser in the rivers of north-western Bharat, e.g. in Sutlej, Vyas, Ravi, Chinab and Jhelum rivers, while floods are more severe and frequent in the eastern rivers like Ganga, Yamuna, Gomati, Ghaghra and Gandak rivers. The flooding in Kosi and Damodar rivers is very damaging. Hence, Kosi river has been termed as **Sorrow of Bihar** and Damodar river as **Sorrow of Bengal**.

Brahmaputra river flows in the north-eastern Bharat. It causes floods every year. The average annual rainfall is also more than 250 cms. in this region. When it rains heavily in northern and north-eastern Bharat, floods occur in the rivers of the region. If coincidentally it also rains heavily in central Bharat, the severity of floods increases. The

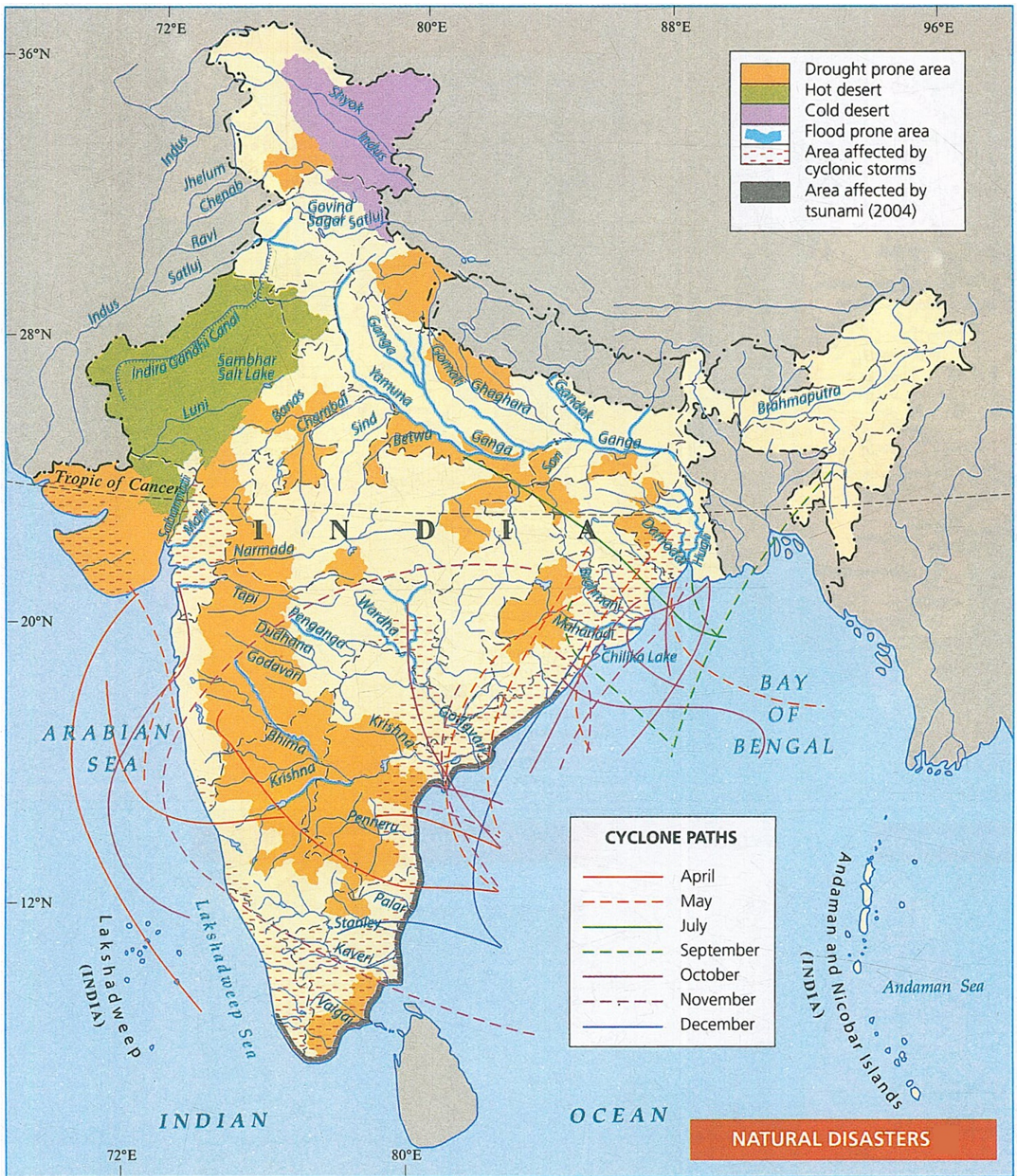


Fig. 11.1 : India : Natural Disasters (Cyclone)

rivers Chambal, Son, Betwa and Damodar drain rain water from central Bharat. Water of these rivers joins with the water brought by the rivers coming from the north, so that it spreads in a huge area and is highly damaging.

In peninsular Bharat, floods are more frequent in the coastal regions of Mahanadi, Godawari, Krishna and Kaveri rivers. Most of the peninsular rivers flow from west to east. These rivers originate in the Western Ghats and drop their waters into Bay of Bengal. The catchment areas of these rivers are smaller than that of the rivers of northern Bharat. Hence the severity of floods of these rivers is lesser than that of the rivers of northern Bharat. The main fact regarding occurrence of floods in Bharat is that the floods are highly damaging if heavy and continuous rains added with the active situations like cloudbursts occur in any part of Bharat. Flood prone areas have been shown in Fig. 11.1.

Major Cyclones of India

Cyclone Phethai – 2018

Cyclone Phethai is part of the ongoing 2018 North Indian Ocean cyclone season over the Bay of Bengal

Cyclone Gaja – 2018

Cyclone Gaja hit the Tamil Nadu, Andhra Pradesh and some parts of coastal Puducherry with heavy rainfall in Cuddalore and Pamban.

Cyclone Titli – 2018

Very severe cyclonic storm Titli was part of the 2018 North Indian Ocean cyclone season and makes landfall in Odisha's Gopalpur and Srikakulam of Andhra Pradesh.

Cyclone Ockhi – 2017

Cyclone Ockhi was the most intense and one of the most strongest tropical cyclone of the 017 North Indian Ocean cyclone season. Ockhi from the Arabian Sea affected mainland India along with coastal areas of Kerala, Tamil Nadu and Gujarat.

Cyclone Vardah – 2016

Cyclone Vardah brought heavy rainfall to Andaman and Nicobar Islands then crossed the eastern coast of India and affected Chennai, Kancheepuram and Visakhapatnam.

Cyclone Hudhud – 2014

Cyclone Hudhud was a strong tropical cyclone, done damage to Visakhapatnam city of Andhra Pradesh. Visakhapatnam or Vizag along with Odisha was mostly affected by Hudhud.

Cyclone Phailin – 2013

Cyclone Phailin was second strongest tropical cyclone in India since the 1999 Odisha cyclone, resulted heavy rainfall in Odisha, Andhra Pradesh, Jharkhand as well as other Indian states.

Cyclone Helen – 2013

Cyclone Helen brought heavy rainfalls in eastern India and became a Severe Cyclonic Storm in India. Cyclonic Storm Helen formed in the Bay of Bengal Region and affected Andhra Pradesh.

Cyclone Nilam – 2012

Cyclone Nilam was the deadliest tropical cyclone in India, Originating from an area of Bay of Bengal in South India. The heavy rains and strong winds by Cyclone Nilam affected Chennai Port of Tamil Nadu and New Port railway station in Kakinada in Andhra Pradesh.

Cyclone Phyan – 2009

Cyclone Phyan emerged into the Arabian Sea and caused heavy rainfall in Tamil Nadu, Maharashtra and Gujarat. Phyan was one of the wettest cyclone in India and brought extremely heavy rainfall of over the coasts of Karnataka, Goa and Maharashtra.

Odisha Cyclone – 1999

– Strongest
The Orissa cyclone in the year of 1999 was the strongest storm to hit the Indian coast and also the strongest tropical cyclones that affected India, Here is the list of strong tropical cyclones that affected India.

India Meteorological Department
Tropical Cyclone Intensity Scale

Category	Sustained winds (3-min average)
Super Cyclonic Storm	≥120 kt ≥221 km/h
Extremely Severe Cyclonic Storm	90–119 kt 166–220 km/h
Very Severe Cyclonic Storm	64–89 kt 118–165 km/h
Severe Cyclonic Storm	48–63 kt 89–117 km/h
Cyclonic Storm	34–47 kt 63–88 km/h
Deep Depression	28–33 kt 51–62 km/h
Depression	17–27 kt 31–50 km/h

Floods - Problems and Adversities

Of all the natural hazards, the floods cause the highest damage annually in Bharat. Despite progressive steps, magnitude of loss due to floods in the country is continuously rising, whether the loss of human life or property. More than 1500 persons are estimated to be dying every year due to floods in Bharat. More than 80 lakh hectares of land is affected by floods. The crops are damaged in 35 lakh hectares of land. Human life is disturbed in 3 crore hectares area. Economically, the country suffers the loss of about Rs. 1000 crores. Floods cause maximum damage to cattle life. About 12 lakh cattle are lost. More than 12 lakh houses are damaged.

Of the total loss by floods in Bharat, more than 60% occurs in Uttar Pradesh and Bihar. West Bengal, Assam and Orissa follow the list of loss by floods.

The problem of flood disturbs the life totally. Transportation routes are blocked and crops are destroyed. The sources of drinking water are damaged and contaminated. The means of communication are affected adversely. There remains a high risk of the spread of epidemics in the flood affected areas due to accumulation of filth. Dams, tanks and canals are damaged. The mean annual losses due to flood in Bharat are shown in Table 11.1.

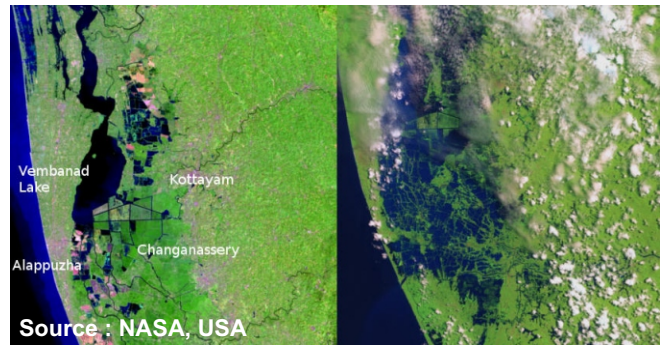
**Table 11.1
Major Flood Damage in India**

KERALA TOLL AT 387				
States	Affected Districts	Lives Lost	In Relief Camps	Total Affected Population
Kerala	14	387	14.5 lakh	54.1 lakh
UP	16	204	10,800	2.4 lakh
W Bengal	23	195	NA	2.3 lakh
Karnataka	11	161	5,800	3.5 lakh
Assam	23	46	2.4 lakh	11.5 lakh

Data as on August 22; Source: Disaster management division, MHA

Management and Responsibilities during Floods

1. At Government and Social Level – Efforts were made initially to control the occurrence of floods. With this objective National Flood



Kerala Flood 2018 Before & After

Control Project was started in 1954. Construction of embankments and water channels was started. Under this scheme, 33630 kms. long embankments and 37904 kms. long water channels were constructed.

In flood affected areas, dams were constructed as part of multipurpose projects. Dams were built on - Mahanadi, Damodar, Sutlej, Vyas, Chambal and Narmada rivers.

Tree plantation in the source region and catchment areas of rivers is essential to check soil erosion and the consequent silt deposition in river beds and to check speedy flow of water in the valleys. Irrational deforestation should be banned, in addition to the plantation efforts.

While constructing transport routes, precautions should be taken so that natural flow of water is not obstructed.

Water accommodating capacity of the rivers should be increased before the rains. The sediments deposited on the river beds should be taken out and be used for embankments. This will not only increase water accommodating capacity of the rivers but embankments will also be higher and sturdy.

An organization was constituted in 1954 for predicting flood and minimizing the loss by floods. At present, flood control cells have been established at all district headquarters. Meteorological and Irrigation Departments closely observe rainfall and water flow during the rainy season. The public should be well informed about the situation through the sources of media.

2. At Individual Level – People should be in touch with radio and television news during rains. If they are residing in flood prone areas, they should abide by the government instructions and advise.

Electric equipments must be switched off. Valuable goods, cloths and food stuffs should be shifted to safer places, so that until the flood water recedes, everybody can receive due care. Pets and vehicles must be moved to safer places. One should shift to a safer place immediately on water level touching the danger mark in the house. Before leaving the house, main entrance should be locked. Unknown depths and flow of water should not be crossed by vehicle or on foot.

Drought (Paucity of Rain)

In the given geographical conditions of an area, if the rainfall is so lower than the mean that it is insufficient for agriculture and household requirements, then that area is termed as drought affected. Drought is a natural disaster related to the paucity or negligible rain. Droughts are very common in some areas of Bharat.

It is essential to understand the difference between drought and aridity. Both signify shortage of water. Aridity is related to climate and geographical conditions whereas drought is temporary phenomena arising from the rainfall lower than the mean. Droughts are seldom in areas having sufficient rainfall. Arid and semi-arid areas are more prone to droughts. The Irrigation Commission of Central Government has designated arid areas where mean annual rainfall is less than 10 cms.

Causes of Drought

Various factors are responsible for the occurrence of droughts. The main reason is insufficient rains. Uneven distribution and uncertainty of rainfall is inherent in monsoonal climatic conditions. The underground water level is also reduced due to scanty and uncertain rains. Hence the availability of underground water is also reduced. Rainfall decreases due to deforestation which also reduces the amount of water seepage. The rain water goes waste by draining away into rivers in the absence of obstacles. Underground water level also decreases due to the destruction of natural sources of water. In the absence of sustainable water policy, there is lack of proper exploitation and utilization of water. Continuous increase in population also affects the sources of water supply and results in its shortage. Hence it is clear that scarcity of water is the main cause of

drought. The scarcity may be of rain water or underground water.

Drought Prone areas of Bharat

Western Bharat is the most drought prone area. Droughts are most frequent in Rajasthan and Gujarat. Droughts also occur in Haryana, some parts of Madhya Pradesh, central Maharashtra, central and eastern Karnataka. Occasionally Orissa, Himachal Pradesh and parts of western Uttar Pradesh also experience drought. The main cause for this is insufficient and uncertain rainfall. In some states of Bharat, drought is a permanent feature. These states are Rajasthan and Gujarat.

About 30% of the country's area is affected by drought every year and on an average 5 crore people are affected by drought annually. Irrigation Department of Bharat has classified these areas into two groups – First, areas having more than 25% uncertainty of rainfall which include western Rajasthan and western Gujarat. Second, areas having less than 25% uncertainty of rainfall which include eastern Rajasthan, Punjab, Haryana, Uttaranchal, western Madhya Pradesh, central Maharashtra, interior Karnataka, southern Andhra Pradesh, central Karnataka, north-western Bihar, western Uttar Pradesh and Orissa. About 77 districts of Bharat have been marked as famine prone and most of these districts are situated in western Bharat. More than half districts of Rajasthan and Gujarat are generally drought prone. The drought prone areas of Bharat are shown in Fig. 11.1 & Fig.11.2.

