

GEOGRAPHY

HIGHER SECONDARY - FIRST YEAR

Untouchability is a sin
Untouchability is a crime
Untouchability is in human



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PREFACE

Geography is a very wide subject and this has caused certain problems for both students and teachers. Its character, aims and methods of approach have altered considerably in the recent past so that a subject was once essentially descriptive and qualitative has become more scientific now. Thus an attempt is made in this textbook, to introduce a new concept, the Earth System Science, both in content and in structure.

The content closely interweaves environmental problems and issues with principles of science necessary to their understanding. By presenting science topics simultaneously with environmental implications, we hope to have achieved a book that is readily teachable and holds student interest. At the same time, the text emphasis the key role of geography in the understanding of environmental problems and their solutions.

For the structure of the text we have also adopted a new format : Our text contains of a small number of study units each deals with a specific topic and the main text portions of each unit contain not only science principles but also conventional ideas. Organizing the book into short units should be easier for students to master.

This textbook is divided into two parts each containing two to three study units. Part I, Theory covers systematically the essential geographical background to understand the dynamic nature of the Earth. The three study units emphasize two distinct facets of Earth system science : 1. The Earth is a system and has components; 2. The environmental impact of humans on the Earth systems.

Geography is a way of thinking, of asking questions, of observing and appreciating the world around us. You can help your students learn by providing interesting activities for them, and by prompting them to ask

questions about their surroundings. The activities suggested in this book are only a few examples of the many ways that students learn geography. We hope they will stimulate your thinking and that you will develop many more activities on your own.

Each lesson is provided with a minimum of two activities. A separate notebook for activities should be maintained and submitted along with the practical record. Questions for evaluation should be framed both from the text (60%) and as well as the activities (40%).

Helping every student develop his or her ability to use maps and to develop mental maps of the world ought to become a priority in our schools. For, as we all know, our lives are becoming an ever tighter weave of interactions with people around the world. If our businesses are to fare well in tomorrow's world markets, if our national policies are to achieve our aims in the future, and if our relationships with other peoples are to grow resilient and mutually enriching, our students must grow to know what in the world is where.

With this in our mind the Part II Practicals is designed with two study units. Expose students to lot of maps and let them see you using them. Get a good atlas as well as a dictionary. Atlases help us ask, and answer, questions about places and their relationships with other areas.

One way to help students see the relationships among specific information (such as the Earth system and its components) is to use concept maps. Concept maps represent information visually and encourage the understanding of complex information quickly. Their use should help students develop their powers of critical thinking. With this book, we hope you, as teachers, will get ideas for activities that will help your students to learn more geography, the study of the Earth.

Dr.S.Rani Senthamarai
Chair person

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1. HUMANS AND THEIR ENVIRONMENT

The interface of air, water and land forms a life supporting layer known as the biosphere. The biosphere is the broadest Earth ecosystem, which is the spatial unit for the study of environmental geography. The prime concern of environmental geography is to study the components of natural environment separately and together, their linkages at various levels through physical and biological processes and human responses to environment relationships. These aspects cannot be studied in isolation. They are not only linked together but also to the physical environment in which they are found. Thus to understand the environment you will need to study each of the Earth system components : lithosphere, hydrosphere, atmosphere, and biosphere.

The physical and biological components of the Earth are interlinked with each other, like a tapestry. If we pull a thread from a tapestry at one end, the whole tapestry can unravel. Similarly even a slight modification in the Earth's environment can lead to disasters such as floods and droughts, extinction of species and so on. In particular, species extinction is quite common these days. One fourth of the species presently living on the Earth may become extinct by the end of this century if the present environmental conditions persist. So, let us understand in this lesson about, the relationship that exists between the humans and their environment.

Human and their Environment

In geography, the relationship between humans and environment are identified as an overall system. In this system, the factors such as humans, animals, plants, climate, rocks and soils have a functional (Fig. 1-1) interaction. This functional interaction is under threat always by the development of science and technology and has adverse effects on our environment.

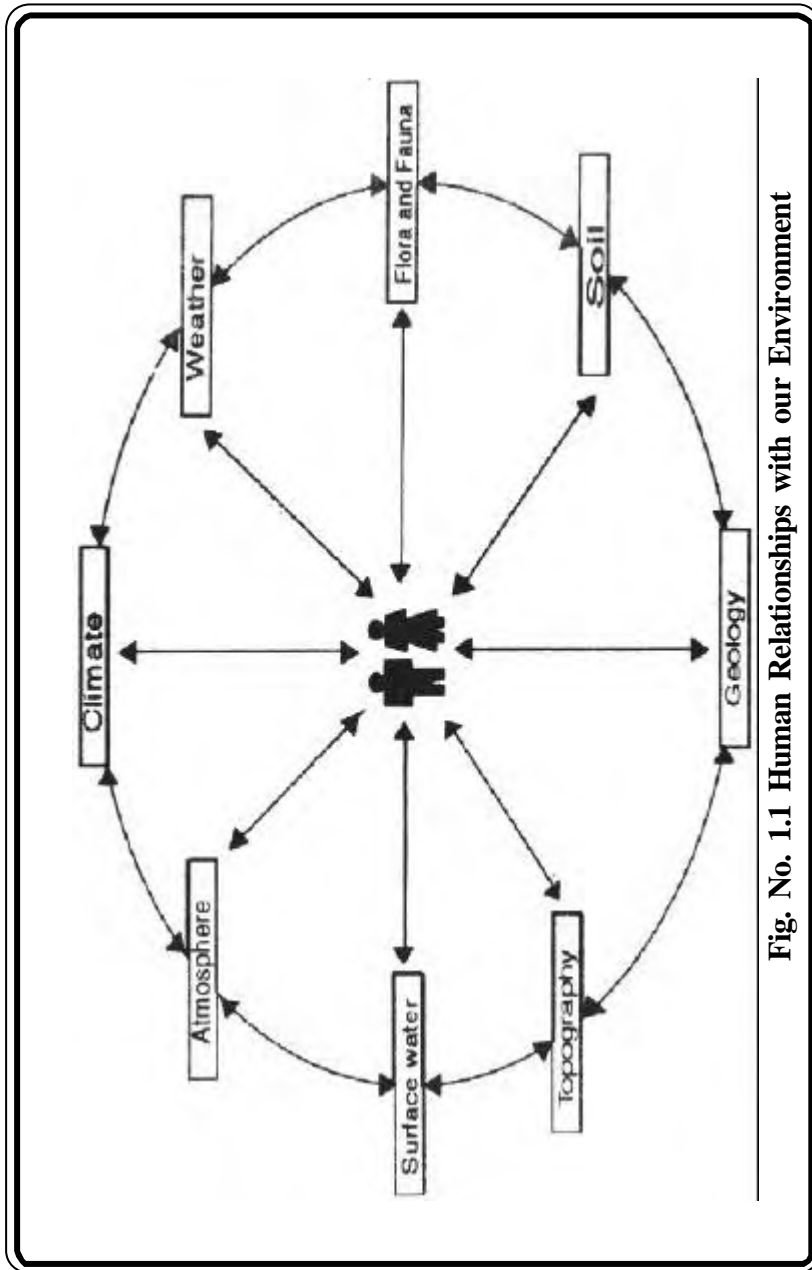


Fig. No. 1.1 Human Relationships with our Environment

The dawn of industrial revolution since eighteenth century initiated the growth of science and technology. Many technological tools were discovered. Over the time, human communities acquired the technical knowhow and developed the skill to handle the technical tools. This in turn helped the modern human community to improve their standard of living and became **technological community**. These technological humans recklessly and indiscriminately exploited natural resources for industrial expansion and urban growth. These events altogether created most of the present day environmental problems.

So, it is the human technology that has drastically changed the human environment relationship from the prehistoric period to the present, most advanced industrial period. Thus a study of changing relationships between humans and the environment from a historical perspective may help in demonstrating the increasing adverse impacts of human activities on the environment. The changing relationships of humans, with the natural environment from prehistoric to modern periods may be divided into four stages:

1. Period of Food Gathering and Hunting
2. Period of Animal Domestication and Pastoralism
3. Period of Plant Domestication and Agriculture
4. Period of Science, Technology and Industrialization.

1. **Period of Food Gathering and Hunting** : This period is related to most primitive humans when they were basically a part of natural environment and their functions were like other animals. The primitive human were functionally a physical human because their basic needs were limited to food only, which they could collect (Fig.No.1.2) from their surroundings. They used to satisfy their hunger by fruits, which were easily obtained from the trees and plants; they spent the nights in the caves and on the trees. So the relationship between human and the environment was very friendly. The natural environment provided all requirements of early humans and thus they were totally dependent on their environment. Hence they are called as Physical Humans.