Droughts - Problems and Adversities

The biggest adversity as a result of drought occur in the form of famines. The severity of famine increases with the scarcity of water. There are **three facets of famine**. First, if the crops are destroyed causing insufficient production of food grains due to paucity of rains, it is known as **food grain famine**. Second, if the rainfall is so scanty that there is insufficient production of food grain and fodder both, it is termed as **food and fodder famine**. It is also known as **dual famine (Dwikal)**. Third, if the rainfall is so less that there is insufficient production of food grains and fodder as well as scarcity of drinking water, it is known as **tri-famine (Trikal)**. In Rajasthan, Trikal of 1987 took the lives of

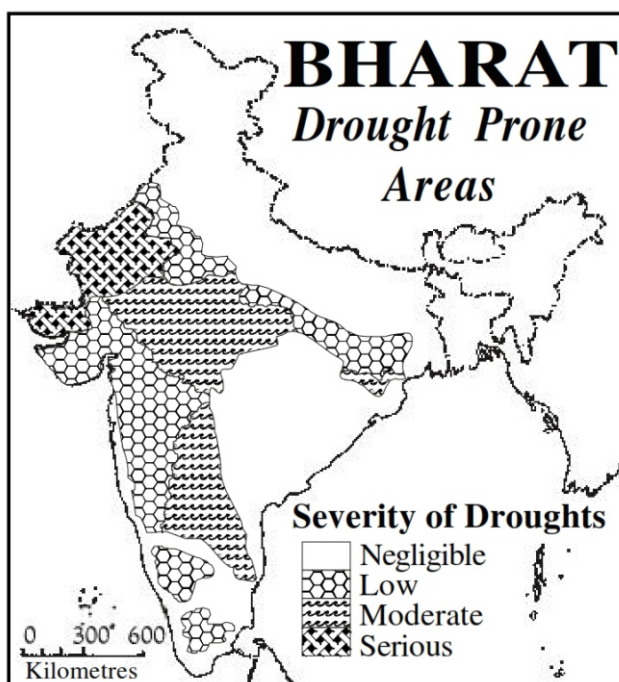


Fig. 11.2 : India : Drought Prone Areas

thousands of cattle. During trikal, relief operations run by central and state governments and by voluntary organizations appear to be insufficient to the public.

The trikal of Vikram Samvat 1956 (1900 A.D.) which is also known as **Famine of fifty six (Chhappaniya Akaal)**, is considered as the worst famine till today. The years of severe droughts and areas affected in Bharat are listed in table 11.2.

**Table 11.2
Years of Severe Droughts and Areas Affected in Bharat**

S.No.	Year	Affected area (in lakh sq.kms.)
1.	1877	20
2.	1899	19
3.	1918	21
4.	1987	15

Drought results in the scarcity of food grains, water and fodder. People and cattle start migrating from the famine affected areas. Thus several villages are deserted. Continuous famines destroy forests and pastures. Agro-based industries do not get raw materials. Malnutrition increases.

Price-hike, hoarding and corruption take steep rise. The debt-burden increases on both the governments and the people of the affected areas. Social homogeneity also suffers.

Drought - Management and Responsibility during the Adversity

1. At Government and Social Level – Drought is associated with scarcity of water. Amount of rainfall depends upon weather conditions. Methods of making water available in a region depends upon the efforts made by the society. Attempts should be made to develop water harvesting areas at village level. The traditional water sources available both at village and town level should be fully utilized. Small annicuts should be constructed to improve the underground water level in villages. Tendency of people's participation in governmental efforts for developing water harvesting areas and traditions of Shramdan should be reinstated.

The severity of drought can be reduced by the availability of underground water. Therefore, new aquifers should be explored through the use of remote sensing satellite mapping and Geographical Information System (G.I.S.)

For long term management of drought, massive task like inter-linking of rivers should be taken up. It will have two fold advantage. Firstly, in areas where ample rain water is available and where floods occur frequently, the problem of flooding will be solved. Secondly, the surplus water of the rivers will be of great use in areas where the underground water and rain water is in scarcity. Proper use of surplus surface flow in this manner will slowly raise the underground water level. The raised underground water level will indirectly help in the growth of greenery in long term.

2. At Individual Level – At this level, it is utmost important to educate people so that they understand the importance of water. They should take interest in the collection and storage of water. They should construct tanks (Tankas) in their houses. Pucca tanks can store the rainwater for its use throughout the year. Kaccha tanks (earthen tanks) will be useful in increasing the underground water level in their area.

In rural areas, people should make earthen

boundary wall all along their fields to store the rainwater. It will increase underground water level in the rural areas through enhanced percolation.

Such seeds should be used which require less water and also take less time in giving the desired production.

People should help each other at the time of drought. This attitude will change the condition of drought into a little comfortable situation.

Sea-Storms

The sea storms are also known as Cyclones in Bharat. These cyclones hover around the tropical zone, therefore, they are called tropical cyclones. In Bharat, the tropical cyclones originate in the oceanic areas and enter into the country through Bay of Bengal and Arabian Sea. Since tropical cyclones originate in the sea, they are laden with moisture. They provide heavy rainfall in coastal areas. Their velocity is also high in coastal regions. Their velocity and the amount of rainfall decreases towards inland areas. Due to high velocity and heavy rainfall, great loss of life and property occurs in coastal areas.

Sea Storms - Causes of Origin

There are difference of opinion regarding the origin of sea storms (Tropical cyclones) in Bharat. Propounders of Frontal Theory believe that these cyclones originate due to frontogenesis like other cyclones. Critiques see a weakness in the theory due to the fact that there is the absence of two air-masses having different characteristics in the equatorial region. More acceptable hypothesis relates origin of cyclones to the convectional

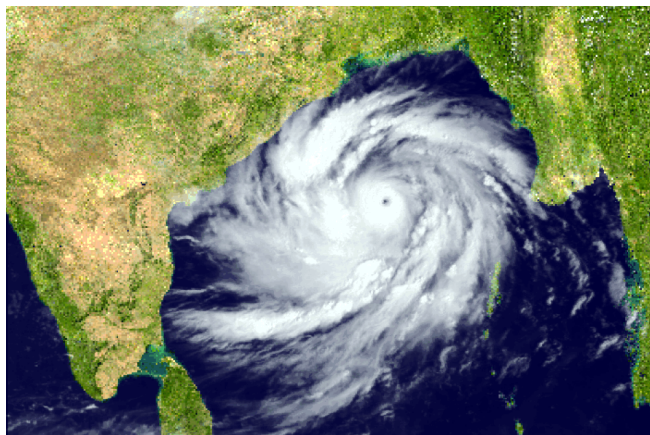


Fig. 11.3 : India : Cyclone in Bay of Bengal

process. Under this process, light air rises above the warm oceanic water. The consequent low pressure attracts winds from all directions which result in the genesis of cyclones or sea storms from the atmospheric disturbances. It is important to note that these storms originate in summer only. These are absent in the equatorial regions. These storms originate between 5° to 30° North latitudes.

In Arabian sea and Bay of Bengal, these cyclones remain active from April to December, but are more frequent in the month of June, July and August. Their annual average frequency is 2 from the Arabian Sea side and 6 to 7 from the Bay of Bengal side in Bharat. Some cyclones die in the coastal areas only while a few cyclones penetrate in the inner areas and cause heavy loss of life and property. Their inward penetration depends upon the intensity of low pressure in the north-western Bharat due to high temperature. Probable months and tracks of tropical cyclones traversing Bharat have been shown in figure 11.1 and their frequencies given in the table 11.3.

Cyclones also visit north-western Bharat in winter season, but these are temperate cyclones. They enter into Bharat from western and north-western side. They provide **winter rains (Mawat)** in north-western Bharat. It is very useful for the Rabi crop.

Table 11.3
Frequency of Cyclones in Bharat

Month	Arabian Sea	Bay of Bengal
January	02	04
February	00	01
March	00	04
April	05	18
May	13	28
June	13	34
July	03	38
August	01	25
September	04	27
October	17	53
November	21	56
December	03	26

Sea Storms – Affected Areas

Bhartiya western and eastern coastal plains and their adjacent regions are affected by sea storms. Sea storms of Arabian sea generally originate between April and June. Their track remains almost parallel to the coast. These cyclones enter into Bharat through Gujarat coast. Sea storms of Bay of Bengal generally originate between October to December. They travel far more inland. Maximum effect of these cyclones is experienced in Andhra Pradesh, Orissa and West Bengal. Initial period of summer monsoon is favourable for the origin of tropical cyclones. Most of the cyclones in this season originate between 10° to 15° north latitudes and die out between 20° to 25° north latitudes. The loss of life due to sea storms in Bharat has been shown in the table 11.4.

Table 11.4

Loss of Human Life in Bharat due to Sea Storms

S.No.	Year	State	Death toll
1.	May 1833	West Bengal	Approx. 50,000
2.	Oct. 1971	Orissa	Approx. 10,000
3.	Nov. 1977	Andhra Pradesh	Approx. 30,000
4.	Oct. 1999	Orissa	Approx. 1,00,000

Sea Storms – Problems and Adversities

The coverage of tropical cyclones remains confined to a small area but due to steep pressure gradient wind velocity is high. Their size is small at the time of origin, but as they proceed onwards over oceanic areas without any hindrance, their size and velocity increase. They move onwards at a speed ranging between 15 to 25 kms. per hour. The wind speed in the inner side of these storms is 20 to 40 kms. per hour. These are humid winds due to the oceanic source. Heavy rainfall occurs in coastal areas by high velocity winds. It rains so heavily that conditions of flood emerge. Due to high velocity winds the trees are uprooted, and electric and telecommunication poles get damaged. Kuccha houses and huts are destroyed. Chaotic situation arise all around. Standing crops fall down. Due to high speed, the sea waves penetrate far inland in the coastal areas. These are also devastating. Boats are

overturned and the lives of sailors are endangered.

Sea Storms – Emergency and Management

1. At Government and Social Level –

There must be a sea storm forecasting system. On the basis of pictures of satellite and informations track of the storms, wind velocity and amount of rain should be observed and reviewed regularly. This information must be broadcast through radio and other means of telecommunication repeatedly. People should be notified about safer places so that they can reach there. Thus life can be saved.

In coastal areas people should be advised to construct the houses which can resist the force of the winds. Houses should not be constructed in low - lying areas. Flood water spreads in such areas.

Intense afforestation programmes should be carried out in coastal areas to reduce the force of these storms. The fishermen should be advised to avoid sailing during these storms. Schemes like group insurance must be carried out in storm prone areas.

2. At Individual Level –

All arrangements made during these emergencies cannot be successful without integrity and honesty of people. People should take proper steps and necessary precautions according to the available information.

People must move to safer places along with the aged persons, children and women.

The relief goods received from government and other agencies must be shared with all victims.

People residing in storm prone areas must get insured for themselves, their cattle and crops to be able to get appropriate compensation.

Important Points

1. When the rain water spreads in a vast area by breaking levees, it is termed as flood.
2. Torrential rains, accumulation of sediments in river beds and unplanned habitations are the main causes of floods.
3. Floods are more frequent in the eastern and north-eastern Bharat.
4. Kosi river is known as **Sorrow of Bihar** and Damodar river as the **Sorrow of Bengal**.
5. The floods are more frequent in the rivers of north Bharat as compared to the rivers of

- southern Bharat.
6. Afforestation, cleaning of river beds and strengthening of river embankments should be done for flood control.
 7. Drought is related to low rains or negligible rains.
 8. Uncertainty of rains is the main cause of drought.
 9. The western parts of Bharat are the most drought affected areas.
 10. When food grain and fodder production and drinking water are insufficient, it is termed as tri-famine (Trikal).
 11. Development of traditional sources of water and construction of annicuts for raising underground water level should be done in all villages and towns to overcome drought situation.
 12. Tropical cyclones enter into Bharat through the Bay of Bengal and the Arabian Sea.
 13. Tropical cyclones are more frequent in the months of June, July and August.
 14. The coastal areas are more affected by sea-storms.
 15. Coastal regions are devastated due to high speed sea storms in a very short time.

Exercise

Multiple Choice Questions

1. The river known as the 'Sorrow of Bengal', is –
(A) Kosi (B) Damodar
(C) Ganga (D) Swarnrekha.
2. The cyclones known as sea storms in Bharat, are –
(A) Temperate cyclones (B) Winter cyclones
(C) Tropical cyclones (D) Desert cyclones.
3. The maximum drought prone area in Bharat, is–
(A) Northern plain (B) North-eastern region
(C) Western region (D) Coastal areas.

Very Short Answer Type

4. What are floods?
5. In which area of Bharat, floods are more frequent?
6. Which river is known as the 'Sorrow of Bihar'?

7. What is the main cause of drought?
8. In which months, sea storms are more frequent in Bharat?

Short Answer Type

9. Which are flood prone areas in Bharat?
10. Explain tri-famine (trikal).
11. Suggest measures to control floods.
12. Explain the origin of sea-storms.

Essay Type

13. Discuss the causes of floods in Bharat.
14. What steps should be taken to control famine?
15. Explain about the sea storms in detail.
16. Throw light on the problems of flood prone areas and suggest remedies to solve the problems.

Skill

17. Show the flood prone areas on an outline map of Bharat.
18. Show the drought prone areas on an outline map of Bharat.
19. Show the tracks of sea storms on an outline map of Bharat.

Answer Key

1. (B), 2. (C), 3. (C).

Lesson - 12

Rajasthan : Introduction, Physical Features and Drainage System

Introduction

Rajasthan has special significance in Bhartiya history due its magnificent historical traditions. Rajasthan happens to be the centre of old civilizations of the world. Their proofs are available in the remains found at Tilwara in Luni basin (Barmer), Ahar (Udaipur), Gilund (Udaipur), Kalibanga (Ganganagar) and Ganeshwar Tila (Sikar). Drainage of Saraswati and Drashaddhati rivers have also flourished Rajasthan in ancient times.

Rajasthan is considered as the land of heroes and sacrificers. The state has repeatedly protected Bhartiya pride. The people of the state have shown bravery and wisdom even after adapting with adverse and difficult situations.

Different areas of Rajasthan used to have their special identities in ancient and medieval periods, viz. Y o d d h a i y (G a n g a n a g a r), Ahichhatrapur (Nagaur), Gurjaratra (Jodhpur-Pali), Valla / Dungal / Maad (Jaisalmer), Swarn giri (Jalore), Chandravati (Abu), Shiv / Medpat / Mewar (Udaipur-Chittorgarh), Vagad (Dungarpur, Banswara), Kuru (Alwar), Shursen / Brijbhumi (Bharatpur, Karauli, Dholpur), Hay-Hay / Hadauti (Bundi-Kota), Virat / Bairath (Alwar, Jaipur), Jangal (Bikaner - Jodhpur), Shakambhari (Sambhar) and Dhundhar (Jaipur-Tonk).

There was rise and fall of several dynasties in Rajasthan between 11th and 18th centuries. Rajasthan was known as Rajputana in British period due to the dominance of princely states and thikanas of Rajput kings. The main princely states were Jaipur-Amer, Marwar, Mewar, Kota, Bundi, Bharatpur etc. Present Rajasthan came into existence by the merger of 19 princely states and 3 chiefships of Rajputana, and centrally administered Ajmer-Merwara after independence. Table 12.1 shows the successive phases of unification of Rajasthan.

The present Rajasthan is administratively

Integration of Rajasthan
Seven Stages of formation of Rajasthan
(1948-1956)

S.No.	Name of Group	States	Date of Integration
01.	Matsya Union	Alwar, Bharatpur, Dholpur, Karauli	17-03-1948
02.	Rajasthan Union	Banswara, Bundi, Dungepur, Jhalawar, Kishangarh, Kota, Pratapgarh, Shahpura, Tonk.	25-03-1948
03.	United State of Rajasthan	Udaipur also joined with the other Union of Rajasthan.	18-04-1948
04.	Greater Rajasthan	Bikaner, Jaipur, Jaisalmer & Jodhpur also joined with the United State of Rajasthan.	30-03-1949
05.	United State of Greater Rajasthan	Matsya Union also merged in Greater Rajasthan	15-05-1949
06.	United Rajasthan	18 States of United Rajasthan merged with Princely State Sirohi except Abu and Delwara.	26-01-1950
07.	Re-organised Rajasthan	Under the State Re-organisation Act, 1956 the erstwhile part 'C' State of Ajmer, Abu Road Taluka, former part of princely State Sirohi which was merged in former Bombay, State and Sunel Tappa region of the former Madhya Bharat merged with Rajasthan and Sironj subdistrict of Jhalawar district was transferred to Madhya Pradesh.	01-11-1956

divided into 7 divisions, 33 districts, 90 sub-divisions, 314 tehsils, 295 Panchayat Samities, 222 Municipalities and 9900 Gram Panchayats.