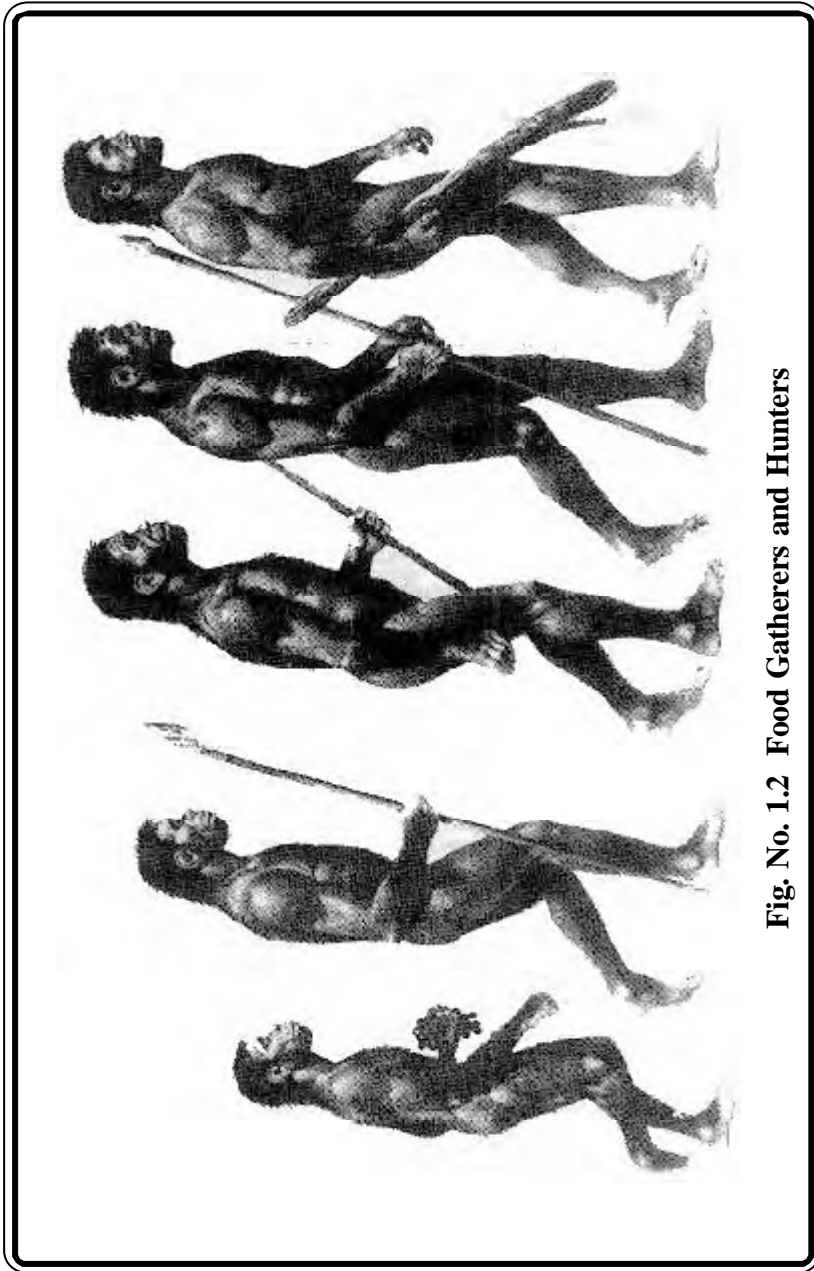


Fig. No. 1.2 Food Gatherers and Hunters

Over a period of time, humans learnt to hunt animals for their food. So, hunting became the first form of destruction of natural resources. But yet, such activities on the natural environment did not make any negative impacts on the environment at a larger scale. This is because of the limited requirements and a very low population existed at that time.

The discovery of fire (Fig.No.1.3) made a significant change in the attitude of humans because they learned to cook animal flesh before eating. This practice required wood, which they got from the forests. Such a demand made another significant starting point in the technology. The humans invented some device to cut and chop trees and their branches to get firewood. They also invented some tools to kill animals. Thus the discovery of fire and the invention of tools and weapons made the humans capable of exploiting the natural resources at a faster rate from their environment. Thus fire became one of the major ecological tools used by humans and changed the environment for their own benefit.

2. Period of Animal Domestication and Pastoralism : With the march of the time early humans learnt to domesticate animals for their own benefits. In the beginning, they domesticated some cattle and other animals for meat. Slowly and slowly their herd of domesticated animals substantially increased. This meant humans had to create temporary habitats, fenced with branches of trees and thorny bushes for domesticated animals. Thus early humans burnt the forest to create temporary home for the domesticated animals. They started to exploit the forest resources to gather fodder for their animals and for their foods. Domestication of animals initiated the community life among the primitive humans, in order to protect their animals and themselves from wild animals.

Over the time the primitive communities gathered larger herds of domesticated animals. But they still stuck to a nomadic way of life, as they had to move from one place to another place, in search of water and fodder for their animals and food for themselves. Even then the natural state of the environment was not disturbed much because their population and their domesticated animals were still under manageable size. So the changes brought in by human activities on the environment were well within the limit of self-regulatory mechanism of the natural environmental system.



Fig.No.1.3 Discovery of Fire

3. Period of Plant Domestication and Agriculture : Domestication of plants for food was a hallmark in the development of human skill of controlling the biotic component of the natural environmental system. Domestication of plants initiated primitive types of agriculture and a sedentary, settled, life for people who previously were nomads and wanderers. But still many of them were nomads.

The cultivation of main food crops resulted in the formation of social groups and organization, which gave birth to early human civilization known as '**river valley civilization**'. Humans settled in the river valleys due to availability of water and fertile land for cultivation. This meant the emergence of socially organized human communities. Human civilization and farming practices changed the cordial relationships that existed between the humans and their natural environment at that time. Gradual but continuous improvements in farming practices resulted in gradual increase in human population and in the number of domesticated animals. More and more virgin forest land were cleared through felling of trees with the help of more advanced tools and weapons. Additionally, through burning of forest they increased the agricultural land. Humans also moved to other places in search of new fertile land. This led to the spread of human population all over the Earth and more destruction of their natural environment. Shifting cultivation, the most prevalent form of primitive cultivation, was responsible for the destruction of natural forests. Such farming practices are still in operation in many of the hilly regions of South and Southeast Asia.

At one point of time, humans developed their own environment known as 'cultural environment' by building houses and creating villages and towns and cities. The elements of cultural environment, such as buildings and roads, were built. Agricultural development changed the physical human into 'economic human' but no serious damage was done to the natural environment though significant changes, no doubt, were brought in the environment.

4. Period of Science, Technology and Industrialization : After the industrial revolution the science and technology improved the standard of living but destroyed the harmonious relationship between the humans and the natural environment. The impacts of science technology and industrialization on environment fall into two broad categories.

The direct impacts are preplanned because people are aware of consequences, both positive and negative of any programme which is launched to change or modify the natural environment for economic development. Such changes include land use changes, constructions and excavations, agricultural practices and weather modification programmes. The indirect impacts are not planned and arise from those human activities that are directed to accelerate the pace of economic growth, especially industrial development (Fig.No.1.4). Impacts include the release of toxic elements and industrial wastes into the environment systems, and the burning of hydrocarbons. Some of these impacts are listed below.

a) Deforestation

Deforestation either for cropland or for commercial purposes leads to accelerated rates of soil erosion. This results in gully erosion and loss of soil fertility on the one hand, and an enormous increase in sediment load in the river which causes severe floods on the other hand. These chain effects can be effectively stopped by reforestation of the deforested areas. Similarly, changes in farm practices, which introduce adverse changes in the environment, may be changed to suit the environmental and ecological situations.

b) Weather modifications

The 'cloud seeding' technology in meteorological phenomena in turns modifies the local weather conditions. This technology stimulates clouds and precipitation through crystalization of super cooled drops through the application of solid carbon dioxide and certain compounds of iodine. A few hundred grams of solid carbon dioxide or a few grams of an iodine compound are enough to crystalize a cubic kilometer of a super cooled cloud of water drops.

c) Exploitation of ground water : Withdrawal of groundwater for drinking water and irrigation purposes, construction of dams and reservoirs to store water upset the equilibrium of the rocks below. In particular, dams on major rivers increase hydrostatic pressure, which causes disturbances in underlying rocks and triggered off many seismic evnets.



Fig.No. 1.4 Environmental Degradation : Impact of Industrialization

d) Release of toxic elements : The release of toxic elements into the ecosystem through their uses as insecticides and fertilizers changes the food chains and food webs (e.g. the introduction of D.D.T.) Similarly, the release of industrial wastes into stagnant water, rivers and seas contaminates water and causes several diseases and deaths of organisms. These toxic substances, through the food chain, are transported across the placenta and reach the developing foetuses of women and cause miscarriages and premature labour. Increasing urbanisation and industrial expansion are responsible for the release of enormous quantities of pollutants into the rivers and lakes, contaminating the water.

e) The burning of hydrocarbon : The burning of hydrocarbon fuels has increased the concentration of carbon dioxide (CO₂) in the atmosphere. The increase in CO₂ content of the atmosphere may change the heat balance by increasing the level of sensible heat in the atmosphere. CO₂ allows more absorption of incoming solar radiation and out going terrestrial re-radiation.

f) Depletion of the ozone layer : Depletion of the ozone layer means less absorption of ultraviolet rays which increases the temperature of the Earth's surface. Increases in air temperature and decreases in the concentration of ozone can cause skin cancer, decrease photosynthesis, and lower crop yields. Ultraviolet radiation also accelerates the photochemical processes that create urban smog. The marine environment would also suffer drastic damages as the productivity of phyto-plankton would be reduced due to a decrease in photosynthesis. This will also affect the mortality of larvae of zoo-plankton. The species composition of marine ecosystems may change, as certain species are more vulnerable to ultra violet radiation.

Environmentalists fear that as technology advances, human influence on our environment will also increase, both in intensity and extent. Our power over our environment will become more dominant. To control our power over our environment, many geographers employ the concept of a Control System whereby the Earth is viewed as a system. In the next lesson, let us learn how the Control System helps us to understand the functional interactions that make Earth a system.

Exercises

I. Fill in the blanks

1. The _____ is also considered as the broadest Earth ecosystem.
2. The dawn of _____ since eighteenth century initiated the growth of science and technology.
3. Domestication of animals initiated the _____ life among the primitive humans.
4. The release of _____ elements into the ecosystem changes the food chains and food webs.
5. Depletion of the _____ layer means less absorption of ultraviolet rays.