Location and Extent

Rajasthan state lies in the north-western part of Bharat and extends between 23°3' to 30°12' north latitudes and 69°30' to 78°17' east longitudes. Rajasthan is the biggest state of Bharat in terms of area. Tropic of cancer passes through southern tip of the state near Banswara. It is bound by Punjab on the north and Haryana on the north-east, Uttar Pradesh on the north-east, Madhya Pradesh on the east and south-east and Gujarat on the south and south-west.

The international boundary lies between Rajasthan and Pakistan in a length of 1070 kilometres which is known as **Radcliffe**. Ganganagar, Bikaner, Jaisalmer and Barmer are the border districts. This kite-shaped state is 869 kilometres long from east to west and 826 kilometres broad from north to south (Fig. 12.1). The total area of the state is 3.4 lakh sq. Kilometres which is 10.43% of the total area of Bharat. The state is equal to Germany in area, slightly larger than Japan, one and a half times larger than Great Britain, five times larger than Sri-Lanka and more than seventeen times larger than Israel.

Physical Features

Most of the western and north-western Rajasthan is the residue of Tethys sea which, in due

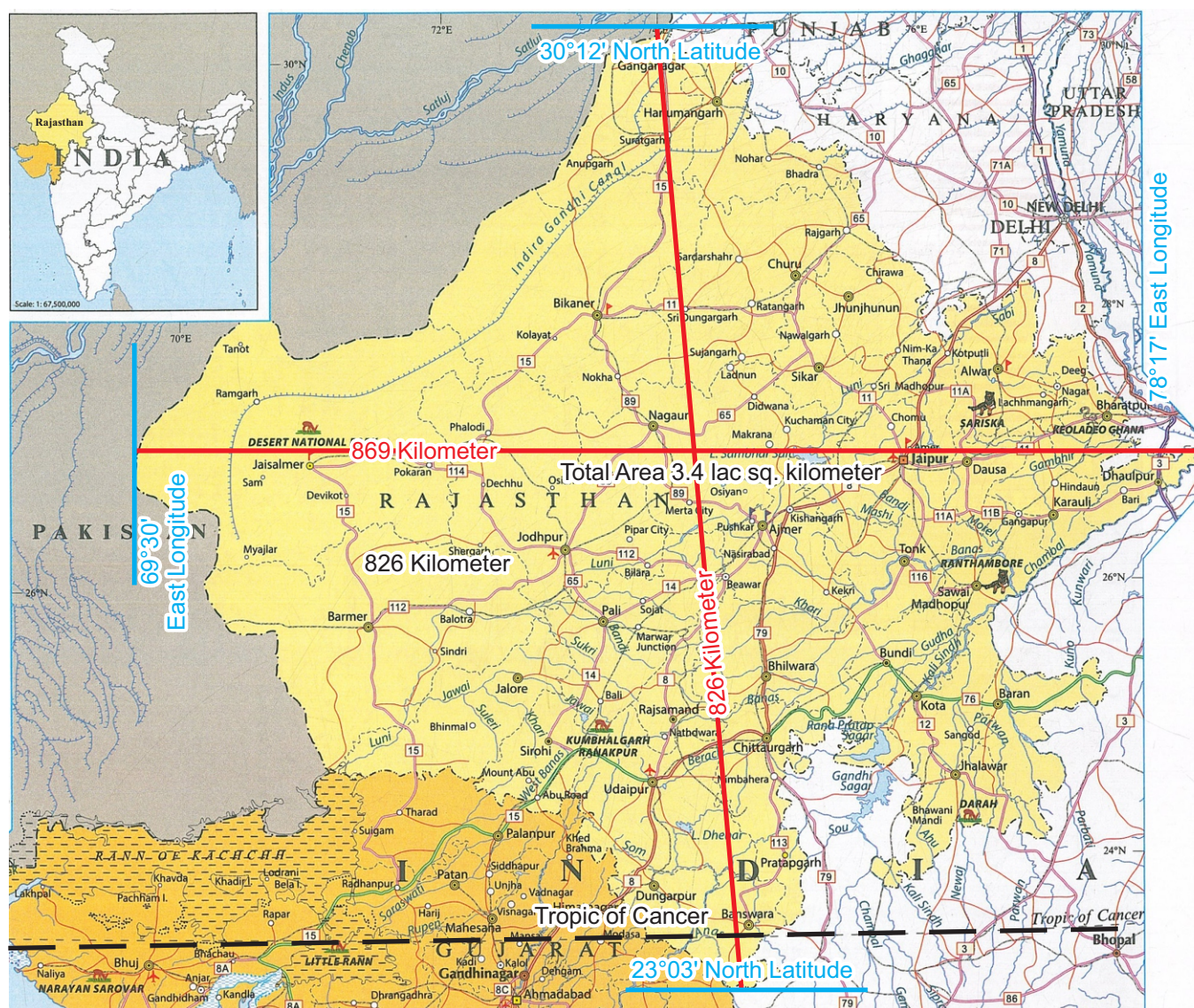


Fig. 12.1 : Rajasthan : Location and Extension

course of time, was filled with the alluvium deposited by the rivers descending from the Himalayas. Salt lakes of Rajasthan like Sambhar, Deedwana, Pachpadra, Lunkaransar etc. are the remains of Tethys Sea. Aravallis of Rajasthan and the Deccan plateau are part of Gondwanaland. Aravallis are one of the oldest mountains of the world. Aravallis act as the major water-divide, making two divisions of the state. The physical features of the state represent the cumulative effect of indogenetic movements, geological structure, denudation and drainage pattern. The relief of

Rajasthan comprises of mountains, plateaus, plains and deserts in which the materials ranging from oldest rocks to newer alluvium are the constituents.(Fig. 12.2)

The state can be divided into 4 major and 11 sub-regions in terms of its relief (Fig. 12.3) –

- (1) Western Desert Region
 - (A) Sandy dry plain,
 - (B) Luni Basin
 - (C) Plain of inland drainage and
 - (D) Ghaggar plain.
- (2) Aravalli Region

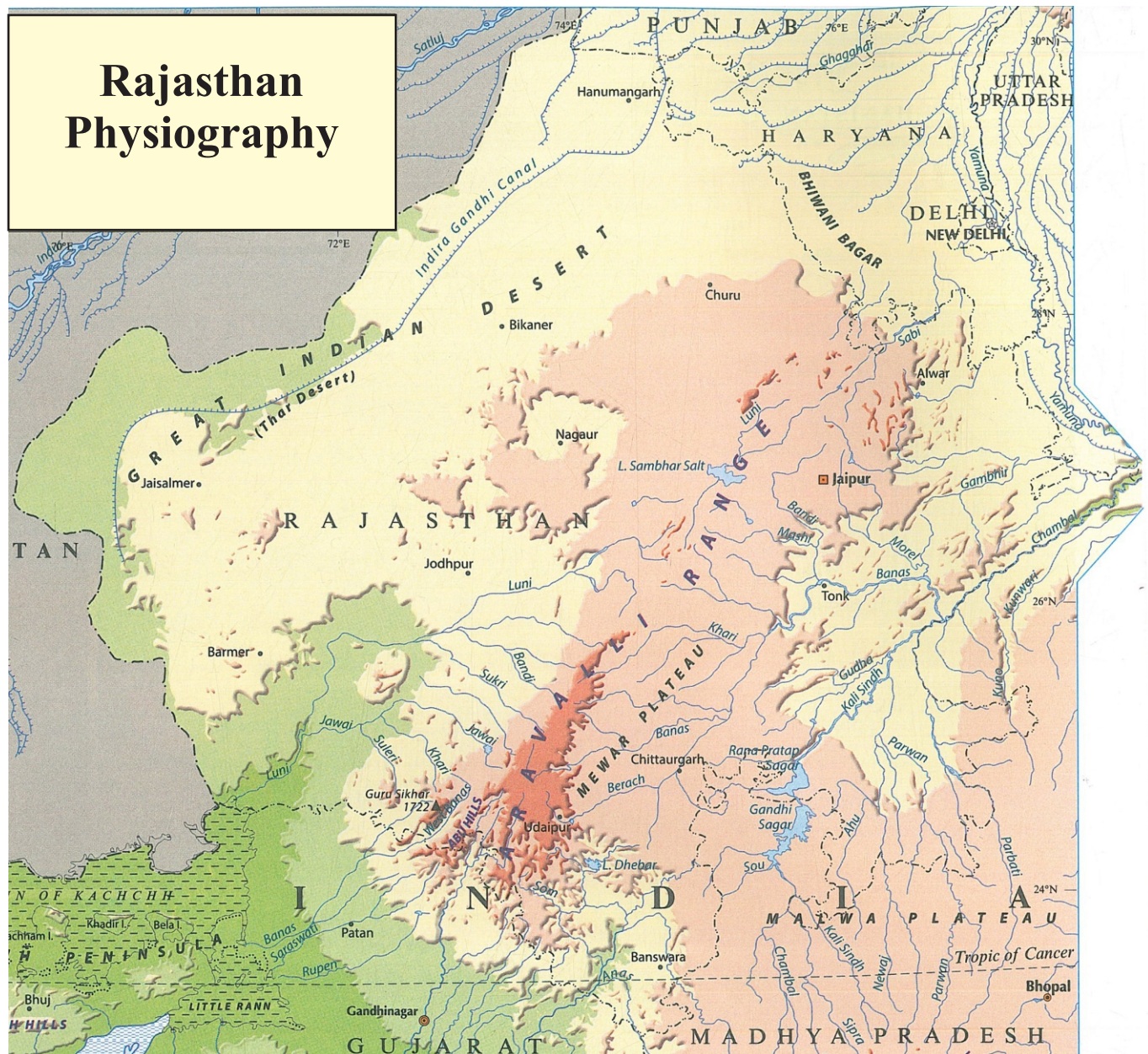


Fig. 12.2 : Rajasthan : Physiography

- (A) Southern Aravalli area,
- (B) Central Aravalli area, and
- (C) Northern Aravalli area.
- (3) Eastern Plain Region
 - (A) Banas-Banganga Basin, and
 - (B) Middle Mahi and Chhappan basin.
- (4) South-eastern Plateau

- (A) Vindhyan Scarp, and
- (B) Deccan Lava Plateau.

(1) Western Desert Region

Western desert region extends towards north-west and west of Aravallis. Its average elevation ranges from 60 to 360 metres above sea level. It extends over the districts of Ganganagar,

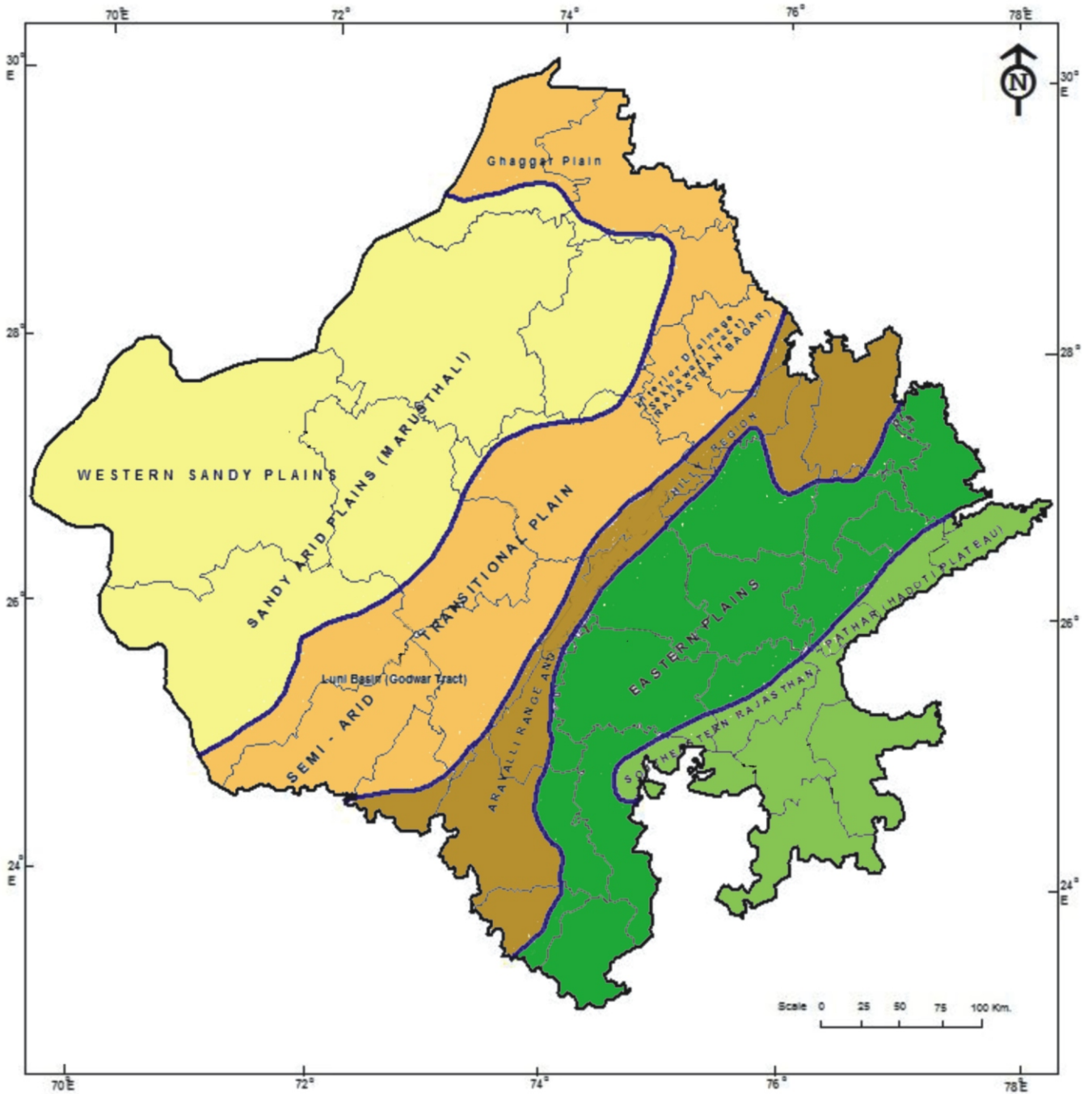


Fig. 12.3 : Rajasthan : Physical Features

Hanumangarh, Jhunjhunu, Sikar, Churu, Bikaner, Nagaur, Jodhpur, Jaisalmer, Barmer, Jalore and Sirohi. This area is covered with sand.

The desert milieu is undergoing the process of transformation due to human influence and extension of irrigation in some areas (Ganganagar, Hanumangarh and Bikaner). There are three types of sand dunes found in the area –

(i) **Longitudinal** – These sand dunes are formed, parallel to the prevailing winds.

(ii) **Transverse** – These sand dunes are formed at rightangle to the prevailing winds.

(iii) **Barkhan** – These are the crescent shaped sand dunes.

On the basis of surface features, western desert region is subdivided into four parts –

(A) **Sandy Dry Plain** – Situated to the west of 25 cm isohyet line, it is a dry desert plain. It encompasses the districts of Jaisalmer, Barmer, Bikaner and Jodhpur, and the western parts of Nagaur and Churu. Rock projection intercept with the sand dunes in some parts of Jaisalmer, Barmer and Bikaner. These projections consist of granite, limestone and sand stone. All the three types of sand-dunes are found here. There are shallow depressions of brackish water known as **Rann**.

(B) **Luni Basin** – The basin lies to the south-west of Aravallis between 25 to 50 centimetres isohyet lines. Luni basin encompasses southern Jodhpur, Pali, Jalore and western Sirohi districts. There are alluvial plains in the drainage areas of Luni and its tributaries like Lilri, Sukari, Jawai, Jojari and Bandi. These are all seasonal rivers. Pachpadra is the major brackish water area in the region where salt is made.