II. Match the following

1. Landuse changes - Agriculture
2. Economic humans - Rock equilibrium
3. Deforestation - Carbon dioxide
4. Seismic event - Direct impact
5. Heat balance - Severe flood

III. Write short notes on

1. Technological Community
2. Ecological tools
3. Deforestation
4. Depletion of ozone
5. Release of toxic elements

V. Explain in detail

1. Illustrate the human-environment relationship.
2. The fire became one of the important ecological tool - Explain.
3. Write about the impacts of science, technology and industrialization on the Earth's environment.

Activities

1. Collect pictures that shows a. Land Pollution, b. Water Pollution and c. Air Pollution and Write a small note on the effects of such pollutions on environments.
2. See the photo plate 1. and explain the impact of toxic and hazardous Waste Disposal in few words.



Photo Plate 1. Toxic and Hazardous Waste Disposal

2. EARTH SYSTEM SCIENCE

In the Solar System, our Earth is a unique planet because of the life forms that exist on its surface. Somewhat more than a decade ago, it was recognized that the Earth is a sub system in which, its nonliving elements such as oceans, atmosphere, and land and the living parts are all connected. While accepted by many, this working hypothesis seldom formed the basis for global change research. Little understanding existed of how the Earth worked as a system, how the parts were connected, or even about the importance of the various components of the system. Over the intervening years, much has been learned. In many respects, former uncertainties about the nature and future course of global change have been reduced, in others, the realization that uncertainty is an inherent part of the system has gained credibility.

Over the last thirty years, the understanding of how humans are bringing about global change has undergone a quantum jump. Attempts to separate natural and anthropogenically induced variability in the Earth System have proved to be successful in many respects. Largely through a significant increase in the ability to unravel the past history, our understanding of the natural dynamics of the Earth System has advanced greatly. It is now clear that global change is one of the paramount environmental issues facing humanity at present. Due to a decade of global change research, some of the important research findings that have emerged are as follows :

1. Earth functions as a system. This system has components and controls the system themselves. Living organisms interact with land, water and atmosphere and create the planetary environment.

2. Global change is much more than climate change. It is real, it is happening now, and it is accelerating. Human activities are significantly influencing the functioning of the Earth System in many ways. Anthropogenic changes are clearly identifiable beyond natural variability and are equal to some of the great forces of nature in their extent and impact.
3. Global change cannot be understood in terms of a simple cause/effect paradigm. Because, the human inventions and technology multiply the interacting effects that cascade through the Earth System in complex ways. Cascading effects of human activities interact with each other and with local, and regional, scale changes in multidimensional ways.

So, understanding a changing Earth demands an effective framework between the social and natural sciences. One such framework is the concept of an Earth System introduced by a Russian mineralogist, Vladimir Vernadsky, in the year 1920s. According to him, "Earth's environment is an integrated global system with significant connections among its atmosphere, ocean, land and living biota".

The Earth system :

Our Earth's position is very special in the Solar family. The Earth is placed at a distance from the sun that makes its position very conducive for the growth of living organisms. The recipe of life is unknown, but likely ingredients were methane, carbon dioxide, ammonia and water in the atmosphere and seas of the young Earth. The action of ultraviolet radiation or lightning could have combined these chemicals into amino acids, the building blocks of protein and of all living things. Plants were the first life forms to colonize the early Earth, followed by the proliferation of humans and other animals. These lifeforms are the biotic components of the Earth. Yet another special feature is the shape of the Earth. For several years, people had different views about the shape of the Earth. During the twentieth century, many satellites were launched into space. The images sent by space by space shuttles prove that the Earth has a spherical shape.

The Earth has two motions. It rotates on its axis, inclined at an angle of $23\frac{1}{2}^{\circ}$. Due to this rotation, day and night occur. The Earth also on its inclined axis revolves around the Sun and thus produce seasons. The seasons are classified based on temperature conditions. In a year, there are spring, summer, autumn and winter seasons. So, the knowledge about the “monistic” nature of the Earth system is very much needed, rather than only knowledge about components and elements.

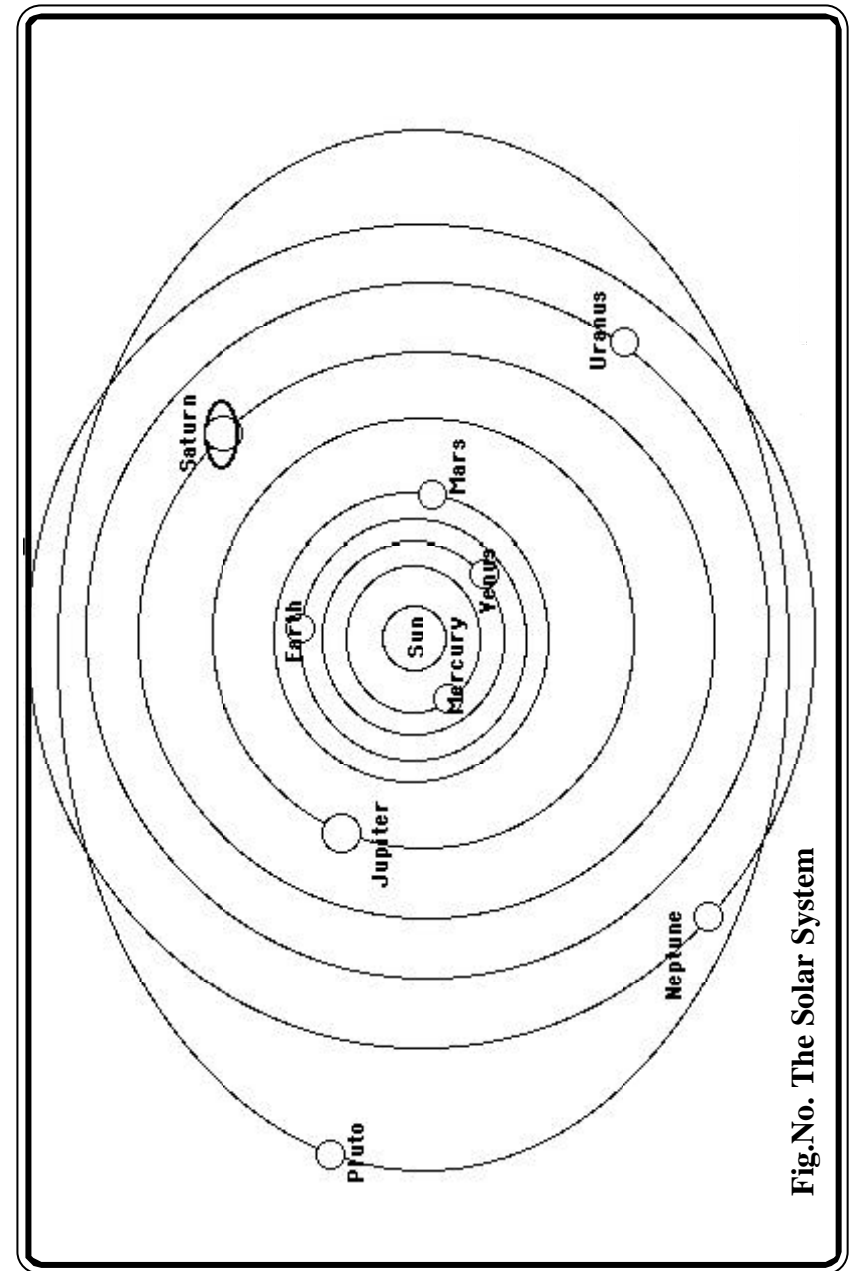


The systems analysis helps us to understand the Earth’s structure as a whole and also the functional interactions that exist between the components. Let us understand this with an example. Assume your school is a system. The students, teachers, and other employees are important components of this system. These components have individual functional elements such as learning, teaching and administration. These functions interrelate all of you so that your school system works effectively.

Besides, the land on which your school is located is a part of the lithosphere. Similarly the water you drink and the air you breathe are part of hydrosphere and atmosphere respectively. The lithosphere, hydrosphere and atmosphere are the abiotic components of the Earth. These components interact with each other and create the fourth component of the Earth, the biosphere. Biosphere interact with the abiotic elements and a number of ecosystems are created on the surface of the Earth. Thus the Earth is considered a unique subsystem in the planetary system.

The Planetary System :

Gases and dust surrounded our star, the **Sun** approximately 5 billion years ago. Over time they condensed and formed planets. The planetary system consists of nine planets : Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto and about 90 satellites.



All these planets revolve around the Sun on their own axes. Every planet has its own elements and mechanisms irrespective of their size. Mercury, Venus, Earth, and Mars are smaller in size. They have large amounts of rocks and smaller amounts of gases. Hence, these planets are called rocky planets. Jupiter, Saturn, Uranus and Neptune are bigger in size. They have small amounts of rocks and large amounts of gases, and are called Gaseous Planets. The lastly positioned Pluto is the smallest planet of the planetary system. Pluto is an asteroid, captured by the Sun's gravity and brought into the orbital path of the planetary system. The prevailing temperature (-210°C) on Pluto freezes the gases into solid. So Pluto is called, a Snow Ball. This planetary system is maintained by the Sun. This system is a subsystem of the Solar System (Fig.No.2.2).

The Solar System :

The Sun is the main source of energy for the planetary system. The Sun is a mixture of gases. It consists of 92% hydrogen, 7.8% helium and 0.2% other gases. The temperature on the surface of the Sun is 6,000 degrees Celsius and the temperature at the center of the Sun is more than 15,000,000 degree Celsius. The Sun shines as a consequence of the fusion of hydrogen into helium, which is constantly taking place in its core. Hence, astronomers call the Sun a "Big Fire Ball".

Scientists believe that the Sun will cease its function when the hydrogen is exhausted. If so, how long it can burn? It can burn for another 5,000 million years. It is estimated that the Sun had enough hydrogen to burn for 10,000 million years. It has burnt already for 5,000 million years. So, now it is literally a middle-aged star. The Sun and its components namely the planets, form the Solar System. This Solar System is a subsystem of the Universe (Fig No. 2.3). The Universe consists of millions and millions of galaxies. Our Solar System is part of one such galaxy known as the Milky Way. Thus Universe is considered as a **general system** that consists of many subsystems.

So far we learnt that the Earth is a system and has components. These components interact with each other and create the Earth's environment. But how do we know about the Earth's components and its interactions ? Are there any operating manuals / pamphlets like the ones

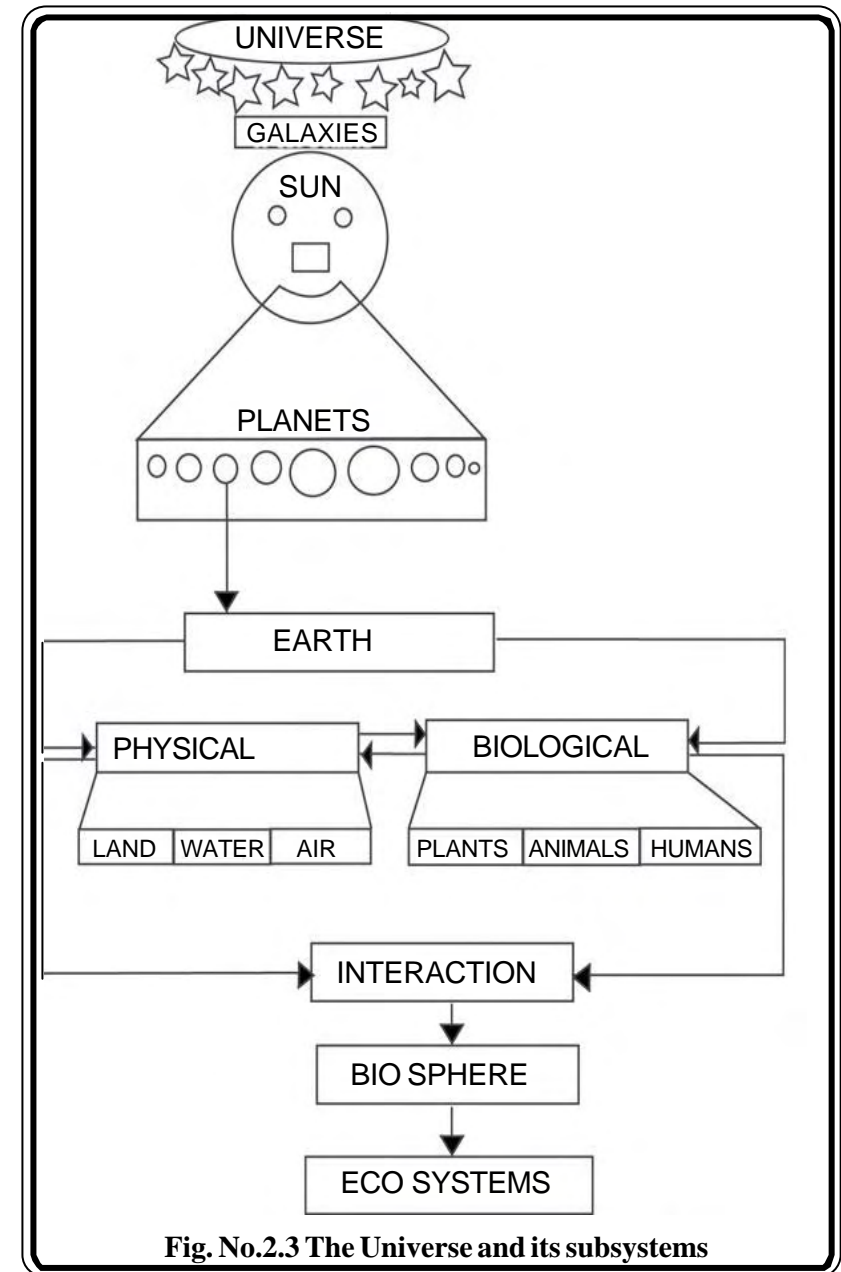


Fig. No.2.3 The Universe and its subsystems

we get when we buy electrical / electronic goods? These manuals / pamphlets contain information about how to operate the system and also its functions. But for our Earth system, there is no such operating manuals. Only through science and technological research activities, we come to know about how Earth operates and how its components functions. In the next lesson, let us learn about the lithosphere, a component of the Earth.

Exercises

I. Fill in the blanks

1. Earth is a unique planet because of the _____ that exists on its surface.
2. Living organisms interact with land, water and atmosphere and create the _____ environment.
3. Plants were the first _____ to colonize the early Earth.
4. The Earth has a _____ shape.
5. Universe is a _____ system that consists of many subsystems.

II. Match the following

1. Snow ball - Big fire ball
2. The sun - season
3. System - Pluto
4. Revolution - rotation
5. Earth axis - interactions

III. Write short notes on :

1. Earth's movements
2. Planetary System
3. Sun
4. General System
5. Seasons

IV. Explain in Detail :

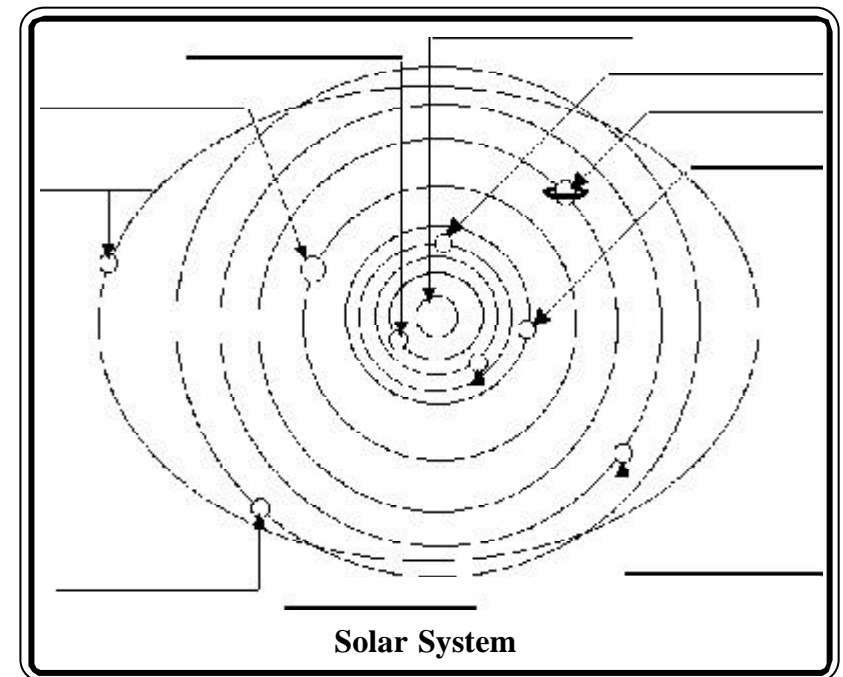
1. List the important research finding about the dynamics of the Earth's system.
2. Earth is a System – explain.

Activities

1. Collect pictures and news about a. Universe, b. Sun, C. Planets and prepare a table showing the rotation, revolution period of the solar family.
2. Draw a line diagram to show that the Earth is a system.
3. Conduct Solar system quiz using the following questions :
 1. How many planets are in our Solar System?
 2. Which planet is nearer to the Sun?
 3. Which planet is farthest from the Sun?
 4. Which planet is the biggest?
 5. Which planet has the biggest, easily – seen rings orbiting it?
 6. What is the name of the group of objects that orbit the Sun between Mars and Jupiter?
 7. What is at the centre of our Solar system?
 8. Are inner planets made of rock or gas?
 9. What are the icy objects with huge tails that orbit the Sun?
 10. Which planet is called the Red Planet?
 11. Is the Sun a star, or a planet?

12. Is the Sun solid, liquid, or gaseous?
13. What element is most plentiful on the Sun?
14. How old is the Sun?
15. Is Mercury composed of rock or gases?
16. Since Mercury is close to the Sun, it gets very hot. Does it ever get cold?
17. Does Mercury have a thick or thin atmosphere?
18. Is Mercury closer to the size of the Earth or our moon?
19. We have four seasons on Earth. Are there any seasons on Mercury?
20. Is Mercury the smallest planet in the Solar System?
21. What is another name for the planet Venus?
22. Is Venus much bigger, much smaller, or about the same size as the Earth?
23. Is Venus the planet nearest the Sun in our Solar System or the second – nearest?
24. Is Mars bigger, smaller, or the same size as Earth?
25. Mars' surface is mostly water, rock, or magma?
26. Are there polar ice caps on Mars?
27. Does Mars have any rings orbiting it?
28. When did the first spaceship from Earth land on Mars?
29. Is Jupiter composed mostly of solids or gases?
30. Jupiter is about 11-times, 111-times or 1,111-times bigger than the Earth.
31. How long is a Jovian day (a day on Jupiter)?
32. How long is a Jovian year?
33. Is Jupiter's Great Red Spot a deposit of iron-rich soil, a storm, or a huge crater?
34. Does Jupiter have any rings?
35. Can you ever see Jupiter from Earth without using a telescope?
36. Saturn is notable for its rings What are they made of?
37. Are Saturn's rings visible from Earth without using a telescope?
38. Is Saturn the largest planet in our Solar System?
39. Uranus is the third-largest planet in the solar System. Is its diameter 4-times, 14-times, or 24-times bigger than the Earth?
40. How long does it take Uranus to revolve around the Sun?
41. Uranus' axis is very tilted; what does this lead to?
42. Does Uranus have a solid surface?