(C) **Plain of Inland Drainage** – It is also known as Shekhawati region. The semi-arid plain extends in the districts of Jhunjhunu, Sikar, Churu and northern nagaur. It is a sandy plain covered with sand-dunes of medium and low height. Barkhans are dominant in the region. It is an area of inland drainage. There are rivers and nallas which disappear after flowing in a short distance in the region. Mendha and Kantli are the major rivers of this area. There are a number of salt water lakes and Ranns in this area. Sambhar, Deedwana, Kuchaman, Sujangarh, Tal-Chhapar and Parihara (Churu) are the main salt water lakes.

(D) **Ghaggar Plain** – It is the northern part of the desert which extends in districts of Ganganagar and Hanumangarh. Barkhans are dominant in the region. Ghaggar river is the part of inland drainage system of this area. The dry bed of the streams of Ghaggar are considered to be the part of Saraswati river originating from Himalayas as described in the Puranas. Intensive agriculture is practiced in this area due to availability of irrigation facility through Indira Gandhi Canal and Gang Canal. Consequently, the problems of water logging and alkalinity have increased in the area.

(2) Aravalli Region

Aravalli range is the main and the oldest mountain in Rajasthan. About 9.3 percent area of the state is covered by this range. The range extends in a length of 692 kilometres from south-west to north-east direction. The range extends in a length of 550 kilometres from Khed Brahma (Gujarat border) to Khetri in Rajasthan. It extends in a continuous chain from Sirohi to Khetri but it extends in the form small hills onwards upto Delhi. It mainly extends in nine districts of Sirohi, Udaipur, Rajsamand, Ajmer, Jaipur, Dausa, Alwar, Sikar and Jhunjhunu in the state. The average height of this hilly region is 930 metres. Aravalli hills are divided into three sub-regions –

(A) Southern Aravalli area (from Abu to Ajmer),
(B) Central Aravalli area (from Ajmer to Jaipur),
and



Fig. 12.4 : Rajasthan : Relief

(C) Northern Aravalli area (from Jaipur to Khetri).

(A) Southern Aravalli Area – It includes the districts of Sirohi, Udaipur and Rajsamand. Here the Aravallis are very complex and high. There are a number of ranges and peaks in Abu-Sirohi section of Sirohi district. Gurushikhar, located in this section, is the highest peak (1727 m) of Rajasthan. Achalgarh (1380 m), Dilwara (1442 m), Kumbhalgarh (1224 m) are other major peaks. Jarga (1431 m) is the highest peak of Udaipur-Rajsamand area. Borhat plateau is situated between Kumbhalgarh and Gogunda to the north of Udaipur. East-flowing rivers originate from the plateau.

(B) Central Aravallis – It extends between Ajmer and Jaipur. There is an alternate arrangement of ranges, narrow valleys and plains in this section. Taragarh (885 m) is the main peak of this area. Luni, the main river of western Rajasthan, originates from Nag Pahar lying in this section.

(C) Northern Aravallis – Northern Aravallis extends in the districts of Jaipur, Dausa, Alwar, Sikar and Jhunjhunu. Aravallis are spread in the form of scattered and isolated hills, instead of a continuous chain in the area. It includes the hills of Shekhawati, Torawati, Jaipur and Alwar. These hills have an elevation ranging between 450 to 700 metres. Raghunathgarh (1055 m) in Sikar district and Kho (920 m) in Jaipur district are the main peaks of the area.

(3) Eastern Plain Region

The region covers 23.9 percent area of Rajasthan. It includes Banas basin and middle Mahi basin (Chhappan plain). As a matter of fact, it is a river basin area. It extends over the plains of Bharatpur, Alwar, Sawai Madhopur, Karauli, Jaipur, Tonk and Bhilwara in its northern section and over the plains of fifty six villages of Dungarpur, Banswara and Chittorgarh districts in its southern section. The plain is made up of fertile alluvial soil and is irrigated by a number of rivers. Situated between Aravallis and Hadauti plateau, it can be divided into two geomorphological sections –

(A) Banas-Banganga Basin – The plain of Banas and its tributaries is known as the **plain of Mewar** in the south and the **plain of Malpura-Karauli** in the north. Berach, Khasi, Mansi, Morel and Banganga etc. are the main tributaries of Banas river. The plain slopes east and north-eastwards.

There are flat-topped isolated hills in the region. The plain averages in height between 280 to 500 metres.

(B) Middle Mahi-Chhappan Basin – It covers an area of 7056 square kms. covering south-eastern part of Udaipur, Dungarpur, Banswara and southern part of Chittorgarh district. It averages in height from 200 to 400 metres. Salumbar-Sarada area is locally known as **Chhappan** and Dungarpur-Banswara area as **Vagad**. Banswara is also known as the **Area of Hundred Islands** due to the presence of several rivers. Main tributaries of Mahi river are Som, Jakham, Kagdar, Jhamri etc. Bhils and Garasiyas are the local tribes who practice shifting cultivation locally known as **Walra**.

(4) South-Eastern Plateau

The south-eastern plateau of Rajasthan is popularly known as **Hadauti**. It covers 9 percent area of Rajasthan. Here resides 13 percent of the population of the state. It spreads over the districts of Kota, Bundi, Baran, Jhalawar and eastern part of Chittorgarh. It is composed of lava mixed rocks and Vindhyan rocks. The average height of the plateau is 500 metres above mean sea level. Black and red soils are found in this area. Major rivers of this area are Chambal, Parvati and Kali Sindh. The plateau is divided into two sub-physiographic regions –

(A) Vindhyan Scarp – The scarp mainly consists of sandstone and limestone. It rises to an elevation ranging between 350 to 550 metres above MSL. The scarp faces south-east and eastwards continuously between Banas and Chambal rivers. The scarp extends northwards in Sawai Madhopur, Karauli and Dholpur along the Chambal river.

(B) Deccan Lava Plateau – It is wider and raised rocky feature of south-eastern Rajasthan. It is composed of sandstone and limestone rocks. Its eastern and southern part is covered with lava. Fertile black soil is found here. Chambal and its tributaries Kali Sindh and Parvati rivers have formed a **triangular alluvial plain** in Kota.

Drainage System

The drainage system of Rajasthan is determined by Aravalli ranges. The great water divide line of Bharat bifurcates the rivers of Rajasthan into two parts. The drainage system of Rajasthan is shown in Fig. 12.5 & 12.6.

This water divide line extends along



Fig. 12.5 : Rajasthan : Drainage System

Aravalli axis in the north upto the southern part of Sambhar lake. From here it goes towards south-west through a few kilometres east of Beawar, Deogarh, Kumbhalgarh, Haldighati in the south of Udaipur upto Udaisagar. Further to the south-east it passes through Bari Sadri, Chhoti Sadri and reaches upto Pratapgarh. The rivers to the west and the south of the water divide drain into Arabian sea. Amongst these, Luni, western Banas, Sabarmati and Mahi are the main rivers. To the east of water divide, Banas and its tributaries join Chambal which ultimately drains into Bay of Bengal through Yamuna and Ganga. About 50% area of Rajasthan does not have drainage into any open sea and is the part of inland drainage system. The drainage consists of separate river basins, the waters of which disappears in desert itself. Thus the drainage system of Rajasthan can be divided into three parts –

(1) Rivers Draining into Bay of Bengal

(i) Chambal River – This river originates from Janapao hill and joins Yamuna in Uttar Pradesh. It is the main river of this system. Banas, Parvati, Kali Sindh etc. are its main tributaries.

(ii) Banas River – This river originates from Khamnor hills of Bhorat plateau and joins Chambal at Rameshwar in Sawai Madhopur district. The main tributaries of this river are Berach, Kothari, Khari, Menal, Bandi, Mansi, Dhoondh and Morel.

(iii) Banganga River – It originates from

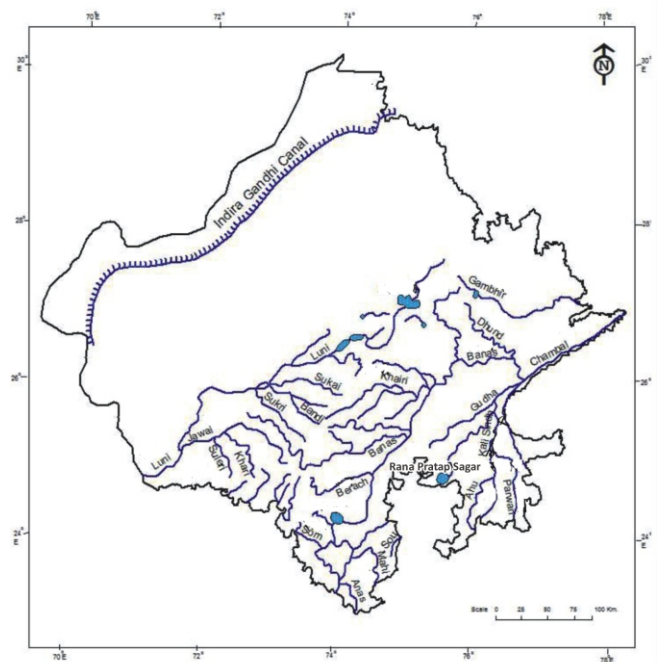


Fig. 12.6 : Rajasthan : Major Rivers, Lakes and Indira Gandhi Canal

Viratnagar of Jaipur district and joins Chambal river.

(iv) Parvati River – It originates from Vindhyan range in Madhya Pradesh and flowing through Baran district joins Chambal near a place Pali.

(v) Kali Sindh River – It also originates from Vindhyan range and flowing through Jhalawar, it joins Chambal. Parvan is its tributary river.

(2) Rivers Draining into Arabian Sea

(i) Luni River – It originates from Nag Pahar in Ajmer and flows into Rann of Kutch. Its water is sweet upto Balotra. Jojari, Lilari, Sukari, Jawai and Bandi are its main tributaries.

(ii) Mahi River – It originates from Amjhor in Madhya Pradesh. It flows in the districts of Dungarpur and Banswara of the state and finally flows into Gulf of Cambay in Gujarat. Mahi and its tributaries Som and Jakham rivers meet at Beneshwar Dham to form **Triveni confluence (Sangam)**. Tribal fair - **Beneshwar** is held every year at the confluence. The Dham is the main religious place of local tribes. Mahi-Bajaj Sagar dam has been constructed on Mahi river near Banswara.

(iii) **Sabarmati River** – It originates from the western hills of Udaipur and after flowing for 44 kilometres in Rajasthan joins Gulf of Cambay in Gujarat.

(3) Rivers of Inland Drainage

There are many such small streams in Rajasthan which disappear in the sand after a short surface flow. Kantli, Sabi, Kakni, Ghaggar etc. are such main rivers. Occasionally these rivers are flooded due to heavy rains.

Lakes

The lakes of Rajasthan can be divided into two categories –

- (A) Salt water lakes, and
- (B) Sweet water lakes.

(A) **Salt Water Lakes** – These lakes are found in the western desert and inland drainage area of the state. These are natural and shallow lakes. Sambhar (Jaipur), Deedwana (Nagaur), Pachpadra (Barmer), Lunkaransar (Bikaner) and Kuchaman (Nagaur) are the main salt water lakes. Salt production from these lakes is done on commercial basis. Sambhar, covering an area of about 145 sq.kms. is the biggest salt water lake of Bharat. The lake is 32 kms. long and 12 kms. broad.

(B) **Sweet Water Lakes** – These lakes are very important as sources of drinking water and irrigation. Jaisamand (Udaipur), Rajsamand (Rajsamand), Pushkar (Ajmer), Silised (Alwar), Ramgarh (Jaipur), Kolayat (Bikaner), Nakki (Mt. Abu), Kaylana (Jodhpur) etc. are the main sweet water lakes. A number of dams have been constructed on some rivers. The lakes and dams attract tourists due to their scenic natural beauty. Jaisamand, also known as **Dhebar lake**, is the largest sweet water lake in Rajasthan.

Important Points

1. Rajasthan had been the centre of old civilizations of the world; its remains are found at Tilwara, Ahar, Gilund etc.
2. The present Rajasthan was organized in seven phases.
3. Administratively, Rajasthan is divided into 7 divisions and 32 districts.

4. The international boundary between Rajasthan and Pakistan is known as Red Cliff
5. Rajasthan is the largest state of Bharat in terms of area.
6. Rajasthan is divided into four physiographic regions.
7. Thirty percent population of Rajasthan resides in the western desert region spread over 57.8% area of the state.
8. Aravallis extend in a length of 550 kilometres from south-west to north-east direction in Rajasthan.
9. Gurushikhar, the highest peak of Aravallis, is situated in Sirohi district.
10. Banas basin and Chhappan plain are included in the eastern plain of Rajasthan.
11. Banswara is known as the **Area of hundred islands** due to the flow of several rivers in the region.
12. The south-eastern plateau of Rajasthan is popularly known as Hadauti.
13. The drainage system of Rajasthan is determined by Aravallis.
14. Approximately half of the area of Rajasthan comes under inland drainage system. The western and southern part of Aravallis is part of the Arabian sea drainage system where as the part lying to the east of Aravallis comes under Bay of Bengal drainage system.
15. At the confluence of Mahi and its tributaries like Som and Jakham, local tribes hold **Beneshwar fair**.
16. Kantli, Sabi, Kakni and Ghaggar are the main rivers of inland drainage system.
17. Sambhar, Deedwana, Pachpadra, Lunkaransar and Kuchaman are the main salt water lakes of Rajasthan.

Exercise

Multiple Choice Questions

1. The district where Ahar is located, is –
(A) Barmer (B) Udaipur
(C) Bikaner (D) Sikar.
2. Swarn giri is the ancient name of –
(A) Nagaur (B) Sambhar
(C) Jalore (D) Ganganagar.

3. The river associated with Arabian sea drainage system, is –
 (A) Banas (B) Banganga
 (C) Parvati (D) Mahi.
4. The biggest sweet water lake of Rajasthan, is –
 (A) Kaylana (B) Nakki
 (C) Jaisamand (D) Pushkar.

Answer Key

1. (B), 2. (C), 3. (D), 4. (C).

Very Short Answer Type

5. When did the present Rajasthan form?
6. Which princely states were included in Matsya Sangh?
7. How much is the total area of Rajasthan?
8. Which range divides the drainage system of Rajasthan into two parts?
9. From where does the Sabarmati river originate?

Short Answer Type

10. Write about the location of Rajasthan.
11. Which are the major physical divisions of Rajasthan?
12. Describe the relief features of Southern Aravallis region.
13. Describe the extension of eastern plain.
14. Make clear the drainage system of Bay of Bengal of Rajasthan.
15. Name the salt water lakes of Rajasthan.

Essay Type

14. Enumerate the phases in which Rajputana became Rajasthan? Present the process in tabular form.
15. Divide Rajasthan into physical divisions and give a detailed discription of the western desert region.
16. Describe the drainage system of Rajasthan.

Skill

17. Show the following on an outline map of Rajasthan – (i) Tropic of Cancer, (ii) Aravallis (iii) Neighbouring states (iv) International boundary.
18. Show the physical divisions on an outline map of Rajasthan.
19. Show the major rivers along with the water divide on an outline map of Rajasthan.

Lesson - 13

Rajasthan : Climate, Vegetation and Soils

CLIMATE

Climate is an important geographical factor which not only influences the natural elements but also affects the economic and demographic aspects. The average weather conditions of a large area taken for a long period (for more than thirty years) is known as climate of that region whereas the sum of atmospheric conditions of a place at a particular time is called as the weather of that place. Temperature, atmospheric pressure, winds, rainfall, duration of the day etc. are the elements of climate. Temperature is the basic component of climate because other elements of climate are directly or indirectly associated with temperature. The world has been divided into torrid, temperate and frigid zones on the basis of temperature. Similarly, rainfall pattern is the fundamental element in the determination of climatic regions. The humid, sub-humid and dry climatic categories are based on it.

The climate of Rajasthan varies from dry to sub-humid monsoon type. The dry climate full of high daily and annual range of temperature, low rainfall, hot scorching Loo and sand storms are the climatic characteristics of western Rajasthan whereas comparatively low temperatures, low range of temperature and slightly higher rainfall are the characteristics of sub-humid climate to the east of the Aravallis. Latitudinal location, distance from sea, altitude above sea level, location and direction of Aravallis, soil structure and vegetative cover are the major factors which affect its climate.

Climatic Characteristics of Rajasthan

1. Rajasthan enjoys dry and sub-humid monsoon type of climate.
2. The distribution of rainfall is highly unequal.
3. The daily and annual range of temperature remain high due to abundance of sand.
4. The maximum daily temperature touches the mark of 49°C in summer season.
5. The hot, dry and stormy Loo blows in summer season.
6. At some places the temperature falls to freezing point in winter season.
7. Maximum rainfall occurs in rainy season. The quantity of rainfall decreases from east to west and south to north.
8. Droughts and famines are frequent here. It is an proverbial saying about the extension of famine that the legs of famine spread upto Poongal (a place of Bikaner), main body spreads is Kotre (Marwar), stomach at Bikaner, strayed occurrence at Jodhpur and permanent in Jaisalmer. It is quoted here - Pag Poogal, Dhad Kotre, Udraj Bikaner, Bhulyo-Chukyo Jodhpur, Thano Jaisalmer.

Seasons of Rajasthan

The twelve months period can be divided into three main seasons in Rajasthan –

- (a) Summer season (March to Mid June)
- (b) Rainy season (Mid June to September)
- (c) Winter season (October to February)

(A) Summer Season (March to Mid June)

– With the advancement of the sun towards Tropic

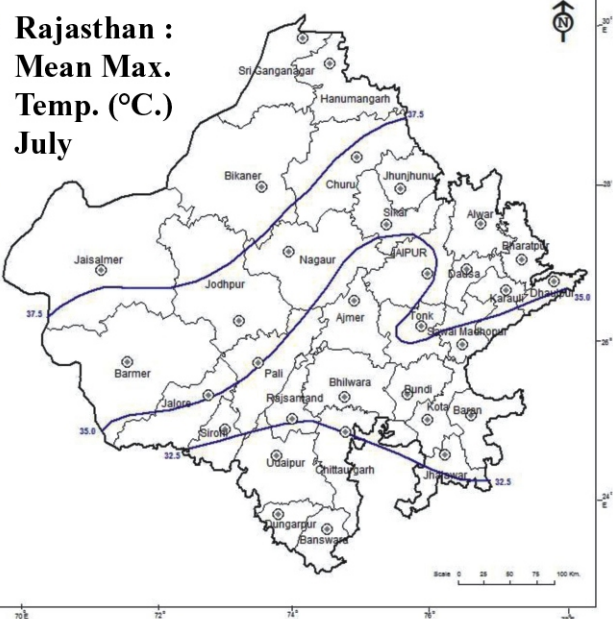
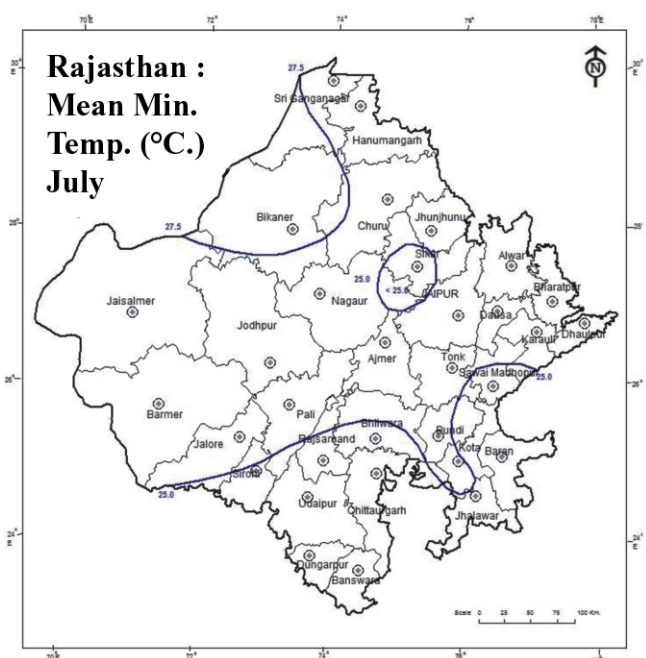


Fig. 13.1 : Rajasthan : Temperature (July)

of Cancer in northern hemisphere in March, temperatures begin to rise (Fig. 13.1). The sun shines vertically in the month of June over the Tropic of Cancer which passes through the southern part of the state. The average temperature remains between 30°C to 36°C in most of the state due to dry, sandy soil. At some places, day temperatures may go up to 48°C. Days are extremely hot. Body starts

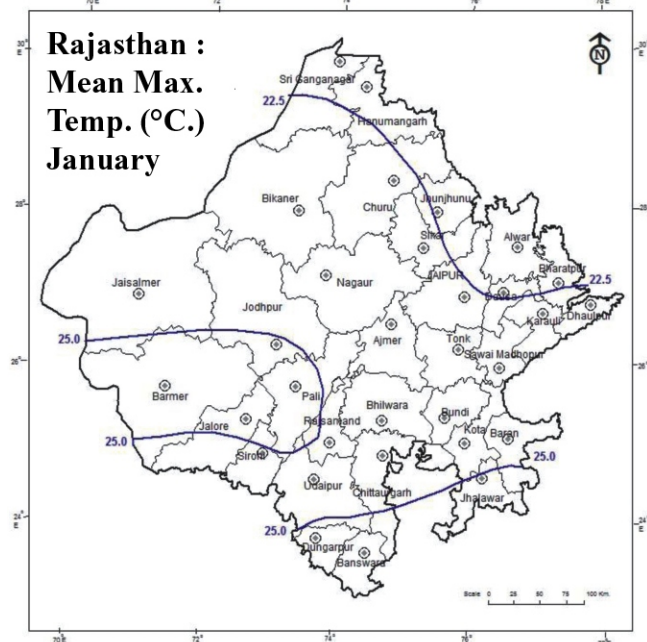
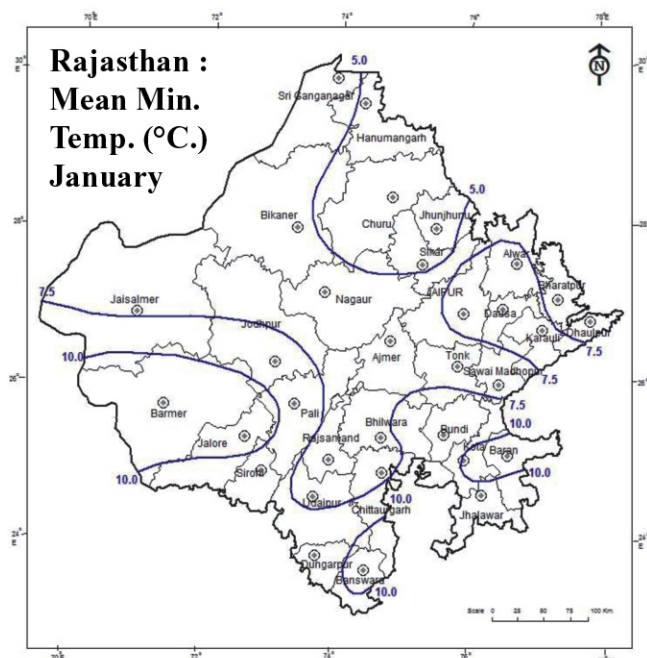


Fig. 13.2 : Rajasthan : Temperature (January)

parching. Fierce loo and sand storms are frequent. Loo is a hot and dry wind. Nights are pleasant. Humidity is also considerably reduced. The climatic extremities are lower in the eastern Rajasthan as compared to the west.

(B) Rainy Season (Mid June to September) – Whole of the state is heated by mid June resulting into the reversal of pressure and wind

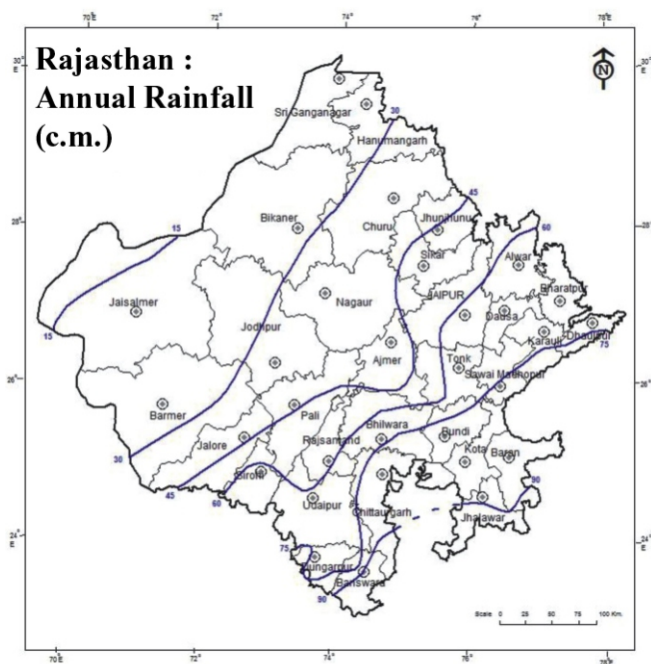


Fig. 13.3 : Rajasthan : Annual Rainfall

direction. Monsoon reaches Rajasthan by the end of June or beginning of July. It receives rainfall by both - the Arabian Sea branch and Bay of Bengal branch. Bay of Bengal branch of monsoon is more effective in the north, east and south-eastern Rajasthan due to the specific location of the Aravallis. It is clear from Fig. 13.2, showing the distribution of rainfall, that 50 cms. isohyet line divides the state into two parts. Arid and semi-arid desert lies to the west of the line. The rainfall ranges between 50 to 100 cms. to the east of Aravallis (Fig. 13.3). Most of the rain of the state falls in this season. The rainfall decreases from east to west and south to north in the state. The overall average of rainfall of the state 52.37 cms.

The factors that are responsible for the low rainfall despite the fact that both the branches of monsoon reach the state are as follows –

1. The extension of Aravallis is parallel to Arabian Sea branch of monsoon which escapes northwards without providing much rain in the state. This fact is shown in Fig. 13.4.

2. Moisture is considerably reduced in Bay of Bengal branch of monsoon by the time it reaches in Rajasthan.

3. Low height and lack of vegetation on Aravallis are also responsible for low rainfall in the state. The southern part of the state receives more than 100 cms. rainfall due to higher elevation and

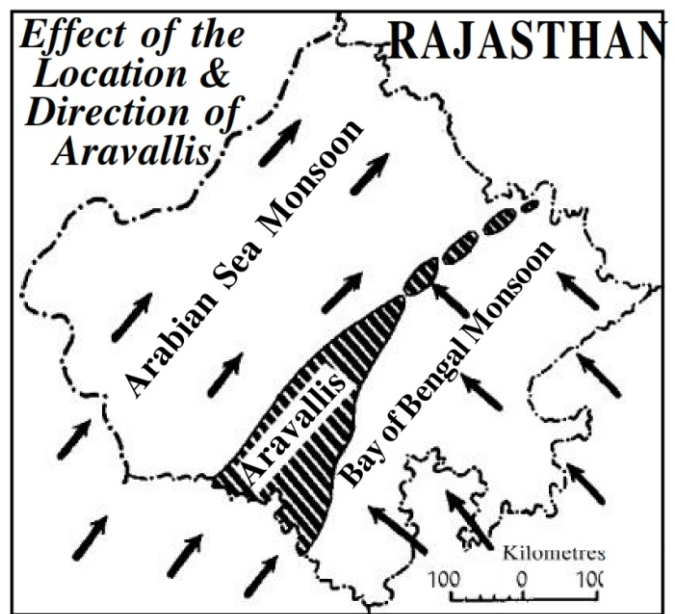


Fig. 13.4 : Rajasthan : Effect of the Location and Direction of Aravallis

dense vegetative cover.

(C) Winter Season (October to February)–

According to the Meteorological Department of Government of Bharat, winter season is divided into two parts -

1. Autumn season or Retreating monsoon period (October to Mid December), and
2. Dry winter season (Mid December to February).

1. Retreating Monsoon Period (Autumn Season) – Monsoon winds begin to retreat because lower pressure over land fades out and due to rise in temperature in Indian Ocean, low pressure develops there. Due to high temperature and high humidity in September and October sultriness prevails. The maximum and minimum temperature by the end of October remains at 35°C and 20°C respectively. This is the period of retreating monsoon. The winds are calm, very light and very unstable during this period.

2. Dry Winter Season – The commencement of actual winter season in the state occurs in December because sun shines vertically over Tropic of Capricorn in the southern hemisphere. North-westerly cold winds begin to blow in the state. Light rainfall occurs twice or

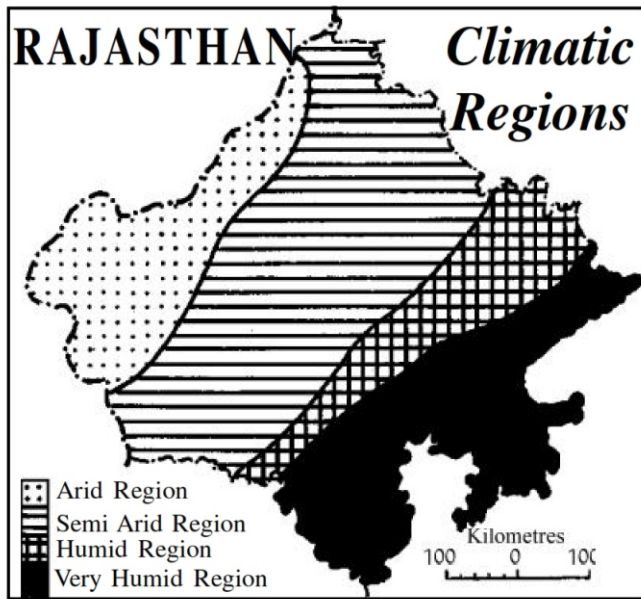


Fig. 13.5 : Rajasthan : Climatic Regions

thrice in the state by temperature cyclones coming from west in December-January and is known as **Mawat**. This rainfall is a boon to rabi crop. It is clear from Fig. 13.2 that the temperatures are less than 10°C in northern Rajasthan in January and it remains around 20°C in Hadauti area. The average temperatures in the remaining Rajasthan ranges between 10° to 20°C. The state comes in the grip of cold wave, and temperature falls below freezing point at many places due to snowfall in Himalayan region.

Climatic Regions

Rajasthan can be divided into four major climatic regions on the basis of temperature and rainfall (Fig. 13.5)–

1. Arid Region – It is also known as desert region. Hot and dry climatic conditions prevail in the region. The maximum temperature ranges between 45° to 49°C in summer season in this region and minimum temperature in winter season ranges between 0° to 8°C. Rainfall average is below 25 cms. Dust storms are frequent in summer season due to abundance of sand. High daily and annual range of temperature is the characteristic of this area. This type of climate is found in Jaisalmer, Barmer and Bikaner.

2. Semi Arid Region – It extends between western part of Aravallis and the arid climatic region. Annual rainfall averages between 25 to 45

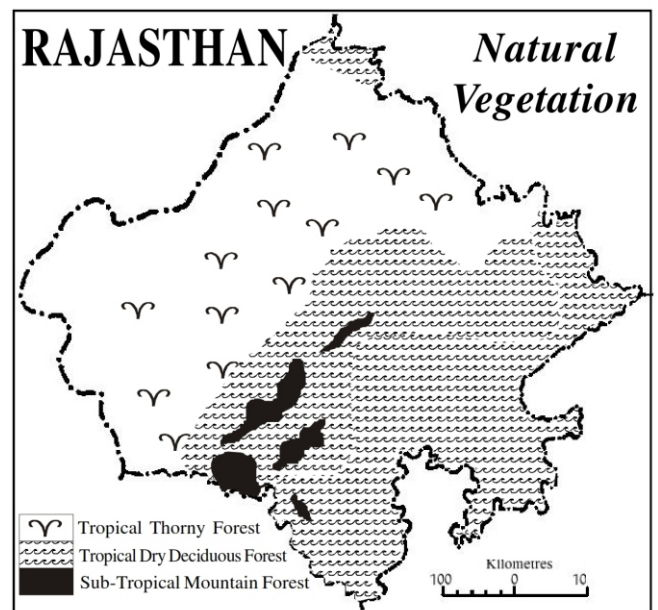


Fig. 13.6 : Rajasthan : Natural Vegetation

centimetres in the region. Summer temperature varies between 36° to 42°C and winter temperatures between 10° to 17°C.