43. Does Uranus have rings circling it?
 44. When was Uranus discovered?
 45. Is Neptune always the eighth planet from the Sun?
 46. Can Neptune be seen from the Earth without using a telescope?
 47. How long is a Neptune year?
 48. Is Pluto always the farthest planet from the Sun?
 49. Is Pluto a rocky planet or a gaseous planet?
 50. Is Pluto bigger than the Earth, smaller than the Earth, or about the same size as the Earth?
 51. How long does it take Pluto to revolve around the Sun once?
 52. Is Pluto's orbit close to being circular or quite eccentric?
 53. How many degrees is the orbit of Pluto tilted from the plane of the ecliptic?
 54. Has a spacecraft from Earth ever visited Pluto?
4. Label the planets in the Solar System



3. LITHOSPHERE AND TECTONIC PLATES

Scientists believe the Earth began its life about 4.6 billion years ago. The continents probably began forming about 4.2 billion years ago as the Earth continued to cool. But it was not until the turn of the 20th century that scientists determined that our planet is made up of four main layers: the **inner core**, **outer core**, **mantle**, and **crust** (Fig. No. 3.1). The core is composed mostly of iron and is so hot that the outer core is **molten**, with about 10% sulphur. The inner core is under such extreme **pressure** that it remains solid.

Most of the Earth's mass is in the mantle, which is composed of iron, magnesium, aluminium, silicon, and oxygen **silicate** compounds. At over 1000 degrees C, the mantle is solid but can deform slowly in a **plastic** manner. The crust is much thinner than any of the other layers, and is composed of the least dense calcium and sodium (Na) aluminum-silicate minerals. Being relatively cold, the crust is rocky and **brittle**, so it can fracture in **earthquakes**.

The crust and the upper layer of the mantle together make up a zone of rigid, brittle rock called the **Lithosphere**. The layer below the rigid lithosphere is a zone of about 50-100 km down, is especially soft and plastic, and is called the **asthenosphere**. The asthenosphere is the part of the mantle that flows and moves the plates of the Earth. A heavy load on the crust, like an ice cap, large glacial lake, or mountain range, can bend the lithosphere down into the asthenosphere, which can flow out of the way. The load will sink until it is supported by **buoyancy** (Fig.No. 3.2).

The crust is composed of two basic rock types granite and basalt. The continental crust is composed mostly of granite. The oceanic crust consists of a volcanic lava rock called basalt. Basaltic rocks of the ocean crust is much denser and heavier than the granitic rock of the continental crust. Because of this the continents ride on the denser oceanic plates.

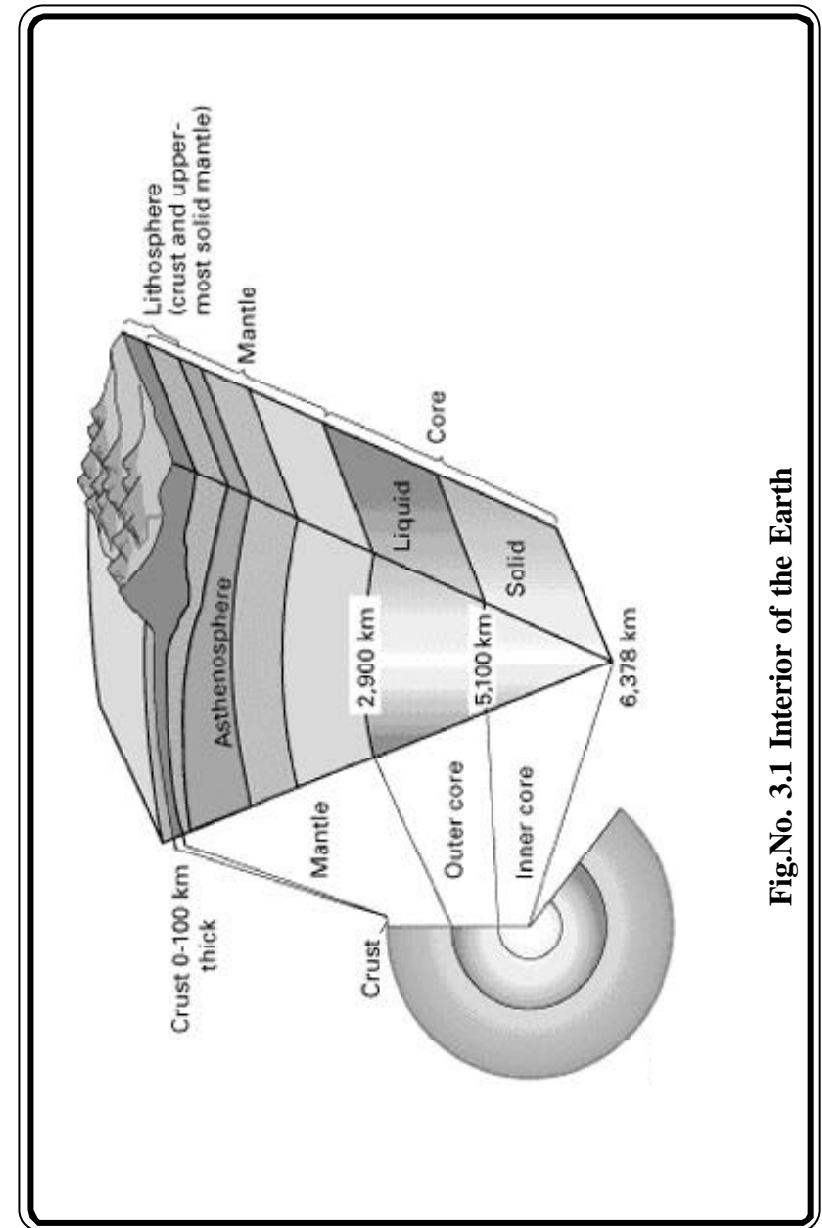
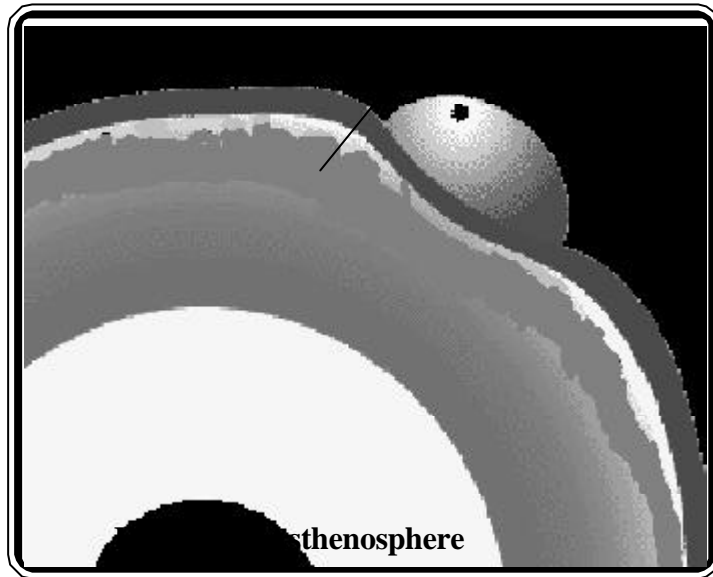


Fig.No. 3.1 Interior of the Earth



The Earth's outermost layer, the lithosphere, is broken into 7 large, rigid pieces called plates: the African, North American, South American, Eurasian, Australian, Antarctic, and Pacific plates. Several minor plates also exist, including the Arabian, Nazca, and Philippines plates. These plates are all moving in different directions and at different speeds from 2 cm to 10 cm per year.

This theory of Plate tectonics explains "how the earth works" and let us continue and learn more about the plates and their movements. The place where the two plates meet is called a plate boundary. Boundaries have different names depending on how the two plates are moving in relationship to each other.