3. Humid Climatic Region – The region receives 50 to 75 cms. of rainfall. Summer temperature varies between 32°C to 34°C and winter temperature between 12° to 18°C. The region encompasses the districts of Alwar, Bharatpur, Dholpur, Sawai Madhopur, Tonk, Bundi, Rajsamand and northern part of Chittorgarh.

4. Very Humid Climate Region – The region receives more than 75 cms. of rainfall. It covers the districts of Kota, Baran, Jhalawar, Banswara, Dungarpur, Sirohi, Udaipur and southern part of Chittorgarh. Monsoon remains most active in this region.

NATURAL VEGETATION

Natural vegetation and forests play an important role in maintaining the environmental and ecological balance. Forests ameliorate local weather conditions, check soil erosion, regulate river flow and provide raw materials for various industries. Forests provide livelihood to many communities and recreational opportunities are provided. Forests minimize the velocity of storms. Forests provide industrial wood, wood for building materials, fuel wood, fodder and many useful and valuable products. Forests provide natural

environment for wild life. Description of the importance of forests is also found in our ancient religious treatise. There had been age-old tradition of worshipping trees as God. But it is regrettable that man has exploited and destroyed forests cruelly in the modern period.

Distribution of Forests

The forest cover in Rajasthan is very thin in comparison to the other states of Bharat because of its physical and climatic conditions

According to the National Forest Policy (1988), about one-third forest cover is required to conserve lively ecosystem whereas the percentage is 24.39 for Bharat and only 9.57 for Rajasthan. The dense forest coverage is found only on 3.83 percent area of Rajasthan. Per capita forest cover in Rajasthan is only 0.03 hectare which is very small in comparison to 0.13 hectare in Bharat. There are large variations in the geographical distribution of forests in Rajasthan (Fig. 13.6).

Dense forest cover in Rajasthan is concentrated mainly in the districts of Sirohi, Banswara, Dungarpur, Udaipur, Rajsamand, Chittorgarh, Jhalawar, Kota, Bundi, Sawai Madhopur and Alwar. More than 20% area of these districts is forested. Dry and desert districts of Churu, Nagaur, Jodhpur, Jaisalmer, Barmer etc. have less than 2 percent of their area under forest cover. Sirohi has the maximum forest coverage (31%) and minimum is in Churu (0.05%), and Jaisalmer is devoid of vegetation. Only thorny bushes and sevan grass is found in Jaisalmer. Now greenery is increasing here with the availability of water by Indira Gandhi Canal.

Types of Forests

The following types of forests are found in Rajasthan due to variations of relief features, climate and soils –

- 1, Tropical Thorny Forests,
2. Tropical Dry Deciduous Forests, and
3. Sub-Tropical Mountain Forests.

1. Tropical Thorny Forests – These forests are found in western arid and semi-arid regions especially in the districts of Jaisalmer, Barmer, Jodhpur, Pali, Bikaner, Churu, Nagaur, Sikar, Jhunjhunu etc. Trees are dwarf in these forests with preponderance of stunted bushes. Khejari, Rohida,

Ber, Ker, Thor trees etc. and a few bushes grow in these forests. Their roots are long and leaves are thorny. **Khejri** is known as the **Kalp Vriksha** of desert due to its tremendous utility in the desert.

A number of bushes are also found in these forests. Foag, Akra, Ker, Lana, Arna and Jharber are the main bushes of this region. Besides, different types of grasses are also found in the region. Amongst these, **sevan** and **dhaman** grasses are very famous. Dhaman grass is very nutritive and useful for dairy cattle whereas sevan grass is nutritive for all animals.

2. Tropical Dry Deciduous Forests – These forests cover a huge area in Rajasthan (Fig. 13.6). These are found in the areas of 50 to 100 centimetre rainfall. Following varieties of trees are found in these forests –

(i) Dry Teak Forests – These forests are found in the areas ranging in elevation from 250 to 450 metres above M.S.L. These forests are so named because of abundance of teak trees. These forests are found in the district of Udaipur, Dungarpur, Jhalawar, Chittorgarh and Baran. Of the total forests, share of teak trees ranges from 50 to 75 percent. Besides, Tendu, Dhawara, Gurjan, Godal, Siris, Haldu, Kher, Semal, Reetha, Baheda and Imali trees are also found in these forests.

The teak trees cannot bear severe cold or frost, therefore, their concentration is in the southern areas of Rajasthan. Teak wood is very useful for making agricultural implements and building materials.

(ii) Salar Forests – These forests are found in the hills rising to more than 450 metres. These forests are prevalent in the districts of Udaipur, Rajsamand, Chittorgarh, Sirohi, Pali, Ajmer, Jaipur, Alwar and Sikar. The main trees of these forests are Salar, Dhok, Kathira and Dhavar. Salar tree is a good source of gum. Its wood is used for packing. Dominance of Salar trees has earned it the name of Salar forests.

(iii) Bamboo Forests – Due to the abundance of bamboo trees these forests are known as bamboo forests. These forests are found in the areas of abundant rainfall in Rajasthan. These forests are prevalent in the districts of Banswara, Chittorgarh, Udaipur, Baran, Kota and Sirohi. Banswara has earned its name from the abundance

of bamboo trees. Dhawara, Teak, Dhokra etc. are also found in these forests.

(iv) Dhokra Forests – The Dhokra forests are found in a very large area of Rajasthan. Except that of the desert, geographical environment of all the areas of Rajasthan are favourable for dhokra trees. Therefore, it is found extensively in the state. These are more prominent at the height ranging from 240 to 760 metres in Rajasthan. These are more prevalent in the districts of Kota, Bundi, Sawai Madhopur, Jaipur, Alwar, Ajmer, Udaipur, Rajsamand and Chittorgarh. Dhokra is also known as **Dhok** in Rajasthan. These forests are included in the chief forest wealth of the state.

The trees of Arunj, Kher, Khirni, Salar, Godal are also found in addition to Dhok trees in these forests. Palash trees are prominent companions of Dhok in hilly and foot-hill areas. Occasional companions are Jharber and Adusa. The dhok wood is very durable. Coal is prepared by burning it.

(v) Palash Forests – These forests are found on hard and rocky surfaced. These trees are more prominent on plateau surfaces surrounded by hills. These forests are also prevalent in the stony plains and in those areas where the soil is hard. Companions of Palash are Jharber, Kankeri, Hingota, Harjan and Arunj trees. These forests are found in the districts of Alwar, Ajmer, Pali, Sirohi, Udaipur, Rajsamand and Chittorgarh.

(vi) Kher Forests – These forests are found in the southern plateau area of Rajasthan, covering Jhalawar, Kota, Baran, Chittorgarh and Sawai Madhopur districts. Bel, Dhokra and Arunj are also found with Kher trees.

(vii) Babool Forests – These forests are found in the districts of Ganganagar, Bikaner, Nagaur, Jalore, Alwar, Bharatpur etc. Their cover is thinner where surface moisture is low and denser in higher moisture areas. Neem, Hingota, Arunj, Ker and Jharber are also found with Babul trees.

(viii) Mixed Deciduous Forests – These forests are found in the southern hills of Rajasthan, covering the districts of Sirohi, Udaipur, Rajsamand, Chittorgarh, Kota and Baran. None of the tree is prominent in these forests. All kinds of trees are found in them. Main trees are Amla, Rosewood (Sheesham), Salar, Tendu, Amaltash,

Rohan, Karanj, Gular, Jamun, Arjun etc.

3. Sub-Tropical Mountain Forest – These forests are found only in Mount Abu area. These include evergreen and semi-evergreen vegetation. Greenery continues throughout the year due to dense vegetation. Mango, Bamboo, Neem, Teak trees etc. are found in these forests. These forests are found in less than 0.5% of the total forested area of Rajasthan.

Administrative Classification of Forests

The forest resources of Rajasthan have been divided into three divisions on the basis of administrative set-up.

1. Reserved Forests – These are state-owned forests in which cutting of trees and grazing is prohibited. These forests cover 38 percent of the total forest area of the state.

2. Protected Forests – These forests are also under government control. Tree cutting and grazing may be done with permission. These forests are found on 51 percent part of the total forested area of the state.

3. Unclassified Forests – There is no government control on tree cutting and grazing in these forests. The remaining 11 percent forested area of the state comes into this category.

Now the aforesaid classification has been replaced by a new classification. The detailed description of which is given on pages 81-82 of this book.

Importance of Forests for Rajasthan

Forests are very important for environment and human society. According to the Forest Policy of 1952 of Government of Bharat, 33 percent area of the country should be devoted to forest. Of this, 65% should be in hilly areas and 20% in plain areas. On this scale, forest cover in Rajasthan is very limited. Hence all efforts should be made for its expansion. There are direct and indirect advantages of forests.

Direct Advantages of Forests – Wood for fuel and building materials, and bamboos etc. are obtained from forests. Besides, honey, wax, catechu, gum etc. are also obtained. Tendu leaves are used in Bidi industry. Many nutritive fruits like mango, jambu (Jamun), mulberry, amla, timru, corinda (Karonda), khirni, custard apple (Sitafal) etc. are obtained from forests. Forests provide fragrant grasses which are used for extracting

fragrant oil and scent. Khas grass is very useful for keeping rooms cool and fragrant. Many herbal plants are obtained from forests. These are used for preparing Ayurvedic medicines.

Indirect Advantages of Forests – Forests also yield many indirect benefits which cannot be evaluated in terms of money. They help in providing rainfall by attracting monsoons, checking the velocity of storms, keeping summer temperatures

mild, checking soil erosion, enhancing beauty of natural scenery, patronizing wild life, maintaining environmental equilibrium and providing oxygen. Forests promote aesthetic sense and positivism of thoughts in the society.

Due to so many benefits of forests, tree plantation is considered to be the holy task in Bhartiya scriptures. Nurturing a tree is also a saintly task.

SOILS

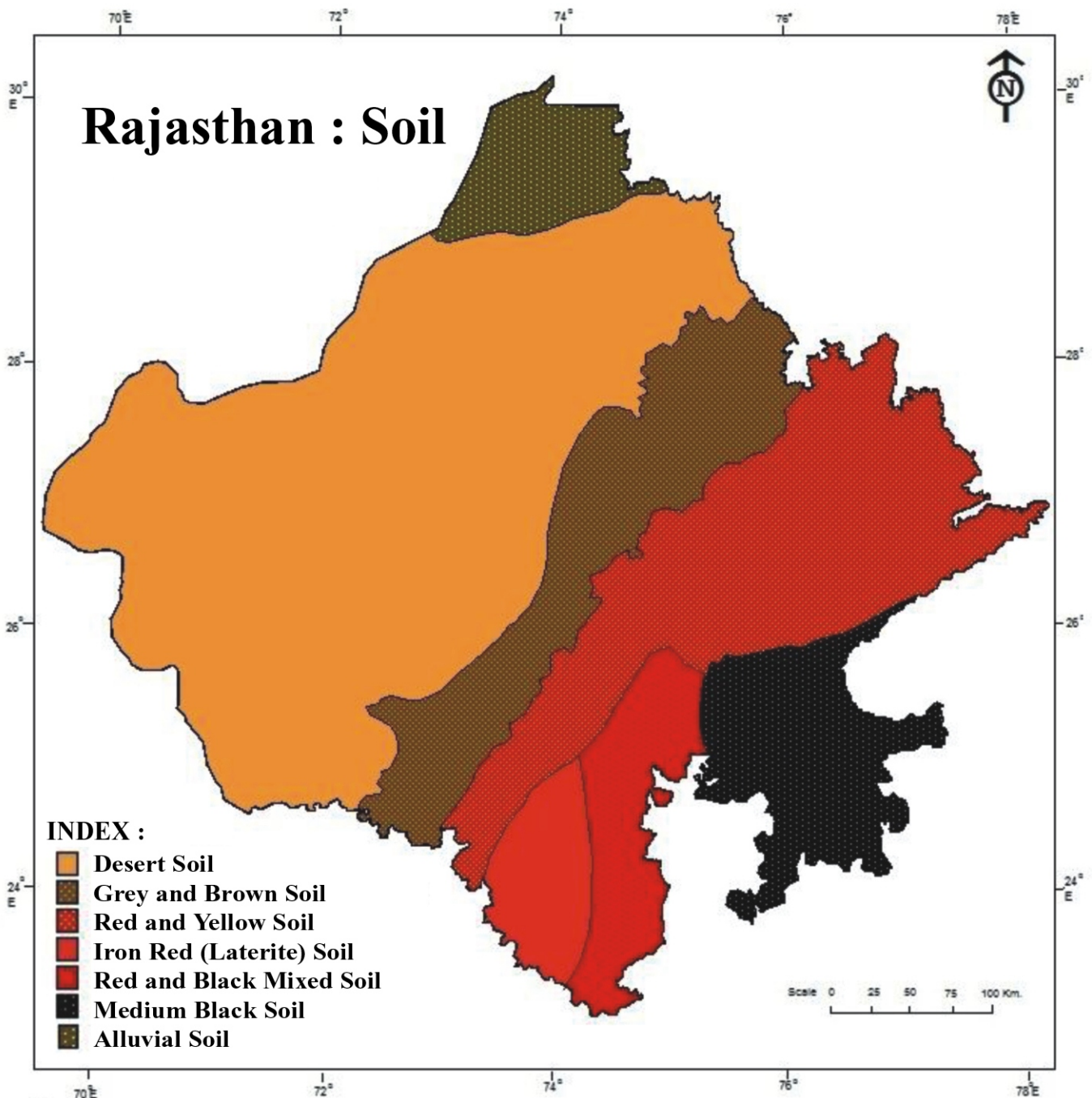


Fig. 13.7 : Rajasthan : Types of Soil

Of all the gifts of nature, soil is the supreme gift to man. It is a valuable wealth of farmer. Entire agricultural production depends on it. Rajasthan is an agricultural state and cattle rearing is a supplementary occupation. Therefore, the importance of soil for the state is further more. According to American pedologist Dr. Bennet - **Soil is the upper layer of unconsolidated materials, found on the surface of the earth which is formed by the combination of disintegrated rocks and vegetative materials.**

A large variety of soils are formed due to environmental diversities. Factors like relief, climate, natural vegetation, length of time etc. influence soil formation process. Parent material, water, air and humus are the four major constituents of soil. Soil is the mixture of solid, liquid and gaseous materials which are the result of interaction between weathering of rocks, climate, plants, and innumerable bacteria.

Types of Soil

The soils of Rajasthan have been divided into six categories on the basis of colour, composition and fertility. These have been shown in Fig. 13.7.

1. Desert Soil – It is found in western Rajasthan. This soil is found in most of the areas of Jalore, Barmer, Jaisalmer, Jodhpur, Bikaner, Churu, Jhunjhunu, Nagaur districts etc. It is a less fertile soil. High range of temperature and physical weathering are the major factors of its formation.

Characteristics –

- (i) The soil is mainly formed by physical weathering.
- (ii) It moves frequently with the wind.
- (iii) It has low fertility and high salinity.
- (iv) Its water holding capacity is low.

2. Red-Yellow Soil – The soil is found in the western parts of Sawai Madhopur, Sirohi, Rajsamand, Udaipur and Bhilwara districts.

Characteristics –

- (i) This soil is suitable for groundnut and cotton cultivation.
- (ii) This soil lacks fertile elements.
- (iii) It is made up of the disintegrated materials of granite, schist and gneiss rocks.
- (iv) It lacks calcium and nitrogen.
- (v) Red and yellow colour of this soil is due

to its iron content.

3. Laterite Soil – It is found in Dungarpur, central and southern part of Udaipur and southern Rajsamand districts. This soil is composed of the disintegrated materials of old crystalline and metamorphic rocks.

Characteristics –

- (i) It lacks nitrogen, phosphorous, humus contents etc.
- (ii) The colour of this soil is red due to the presence of iron content.
- (iii) Maize, rice and sugarcane are cultivated in this soil.

4. Mixed Red and Black Soil – It is found in Banswara, eastern Udaipur, Dungarpur, Chittorgarh and Bhilwara districts.

Characteristics –

- (i) It lacks calcium, nitrogen and phosphorus but contains sufficient potash.
- (ii) It has a larger proportion of clay.
- (iii) Cotton, sugarcane, maize etc. are cultivated in this fertile soil.

5. Black Soil – This soil is found in the state's south-eastern districts of Kota, Bundi, Baran and Jhalawar.

Characteristics –

- (i) It is a loamy soil with higher clay content.
- (ii) Calcium and potash are sufficient in this soil but it lacks nitrogen.
- (iii) The fertile soil yields high production of commercial crops like sugarcane, coriander, rice and soyabean.

6. Alluvial Soil – The soil is found in the state's northern and eastern districts of Ganganagar, Hanumangarh, Alwar, Bharatpur, Dholpur, Karauli, Sawai Madhopur, Dausa, Jaipur and Tonk.

Characteristics –

- (i) It has a light brown red colour.
- (ii) It is a sandy loam in composition.
- (iii) It is a fertile soil.
- (iv) It is rich in calcium, phosphorous, potash and iron contents but lacks nitrogen.
- (v) This soil is suitable for growing wheat, mustard, cotton and tobacco.

Soil Problems

1. Soil Erosion

Soil erosion is a serious problem in

Rajasthan. It is known as **creeping death** in view of the loss of soil and its fertility. Flowing or blowing away of upper fertile layer of soil by water or wind is known as soil erosion. Soil erosion occurs in the form of sheet erosion and gully erosion. About 4 lakh hectares of land of Rajasthan is affected by water erosion. Chambal and its tributaries have eroded Hadauti plateau considerably. Kota, Sawai Madhopur and Dholpur districts have suffered gully erosion whereas the western dry desert is affected by wind erosion (sheet erosion). Thus, thousands of acres of Rajasthan has become and is becoming badland.

Causes of Soil Erosion

1. Fast flowing water carries upper fertile layer of soil.
2. Several gullies and depressions are created by fast flowing water on steep and vertical slopes.
3. Unconsolidated soil particles are blown away by speedy winds in the absence of vegetative cover.
4. Soil erosion is enhanced by illogical deforestation. Tree roots keep the soil bound and consolidated.
5. Overgrazing has exposed surface soil for erosion.
6. Jhooming or shifting cultivation promotes soil erosion.
7. Unscientific ways of agriculture enhance soil erosion.

Measures to Check Soil Erosion

1. Velocity of running water should be checked by bunding the fields and by constructing dams and anicuts in areas of flooding.
2. Deforestation should be checked and afforestation be encouraged.
3. Grazing should be controlled.
4. Plantation should be done in rows in order to check wind velocity and soil erosion in arid areas.
5. Soil erosion can be checked considerably by terracing fields, contour ploughing and practicing crop rotation.

2. Problem of Soil Fertility Loss

Soil fertility decreases and the problems of salinity and alkalinity arise due to continuous use of

soil and by adopting faulty ways of cultivation. About 7.2 lakh hectares of land is saline and alkaline in Rajasthan. Although, the problem is prevalent everywhere in the state but it is prominent in Alwar, Bharatpur, Jaipur, Nagaur, Pali, Jodhpur, Bhilwara, Chittorgarh and Sirohi districts. Soils suffer from the problem of water logging in the areas where canal network is dense.

Ways to Maintain Soil Fertility

1. Excessive surface flow of water creates the problem of water logging by which fertile ions of soil are leached. Hence, drainage should be controlled.
 2. Barley, cotton, maize etc. should be cultivated to control soil salinity.
 3. Crop rotation of pulses like gram, green lentil (moong) etc. to recover nitrogen component in the soil.
- Crores of rupees are being spent by the government on various projects but the farmer's awareness and participation can be more effective.

Important Points

1. The long term average weather conditions of a given area is known as the **climate** of that area.
2. Temperature, pressure, winds, rainfall etc. are the elements of climate.
3. The climate of Rajasthan varies from dry to semi-humid monsoon type.
4. Fast moving, dry and hot **Loo** blows in summer season.
5. Maximum rainfall occurs in rainy season.
6. Unequality, variability and uncertainty is found in the quantity, distribution and duration of rainfall.
7. Summer season prevails from March to mid-June.
8. In summers, the sun shines vertically over the Tropic of Cancer which passes through the southern part of Rajasthan.
9. Rajasthan receives rainfall through the Arabian Sea and Bay of Bengal branches of monsoon.
10. The annual average rainfall for the whole of Rajasthan is 52.37 centimetres.
11. Temperate cyclones coming from the west and north-west in winter season provide rains twice

or thrice in the form of **Mawat** which is useful for Rabi crop.

12. Rajasthan has been divided into four main climatic regions on the basis of temperature and rainfall.
13. Forests play a major role in maintaining environmental and ecological balance.
14. The forest cover in Rajasthan is very small in comparison with that of Bharat.
15. The maximum forest cover in Rajasthan is in Sirohi district.
16. Teak forests are mainly found in Banswara, Dungarpur, Chittorgarh and Udaipur districts.
17. Parental materials, relief, climate, natural vegetation and duration are the contributors to the soil formation process.
18. Desert soil is found in western Rajasthan.

Exercise

Multiple Choice Questions

1. Rajasthan's average rainfall is –
(A) 52.37 cms. (B) 65.62 cms.
(C) 25.25 cms. (D) 100.85 cms.
2. The district in which sub-tropical mountain forests are found, is –
(A) Alwar (B) Jaipur
(C) Ajmer (D) Sirohi.
3. The forest cover required in any given area as per the National Forest Policy, is –
(A) 2/3 (B) 1/3
(C) 1/4 (D) 3/4.
4. The types of soil found in Rajasthan, are –
(A) Seven (B) six
(C) Nine (D) Ten.

Very Short Answer Type

5. What type of climate is found in Rajasthan?
6. In which month, the sun shines vertically over the Tropic of Cancer?
7. What is Mawat?

8. In how many climatic regions is Rajasthan divided?
9. In which districts teak forests are found?
10. Give two major soil problems of Rajasthan.
11. What is creeping death?
12. Name two types of soil erosion.

Short Answer Type

13. Define climate and describe its elements.
14. Give any four characteristics of the climate of Rajasthan.
15. Why Rajasthan receives low rainfall?
16. Give the main characteristics of highly arid climatic region.
17. Where are dense forests found in Rajasthan?
18. Give causes of soil erosion.
19. Mention the ways to check soil erosion.

Essay Type

20. Give a detailed description of the main seasons of Rajasthan.
21. Divide Rajasthan into climatic regions and describe them in detail.
22. Give detailed description of the forests of Rajasthan.
23. Describe briefly the soils of Rajasthan.

Skill

24. Mark the isotherms of January and June on an outline map of Rajasthan.
25. Mark the climatic regions of Rajasthan on its outline map.
26. Mark the forest areas of Rajasthan on its outline map.
27. Mark the soil types on an outline map of Rajasthan.

Answer Key

1. (A), 2. (D), 3. (B), 4. (B).

Glossary

A

Abrasion :

The degradation of any part of the earth's surface by the movement of air, water or Glacier.

Absolute Humidity :

It is the mass of water vapour, in a given volume of air which is usually expressed in grams of water vapour per cubic metre of atmosphere, at specific temperature.

Absorbtion :

It is a natural process in which a specific substance absorbs the radiating heat and the observed energy cannot be transformed again in any other form.

Abysal :

It is related to the depth of the oceans. Generally, its depth varies from 2200 to 5500 m (1200 to 3000 fathom)

Abysal deposit :

The organic deposits accumulated on the ocean basins.

Ablation :

It is the natural removal of Snow or Ice from the surface of a Glacier or snow field, this can occur through melting or sublimation.

Actinometer :

The instrument which is used to measure the intensity of radiation.

Advection :

The horizontal movement of wind, water or any other liquid material. For example the horizontal transfer of heat by the wind neither increases nor decreases.

 Aoelin :

The transported, eroded and deposited material by the wind.

Aerology :

The study of atmosphere with the help of atmospheric balloons, airplanes and clouds.

Airmass :

A homogeneous mass of the air that covers a considerable area on the surface of the earth. Air masses are classified according to the regions of their origin example tropical or polar and according to whether they are of maritime or Continental type.

Albedo :

The proportion of the radiation which is being received from the sun and which is falling on a non -luminous body that is reflected later. It is generally expressed as decimal. The albedo of the Earth is approximately 0.4 i.e 40 percent.

Alluvial Cone :

A type of alluvial fan in which the deposit is deep and the surface is steeply inclined due to the sinking and evaporation of the water of the stream.

Alluvial Fan :

The deposition of the sediments brought down by the river as it enters the plain. The Alluvial fan extends to many kms and many alluvial fans of the nearby rivers may often unite to form a continuous plain, which is also known as pedimont Alluvial plain. The Alluvial material may extends upto hundreds of metres.

Alluvial Plain :

A plain formed by the deposition of the sediments brought by the river.

Altimeter :

A type of aneroid barometer, used to display the average height above the ocean floor by the airplane or surveyors.

Antarctic:

It is the portion of the Earth's surface, in the southern hemisphere that lies within the Antarctic circle 66° -32' south. The sun does not rise on 22 December and 21 June.

Anticyclone :

Region where the atmospheric pressure is high compared with that of the nearby regions and is depicted by very close isobars. The winds blow in the clockwise circulation in the Northern hemisphere and anticlockwise in the southern hemisphere.

Antipodes :

The exact opposite points on the surface of the earth to any other given point is known as Antipode. If a line is drawn between these it will pass through center of earth.

Atmosphere :

The envelope of air which includes gases, water vapour and dust particles that surrounds the Earth.

Aphelion :

The position of the Earth on its Orbit when it is farthest from the sun , like on 4th July at this position the Earth is 15.2 million kilometres away from the sun.

Arctic circle :

The parallel or line of latitude of 66° -32' in the Northern hemisphere. The sun does not set here on one day of the year, about 21st June and on 22 December, during the northern mid winter the sun does not rise.

Arete :

Slopy ridge of naked rocks, specially the top between two nearby cirques which is almost horizontal.

Aridity :

The condition of dryness or very less moisture, where the plants cannot grow because of scanty rainfall.

Autumn :

The third season of the year, in the Northern hemisphere, which is observed after

summer and before the winters, from 21st September to 21st December.

B

Barchan:

A crescent shaped heap of sand, having the horns projecting towards wind caused by blowing of the wind. It is mostly found in sandy deserts.

Biosphere:

The biosphere is the part of the earth's surface and atmosphere where there are living things.

Breeze:

The word 'breeze' refers to that current of wind force, which is measured on the Beaufort scale that ranges between force of 2 (Light breeze 5 knots) and force of 6 (strong breeze 28 knots). The current of wind is too light to be known as wind.

C

Caldera:

It is a large basin-shaped 'Crater' that is bound by steep cliffs, generally formed due to lava-eruption and subsidence of the top of volcanic mountain.

Chinook:

These are dry warm south-west wind blowing down the eastern slopes of Rockies in Alberta W. Saskatchewan and Montana. During the spring it causes increase in temperature and the snow melts rapidly.

Cirque:

It is a deep, rounded hollow having steep sides, usually found in the glaciated regions, formed through the erosional work of glacier. It has many names like 'corrie'.

Clay:

A fine grained substance, that can retain moisture and become plastic on being mixed with water, many types of clays contain aluminium silicate, which are formed by the process of decomposition and weathering of different types of rocks.

Cliff:

A high and extremely steep rock face that approaches the vertically, either inland or along a coastline.

Climate:

The total complex of weather conditions, its

average characteristics and range of variation over on large area of the earth for a longer period of time. Usually these conditions are result of weather conditions and are considered for many years and are mainly caused by rainfall, temperature, atmospheric pressure humidity, clouds and other elements of weather.

Cloud:

The tiny visible particles of water, or sometimes ice (0.02-0.06 mm in diameter) which are formed by condensation around a nuclei, such as dust, smoke particles or salts.

Condensation:

The physical process by which a substance is changed from the vapour to the liquid or solid state.

Cone:

A volcanic peak having a broad base tapering in form of a summit is called cone.

Continental drift:

The hypothesis that proposed that the continental masses have changed their relative positions, because of fragmentation and moving apart of an original larger mass. This hypothesis was proposed by Alfred Wegner (1910).

Corrasion:

The mechanical erosion or the frictional wearing down of a rock surface by material moved under gravity or transported by running water, ice, wind and waves.

Corrosion:

It refers to the wearing away of the rocks by chemical actions like solution, hydrolysis, oxidation and hydration

Cumulus cloud:

A cloud having vertical development, usually having a flat base and are round or dome shaped and sometimes reaches to greater heights.

Current:

The distinct and well defined movement of water in a river. The vertical motion of air in an airmass. A permanent or seasonal movement of surface sea-water.

Cycle of erosion:

A complete series of changes or stages through which a landmass passes from the inception of erosion on an exposed surface

to the final stages (youth, mature and old) when its worn down to the sea level or a featureless plain.

Cyclone:

A small tropical low pressure system with a diameter of 80 to 400 kms, occurring in the Arabian Sea and Bay of Bengal between 6° to 20° North.

Cyclone Rain:

It refers to rain associated with cyclone or depression and is usually caused by a warm, moist air mass that is moving upwards over colder or heavier air.

D

Degradation:

It refers to the lowering of the earth's surface due to natural processes, specially by the river. The transportation of the eroded material is also included under this.

Delta:

A fan-shaped triangular alluvial tract formed at the mouth of a river.

Denudation:

The wearing away of the outer cover of the rocks by various natural agents, as water and snow.

Deposition:

The accumulation of the eroded material at a particular place by the natural agents like running water, wind, snow and sea waves.

Desert:

A region characterized by scanty rainfall and very less vegetation.

Dew:

The accumulation of tiny water droplets near the earth's surface and the objects near it is called dew.

Dew point:

It refers to a critical temperature at which the air is being cooled, and becomes saturated with water- vapour and below which the condensation causes the formation of tiny droplets of water, provided that some nuclei for condensation are present.

Doldrums:

The equatorial belt of low atmospheric pressure where the North-East and South East trade winds converge, which lead to the formation of calm and light surface winds and a strong upward movement of air.

Drainage:

The discharge of water from any area or a region through system of natural streams.

Drumlin:

An elongated hill or a ridge of boulder clay, usually oval in shape found in the glaciated region. Its long axis is parallel to the direction of the flow of ice.

Drainage area:

A catchment area where the surface water flows in form of single stream in a specific direction.

E**Earthquake:**

The sudden movements of the rocks (within the rocks) of the earth that generates elastic shock waves which spreads in all directions.

Ecology:

The science that deals with the study of living organisms and their inter relations with their environment.

Ecosystem:

An organic community of plants and animals within its physical environment.

Environment:

The whole sum of surrounding external conditions within which an organism or a community lives.

Epicentre:

A point on earth's surface that is vertically above the point of origin of seismic focus of an earthquake.

Equator:

The 0° latitude, therefore great circle which is located both midway from both the poles and is perpendicular to the earth's axis. Its total length is 40069 kms.