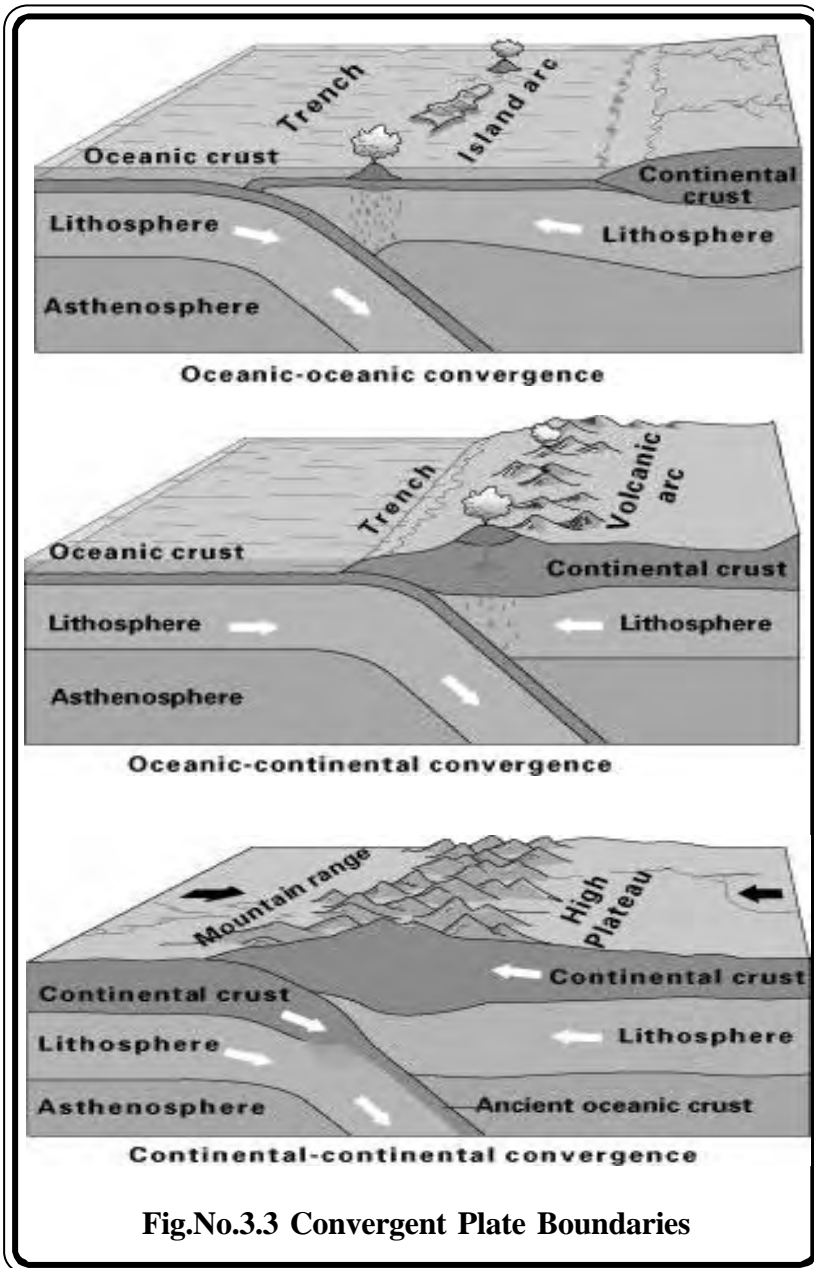
Convergent Boundary : when two plates collide, the edge of one dives beneath the other and ends up being destroyed in the mantle. Places where plates crash or crunch together are called convergent boundaries. Plates only move a few centimeters each year, so collisions are very slow and last millions of years.

Even though plate collisions take a long time, lots of interesting things happen. For example, in the drawing, an oceanic plate has crashed into a continental plate. The continental plate "front ends" bends and the edge of the continental plate as shown, in fig. No.3.3 has folded into a huge mountain range, while the edge of the oceanic plate has bent downward and dug deep into the Earth. A trench has formed at the bend. The folding and bending makes rock in both plates break and slip, causing earthquakes.

As the edge of the oceanic plate digs into Earth's hot interior, some of the rock in it melts. The melted rock rises up through the continental plate, causing more earthquakes on its way up, and forming volcanic eruptions where in finally reaches the surface. An example of this type of collision is found on the west coast of South America where the oceanic Nazca Plate is crashing into the continent of South America. The crash formed the Andes Mountains, the long string of volcanoes along the mountain crest, and the deep trench off the coast in the Pacific Ocean. Thus when two plates collide with each other mountains, volcanoes and earthquakes are formed.

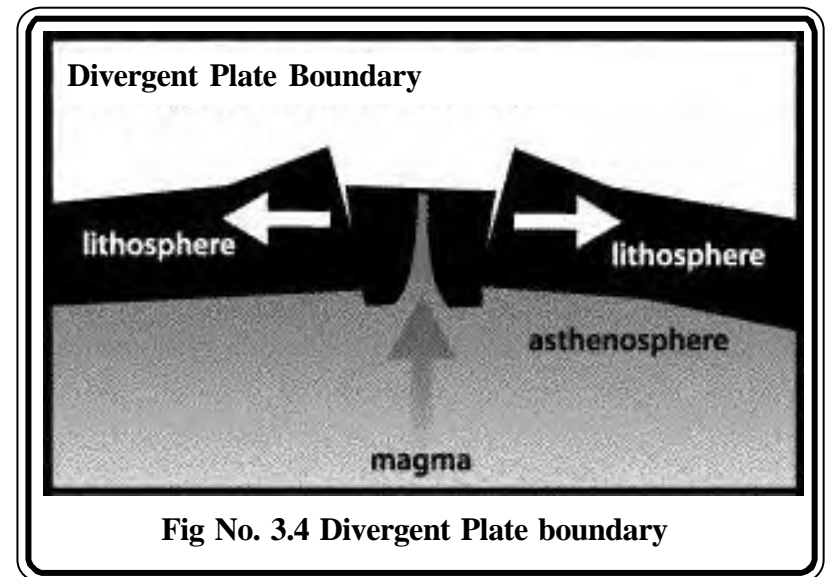
Mountains, earthquakes, and volcanoes form where plated collide. Millions of people live in and visit the beautiful mountain ranges being built by plate collisions. For example, the Rockies in North America, the Alps in Europe, the Pontic Mountains in Turkey, the Zagors Mountains in Iran, and the Himalayas in central Asia were formed by plate collisions. Each year, thousands of people are killed by earthquakes and volcanic eruptions in those mountains.

Occasionally, big eruptions or earthquakes kill large numbers of people. In 1883 an eruption of Krakatau volcano in Indonesia killed 37,000 people. In 1983 an eruption caused mudslide in Columbia killed 25,000 people. In 1976, an earthquake in Tangshan, China killed an astounding 750,000 people. If we choose to live near convergent plate boundaries, we can build buildings that can resist earthquakes, and we can evacuate areas around volcanoes when they threaten to erupt. Yes, convergent boundaries are dangerous places to live, but with preparation and watchfulness, the danger can be lessened somewhat.



Divergent boundary : Places where plates are coming apart are called divergent boundaries. As shown in figure 3.4, when Earth's lithosphere is pulled apart, it breaks along parallel faults. The block between the faults crack and drops down into the soft, the asthenosphere. The sinking of the block forms a central valley called a rift. Magma seeps upward to fill the cracks. In this way, new crust is formed along the boundary. Earthquakes occur along the faults, and volcanoes form where the magma reaches the surface.

Divergence can occur on continent and as well as on oceanic floor. Divergence on the continent causes rift valleys and are 30 to 50 kilometers wide. Examples include the East Africa rift in Kenya and Ethiopia, and the Rio Grande rift in New Mexico. Divergence across the ocean floor causes rift valleys, with only a kilometer or less wide. Divergence along the Mid Atlantic ridge causes the Atlantic Ocean to widen at about 2 centimeters per year.



Most of the world's active volcanoes are located along or near the boundaries between shifting plates. Such volcanoes are called plate-boundary volcanoes. The peripheral areas of the Pacific Ocean Basin, containing the boundaries of several plates, are dotted with many active volcanoes that form the so-called Ring of Fire. The Ring provides excellent examples of plate-boundary volcanoes, including Mount St. Helens.

Geographically these tectonic plates are grouped as seven continents and five oceans. Let us learn more about the continental plates and their features in this lesson, and oceans in the next lesson.

The Continents and its features:

A continent is defined as a large unbroken land mass completely surrounded by water, although in some cases continents are connected by land bridges. The seven continents are North America, South America, Europe, Asia, African, Australia, and Antarctica. The island groups in the Pacific are often called Oceania. These continents occupies nearly 29% of the Earth's total area. Mountains, Plateaus and plains are significant features of those continents.

A mountain is a landmass that stands significantly above its surrounding. The majority of mountains are created when tectonic plates collide, causing folding and uplifting of rocks along the plate boundaries. The uplifted land is then eroded into peaks and valleys.

A plateau is another feature of the Earth's surface. They are broad uplands that rise abruptly from the surrounding area. The majority of them are created when tectonic plates pulled, causing faulting and slipping down of rocks along the plate boundaries. Tibet, the highest plateau of the world, Colorado plateau, Decan Plateau, and East African Plateau are noteworthy.

A plain is a vast, low-lying areas of the continents. They are formed in different ways. Plains made through the actions of rivers are called alluvial plains; the Ganges, the Brahmaputra are the largest river plains in the world.

The plains made through wind sedimentation are called bess. The plain formed where the Yellow River flows in China is loess. Similarly,

the plains formed through the actions of waves are called coastal plains. The eastern coastal plain of India is a good example.

Mountains, plateaus and plains are all part of lithosphere and they are made up of many types of rocks. Some rocks are white and some others are black. A few rocks are brittle and others are hard; some are like sand, are permeable, others, such as clay, are non-permeable. Rocks are composed of many minerals such as silica, aluminum, iron and magnesium. The nature of the rock is determined by the presence of its minerals. Rocks can be classified into three types based on their formation.

Igneous rocks :

The earth is about 4,600 million years old. The oldest rocks that have been found were created by volcanic eruptions over hundreds of millions of years. These rocks are still made every time a volcano erupts. These rocks are formed from molten rock that has slowly cooled underground or erupted to the surface of the earth through a volcano. While molten rock is underground, it is called magma. Molten rock that has erupted from a volcano, by contrast, is called lava. These rocks are usually very hard. Igneous rocks have crystals. The size of these crystals may depend on how quickly the molten rock has cooled. If it cooled slowly, the crystals are large; if it cooled quickly, they are small. Today igneous rocks represent 95 per cent of the Earth's crust.

Sedimentary rocks :

Sedimentary rocks are formed by the accumulation and cementation of mud, silt, or sand derived from weathered igneous rock fragments. Sedimentary rocks represent less than 5 per cent of the Earth's crust but 75 per cent of the Earth's land surface.

Metamorphic rocks :

Metamorphic rocks are igneous or sedimentary rocks that have been altered by heat and / or pressure, either because they have been buried and folded deep in the crust, or because they have come into contact with molten igneous rock. Metamorphism can result in the formation of completely new minerals. It can also destroy original structures such as

sedimentary layering or fossils. Intense pressure causes the realignment of minerals, forming new layers. About one per cent of rocks in the crust are metamorphic.