Equinox:

It refers to that time of the year when the sun appears vertically overhead at noon at the equator. It is the time when all the places on the earth have equal day and night. The sun rises exactly in the east and sets exactly in the west. There are two equinoxes per year, one on March 21 (Vernal equinox) and the other on 22nd September (Autumn equinox).

Erosion :

The process of the wearing way of the earth's surface through natural agents like sea,

rivers and rain. Ice in form of glaciers, frost and melting snow also contributes in the process of erosion.

Eruption:

It is a process during which the solid, liquid or gaseous material gushes out of the interior of the earth towards its surface.

Esker:

A term that is broadly used to describe, a long, narrow ridge of sand or gravel that is usually found in glacial regions.

Evaporation:

It is the process through which the substance changes from liquid to the vapour state. The evaporation of the surface water by the heat of sun, from the oceans, lakes, rivers etc. is the cause of water vapour in atmosphere. As the atmosphere is never completely saturated, the evaporation continues all the time, the rate of evaporation depends on the air temperature, the amount of water vapour already present in the atmosphere, the nature of the water, surface the wind.

Eye of the storm:

The term is used to describe the central area of a Hurricane or a tropical storm, where the atmospheric pressure is 96 mb with almost negligible wind velocity.

F**Flood plain:**

A plain that borders a river, which has been formed by the deposits of the sediments carried by the river. During floods the river deposits fresh layer of alluvial soil over it.

Fog:

The invisibility developed in the layers of the atmosphere due to the condensation of water-droplets, together with particles of smoke and dust held in suspension. According to the International Meteorological Code, the term is defined as a visibility of less than 1 km.

Front:

The line of separation at the earth's surface formed between cold and warm air masses. Generally, it is formed by the horizontal movement of these air masses that have formed in the widely different regions like tropical and polar air. Both the types of air masses comes in contact with each other at

this line of separation.

Frost:

When the temperature of the air is below 0°C or even lower than this, the water vapour present in the air freezes in form of minute ice crystals termed as frost.

G**Geodesy:**

It is a science of the measurement of the shape and size of the earth, including its density and its weight and is also used for surveying of large portions of the earth's surface in which the curvature of the earth has to be considered. It is actually a branch of mathematics.

Glacier:

A mass of ice that moves slowly down a valley, from its source of its origin towards the lower margin, under the impact of gravity. It is also called mountain glacier, valley glacier or Alpine glacier.

Granite:

It is a coarse-grained plutonic rocks that always contain Quartz and Feldspar, along with other minerals. Its structure is so coarse that the different mineral grains can be easily seen and can be clearly distinguished from one another.

Great circle:

A circle on the earth's surface whose plane passes through its centre and bisects it into two different hemispheres is known as great circle. Two opposite meridians together form a great circle, the equator is a great circle. The shortest distance between two points on the earth's surface is the arc of the great circle that passes through them.

Greenhouse effect:

A phenomena related to insolation because of earth's atmosphere, it allows the short wave solar energy to reach the earth's surface and gets heated, but the earth also absorbs the long wave radiation from the earth when its cloudy. Therefore the temperature at the earth's surface remains more than average. Thus our atmosphere acts like the glass of greenhouse.

Grid:

A network of horizontal and vertical lines

that cut each other at right angles on any map series. The location of any point or place is calculated with the help of the grid.

Ground water:

The water that exists inside the earth's surface in the saturated zone of rocks. It percolates from pores on the earth's surface. It is also called underground water.

Gulf stream:

It is a warm ocean current that originates in the Gulf of Mexico and moves along the eastern coast of North America and touches the south-eastern coast of Newfoundland and reaches Scandinavia.

H**Hanging valley:**

When the main valley has been over deepened by a glacier, as a result a stream flowing down a hanging valley suddenly falls as rapids into the main valley. This type of valley is mostly formed in glacial regions.

Hemisphere:

The half of the earth's surface produced when a plane through its centre that bisects the earth. The earth is generally divided into northern and southern hemisphere. Sometimes the earth's surface is also divided into water hemisphere. Water hemisphere is used for North and South America.

Horizon:

The line at which the earth's surface and the sky appears to meet.

Horse latitude:

The sub-tropical belts of the high atmospheric pressure over the oceans, in both the hemispheres between the Trade Winds and Westerlies (in the mid of 30°N - 35°N and 30°S-35°S). These belts shift north and south with the sun and regions of calms and light variable winds.

Hurricane:

It is an intense tropical storm in Western Islands and Gulf of Mexico, mostly occurring in the months of August and September. High velocity winds and storms causes heavy rainfall. Here wind comes down and anti-cyclonic conditions are produced.

I

Inselberg:

It is an isolated hill, ridge, or small mountain that abruptly protrudes out from a virtual level of the surrounding plains. It's height may be upto 325 meters from the surrounding plain.

Insolation :

The energy received by the earth's surface in the form of short waves is termed as Insolation. The sun is celestial body of hot gases where the surface temperature is 5700 degree Celsius and that of the centre is 450 million degree Celsius. It keeps on releasing its radiant energy in the form of waves.

Ionosphere :

The layer of the atmosphere which is just above the stratosphere that reflects electromagnetic waves back to the earth is called as ionosphere. Polar lights (aurora) is also visible in this part. The ionosphere is also called as thermosphere.

Isobar :

It refers to a line on a map or chart, which connect places with equal atmospheric pressure. In order to make the pressure readings comparable with one another they are corrected by reducing to mean sea level.

Isoneph :

It refers to a line on a map that connects the places with equal average cloudiness over a certain period.

Isotherm :

A line on a map that connects places with the same temperature over a certain period. The temperature is normally reduced to mean sea level so as to remove the differences on account of altitude.

J

Jet stream :

A strong wind blowing horizontally at the speed of 50 to 60 knots at the altitude of 12000 meters.

K

Kame :

A mound of gravels and sand that is formed by the deposition of the sediments brought by the stream. Mostly they are formed by sand and gravel in glacial regions.

Karst:

1. A name given to an area of rugged limestone plateaus and ridges near Adriatic coast of Yugoslavia.
2. Area of limestone topography, which is usually barren. Mostly of the entire drainage pattern is underground.

L

Landform:

The particular shape or form and nature of any feature on the earth's surface.

Landscape :

The sum of all the aspects of any region, which may be rural or urban.

Landslide :

The movement of a mass of rock or debris on earth down a slope due to gravity or increase in moisture.

Limestone :

A type of rock, which consists 50% of calcium carbonate.

Longitude :

The angular distance of a place either east or west of main meridian (0° or Greenwich) measured along the equator between the meridians that runs from east to west. It can be measured in any of these two directions upto 180 degrees.

Long profile :

The profile of a river, from its source to its mouth.

M

Magma :

The molten material that exists inside the earth's crust, having very high temperatures and contains gases and volatile material.

Magnetic pole :

The two poles of earth's magnetic field, that are situated in North America and Antarctica and are depicted by free swinging magnetic needle in a horizontal plain.

Mantle :

The layer of ultra basic rocks with the thickness of 2900 kilometres and density 3.3 to 3.3 found between crust and core.

Meander :

The curve in the course of a river. It is derived from a river named Meander in Turkey.

Mid latitude :

A latitudinal region that extends between 23 to 26 degree in northern and southern hemisphere. It is now being used in place of temperate latitude.

Millibar :

A unit to measure the pressure, which is equal to 1000 of a bar. It is used to depict the distribution of atmospheric pressure on synoptic charts. The registered pressure at 45 degree north and south latitudes is 1013.2 millibar the mean sea level.

Moon :

The satellite of the earth, that revolves around it. It is the only celestial body which revolved around the earth. In cosmology this word is used for satellite of a planet. The moon completes its one revolution around the earth in 29.5 days. The diameter of the moon is slightly more than 1/4th of the earth.

N

Nunatak :

A rock peak that projects prominently above the surface of the ice sheet. It is mostly found in Greenland and Antarctica.

O

Ocean Current :

An ocean current is a continuous, and directed movement of sea water generated by prevailing winds, different temperature and variation in salinity distribution.

Orbit :

The path of the heavenly body through space in relation to some selected point.

P

Peninsula :

A stretch of land which is surrounded by water on three sides. For example, peninsula of India and Italy.

Perihelion :

The nearest point of any celestial body in its orbit, around the sun. The earth comes in this position on January 3, when it is 14.73 crore kilometres away from the sun.

Planet :

The solid heavenly bodies, smaller than sun revolving round the sun is called Planet. There are presently 9 planets in our solar system including earth. The planets do not reflect heat and light.

Plateau :

An extensive uplifted land mass with a flat top with one or two stiff slopes.

Pole :

One of the two points at the northern and southern extremes of the earth.

Pole star :

The star that is generally seen in the zenith at the north pole and therefore used to find the true north from any point on the earth's surface.

Precipitation :

Any form of the deposits of water present in the atmosphere, which reaches the earth in liquid or solid form.

R

Radiation :

The process in which a body releases its heat energy in the form of waves. In climatology it means the energy released from short wave radiations from the sun.

Rapid :

When the current of the river is flowing with more than normal swiftness it is called rapid. This may be due to stiff slope or successive rocks at the bottom of the river.

Relative humidity :

A ratio of amount of water vapour actually present in the air having definite volume and temperature to the maximum amount of air can hold.

S

Satellite :

A relatively small body that revolved round the planet. For example moon is the satellite of the earth.

Seasons :

The distinct period into which the year may be divided in terms of duration of day light and of climatic conditions because of changes in duration and intensity of solar radiation. In temperate latitude there are 4 seasons of 3 months each. For example spring season March, April and May, summer season in June, July and August, autumn season in September, October November, and winter season in December, January and February. The seasons are totally opposite in Southern Hemisphere.

Seismic Focus :

The point below the earth's surface where

the earthquake originates and from where the vibrations spread in all the directions. It is now believed that focus is generally to several kilometres in a linear pattern rather than a single point.

Seismology:

The science of the study of earthquakes.

Sirocco :

The southerly wind blowing in north Africa, Sicily and southern Italy and upto Sahara of Africa. As they are originated in desert they are mostly arid. But it becomes moist as it reaches southern Italy.

Snow :

The precipitation which is in the form of ice crystals. These crystals may join together and may form snowflakes.

Solar system:

A group of celestial bodies which include sun and planets, satellites that revolve round the planets, asteroids, meteoroids, comets.

Solstice :

It is the period during summer and winter season when the sun is vertically above equator ($23\frac{1}{2}^{\circ}$ north and $23\frac{1}{2}^{\circ}$ south.) When the sun is at its maximum declination the sun shines vertically over tropic of cancer on June 21 and on tropic of Capricorn on 22nd December.

Spring :

1. The season following winter, reckoned astronomically to the last in northern hemisphere from the spring equinox (about 21st March) to the summer solstice (about 21st June) during February, March and April.

2. A continuous flow of water from the ground.

Standard Time :

The time that is referred to the mean time of certain meridian and is fixed over a wider area for example 82° is taken as standard meridian for India.

Stratosphere :

The layer of the atmosphere that lies just above the troposphere extending upward to the height of 90 kilometre up to ionosphere. It is about 18 kilometres at the equator, 9 kilometres at 50° north and south latitude and 6 kilometres at the pole. Its height

varies according to the changes in the season.

Sunrise; Sunset :

The time at which the sun appears to rise above and set below the horizon due to the rotation of earth.

Syzygy :

The position when the sun, moon and earth are in the same line, either in conjunction or opposition. It happens on full moon day or no moon day (Amavasya).

T

Tarn :

A small lake among the mountains in the cirque basin. Sometimes the stream also originates from it.

Temperate zone :

The zone between torrid and frigid zone, in the northern hemisphere between tropic of cancer and arctic circle and in the southern hemisphere between tropic of Capricorn and Antarctic circle. The sun is never overhead in the zone and the sun rays always slanting. This zone is also called as mid latitude.

Temperature :

The degree of heat of a body measured by thermometer usually expressed degrees in Celsius and Fahrenheit.

Time zone :

When the mean time of meridian near the center of zone is adopted as a standard for the whole region.

Tornado :

A violent storm near the Mississippi basin that whirlwind around low pressure center. The winds blow with the speed of 320 km/hr and causes heavy rainfall and thunder. It takes place most frequently during spring and early summer almost always in the afternoon when the surface temperature is maximum. Its diameter is less than 100 meter. It is also called hurricane, typhoon and willy-willy. It causes economic loss.

Torrid Zone :

It refers to the warmest of the three latitudinal temperature zone that means burning or hot. Hence torrid zone, the others being temperate and frigid zone. It lies on both sides of equator in the form of broad belt.

Trade wind :

The wind that blow from subtropical belts high pressures towards the equatorial region of low pressure from north east in the northern hemisphere and south east in the southern hemisphere.

Tropical cyclone :

A region of low atmospheric pressure relatively small in area but accompanied by violent storm conditions that originate in tropical regions. The winds of hurricane strength circulate round the center and is often called eye of the storm. The velocity of the wind ranges from 112 to 128 kilometers or 70 to 80 miles per hours but sometimes it reaches upto 160 kilometers (100 miles) per hour. The regions that come under this cyclone may observe 5 inches of rainfall in just 24 hours. These cyclones cause loss of lives and property. It is known by different names in different regions. For example hurricanes in Atlantic ocean, Typhoon in west pacific ocean, hurricane in south pacific ocean and willy-willy in north, west of Australia and cyclone Indian Ocean and Bay of Bengal

Tropic of cancer :

The parallel of latitude $23\frac{1}{2}^{\circ}$ north, showing the northern position at which sun shine vertically at noon. This situation occurs on 21st June.

Tropic of Capricorn:

The parallel of latitude $23\frac{1}{2}^{\circ}$ south, indicating the southern position where the sun shines vertically. This condition occurs on 21st of December.

Tropics :

The zone between the tropic of cancer and tropic of Capricorn, where the sun shines vertically two times in a year and the climate often remain warm.

Troposphere :

The lower layer of atmosphere ,which is at the height of 10 to 16 kilometres. It is below stratosphere. Tropopause is found between these two layers. The entire water vapour and clouds are found in this layer.

Typhoon :

A small, intense vertical tropical storm in China sea characterized by winds of terrific force, heavy rains and thunderstorms. It is very similar to the storms observed in the Bay of Bengal and Arabian sea.

V**Valley :**

A long narrow depression surrounded by mountains on both sides on the earth surface having a downward slope through which a river or glacier flows

Visibility :

1. The distance that an observer can see depending on first his height above sea level with which is involved the curvature of the earth's surface.
2. The amount of invisible ground.
3. The clarity of the atmosphere.
4. The time of day and night.

Vulcanology :

The science of the study of volcanoes.

Volcanism :

The process in which, hot molten magma gushes out on the earth's surface.

W**Water fall :**

A sudden fall of water, generally due to a bed of hard rock in the course of the river, overlying the other softer rocks.

Weather :

The condition of the atmosphere at a certain time over a certain short period which includes atmospheric pressure, temperature, humidity, rainfall and wind speed and its direction.

Weathering :

The decay or disintegration of rocks on the earth's surface by the processes of denudation.

Westerlies :

The winds that blow with great velocity, in the regions on the poleward sides of the subtropical high pressure areas (35° to 65° in north and southern hemisphere). They blow in the south west direction in the northern hemisphere and north west direction in southern hemisphere.

Wind :

The movement of air, parallel to the surface of earth which do not have definite direction or speed.

Windward :

The side or a direction that faces the wind. Its opposite side is called leeward.

Year :

The time period during which the earth completes its one revolution around the sun, which is of 365 days 5 hours 48 minutes and 46 seconds. Generally, the duration of the year is considered to be 365 days for the sake of convenience and the fourth year is of 366 days, which is also known as leap year.

Young Mountain :

It is referred to the fold mountains that are created during the last period of folding as Alps and Himalayas.

Zone:

A term generally used to describe general (Similar) conditions of a region specifically it refers to three belts in both the hemisphere which are formed on the basis of latitude. For example torrid zone, temperate zone and frigid zone.