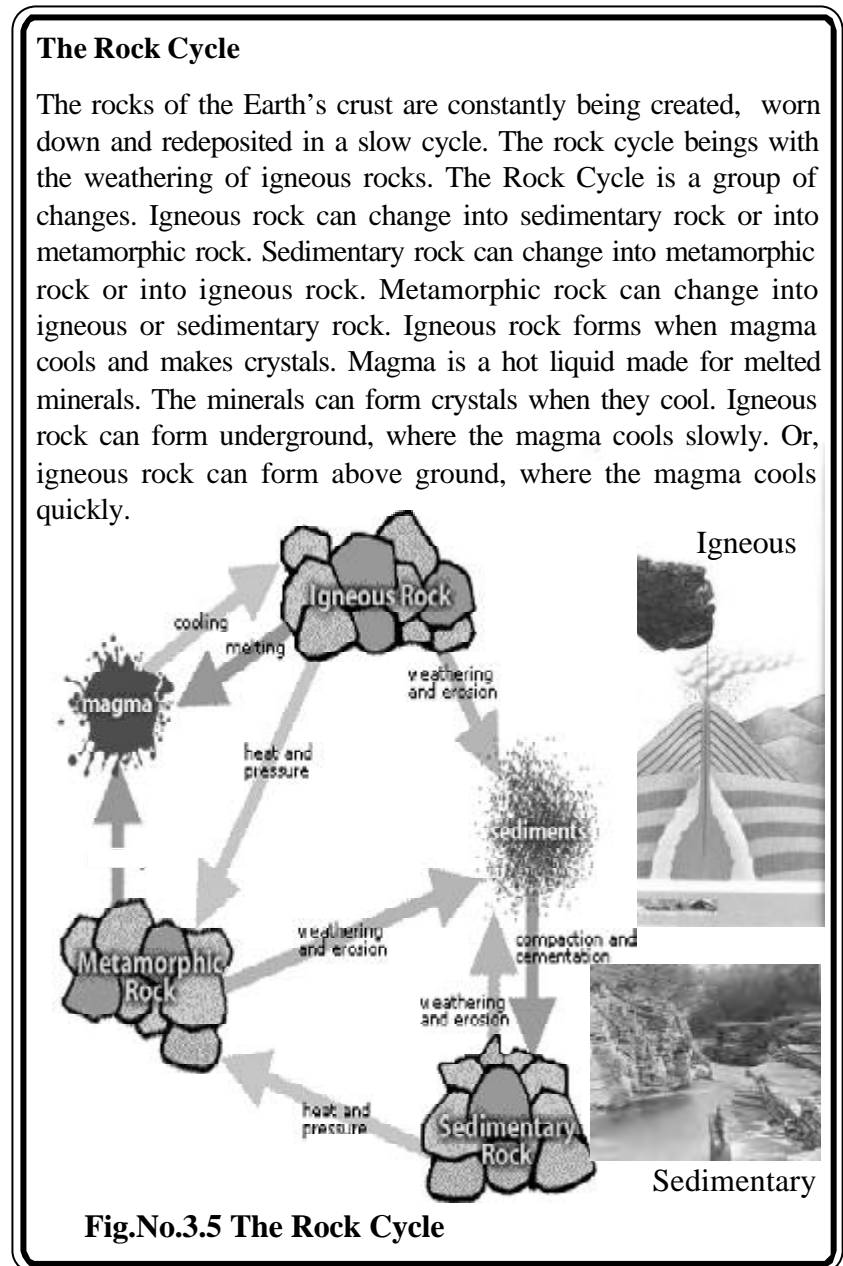
The above said rocks on the Earth crust are constantly being created, worn down and redeposited in a slow rock cycle. In a Rock Cycle, weathering is the first step for a number geomorphic and biogeochemical processes and is fundamental to many other aspects of the hydrosphere, lithosphere, and biosphere. Let us now examine what is weathering and what are the products of weathering.

Weathering : Weathering is the breakdown and alteration of rocks and minerals at or near the Earth’s surface into products that are more in equilibrium with the conditions found in that environment. Most rocks and minerals are formed deep within the Earth’s crust where temperatures and pressures differ greatly from the surface. Because the physical and chemical nature of materials formed in the Earth’s interior are characteristically in disequilibrium with conditions occurring on the surface. Because of this disequilibrium, these materials are easily attacked, decomposed, and eroded by various chemical and physical surface processes.

The products of weathering are a major source of sediments for erosion and deposition. Many types of sedimentary rocks are composed of particles that have been weathered, eroded, transported, and terminally deposited in basins. “Weathering also contributes to the formation of soil by providing mineral particles like sand, silt, and clay. Elements and compounds extracted from the rocks and minerals by weathering processes supply nutrients for plant uptake.

Products of Weathering : The process of weathering can result in the following three outcomes on rocks and minerals :

- (1) The complete loss of particular atoms or compounds from the weathered surface.
- (2) The addition of specific atoms or compounds to the weathered surface.
- (3) A breakdown of one mass into two or more masses, with no chemical change in the mineral or rock.



The residue of weathering consists of chemically altered and unaltered materials. The most common unaltered residue is quartz. Many of the chemically altered products of weathering become very simple small compounds or nutrient ions. These residues can then be dissolved or transported by water, released to the atmosphere as a gas, or taken up by plants for nutrition. Some of the products of weathering, less resistant aluminosilicate minerals, become clay particles. Other altered materials are reconstituted by sedimentary or metamorphic processes to become new rocks and minerals. These rocks may have gone through several cycles, and may have undergone metamorphism or sedimentation before they finally became soil (Fig. 3.6). It takes hundred years to form one centimeter of soil from the weathering of rocks. In a few places, this soil is only a few centimeters deep; in other places it is 20 to 30 centimeters in depth.

Soils are the unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil particles are generally classified according to size; that is, sand as large particles, silt as medium and clay as fine. Particles larger than sand are classified as gravel and are large enough to be identified as an individual rock.

Soil is essential for fixing the roots of plants and also provides the necessary nutrients, suitable temperature, and moisture for its growth. Soil maintains its fertility with the remains of decayed plants and animals. The growth of plants depends on the fertility of the soil. All living organisms depend on these plants. But human interference makes the soil infertile. If this continues, ultimately it will affect the “soil - plant - organism” links and create negative impacts in the rock cycle. To enrich the soil, humans add natural and chemical fertilizers. Chemical fertilizers usually damage soil, partially because they eradicate the natural microorganisms.

Essentially, all life depends upon the soil. There can be no life without soil and no soil without life; they have evolved together. But we abuse soil because we regard it as a commodity belonging to us. When we consider soil as a community to which we belong, we may begin to use it with care and conserve it. Similarly, water is also an important natural resource. Major portion of this water is present in the oceans and sea.

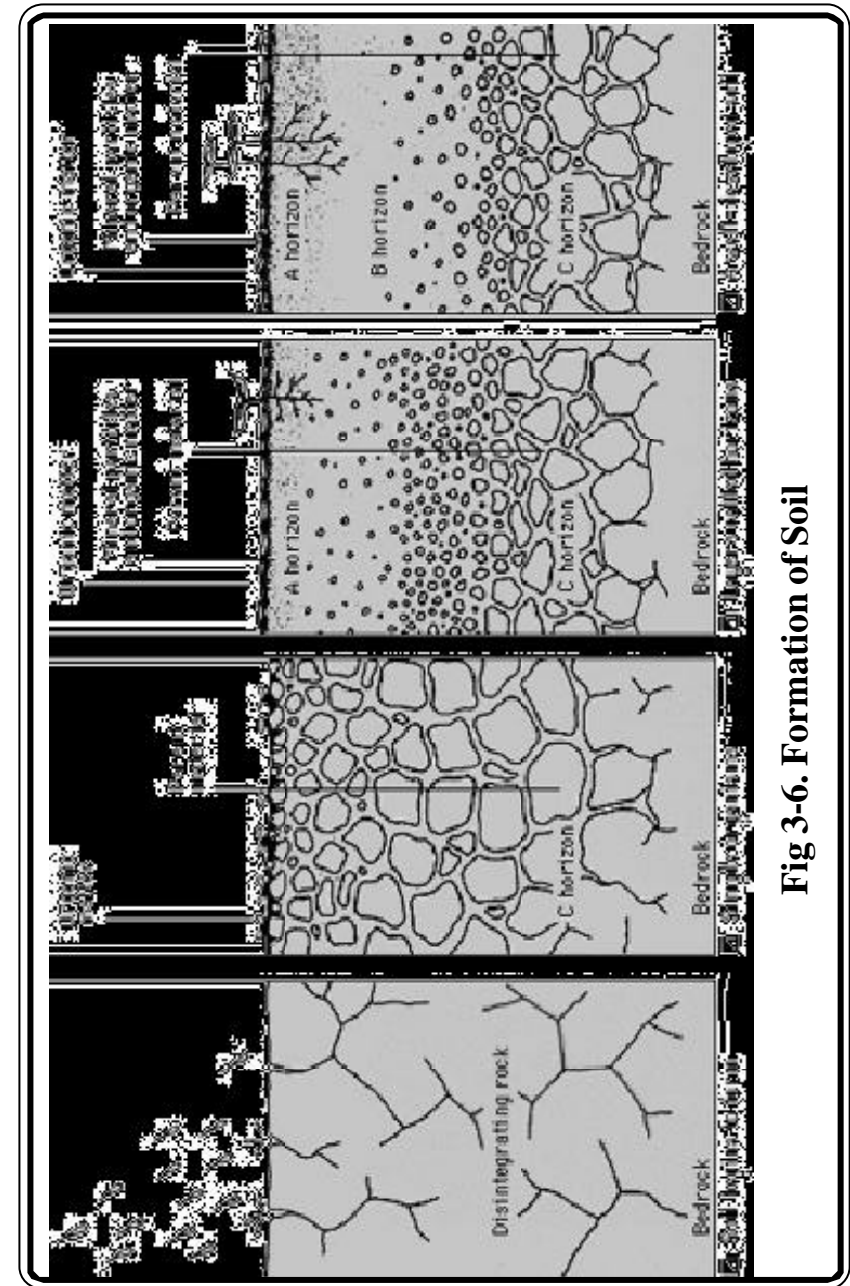


Fig 3-6. Formation of Soil

The remaining portion of water is in rivers, lakes and ponds. All these water bodies form the hydrosphere of the Earth. Let us learn more about hydrosphere, a component of the Earth in the next lesson.

Exercises

1. Fill in the blanks

1. The crust and the upper layer of the mantle together make up a zone called the _____
2. The Continental crust is composed mostly of _____ rocks.
3. The lithosphere is broken into large rigid pieces called _____
4. The plains made through _____ sedimentation are called loess.
5. Soil is essential for _____ the roots of plants.

II. Match the following :

1. New Mexico - Faulting
2. Igneous rock - Rio Grande
3. Earth crust - Plant growth
4. Plateau - Brittle
5. Soil fertility - Magma

III. Write short notes on

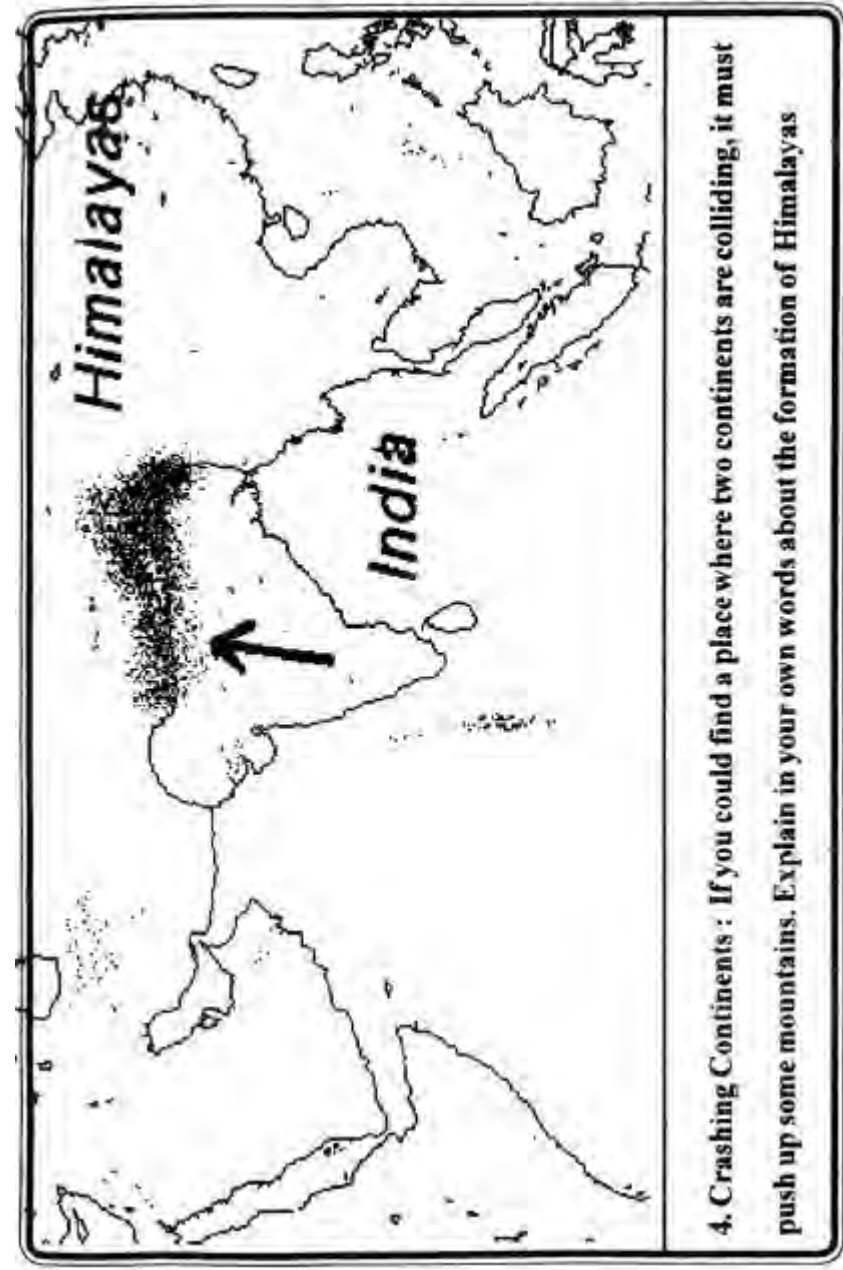
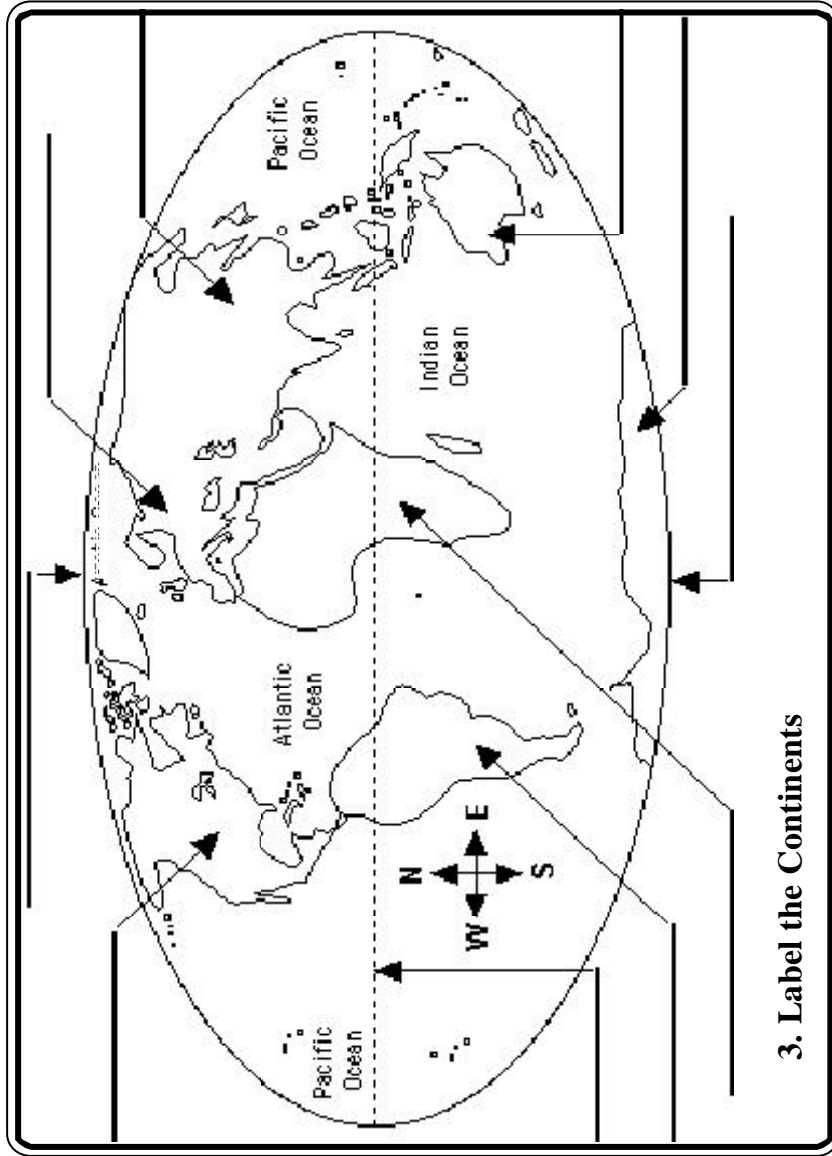
1. Convergent boundaries
2. Lithosphere
3. Divergent boundaries
4. Igneous rocks
5. Weathering

IV. Explain in detail

1. Describe lithosphere with illustration
2. How mountains are created? Explain
3. Soil is an important natural resources. Elucidate.

Activities

1. Conduct Plate tectonic quiz using the following questions
 1. Do plates move horizontally, vertically, or both?
 2. What do plates float on?
 3. What type of rock are oceanic plates made of?
 4. What type of rock are continental plates made of?
 5. What is the name of the zone where the crust sinks into the Earth?
 6. What is the process of new crust formation called?
 7. When two continental plates collide, what types of mountains are formed?
2. Collect news about recent Earthquakes and Volcanic eruptions. Discuss about the impact of such natural disorders.



4. HYDROSPHERE AND CURRENTS

All the Earth's water is found in Oceans, streams, lakes, the soil, groundwater, and in the air. The largest store of water is in the oceans, which contain over 97% of the Earth's water. Ice caps that covers Antarctica and glaciers that occupy high alpine locations contain a little less than 2% of all water. But this small amount of water would have a great impact on the environment if it were to melt. One fear is that global warming will cause the melting and collapse of large ice sheets resulting in a rise in sea levels. Rising sea levels could devastate coastal cities, displace millions of people, and wreak havoc on fresh water systems and habitats.

Water beneath the ground is the third largest store of water. Groundwater and soil water together make up about 5% of all water (by volume). There is a difference between groundwater and soil water. Soil water is held in pore spaces between soil particles. Soil pore spaces usually are partially void of water most of the time but fill with water after a rain storm.

Groundwater, on the other hand, is found in areas that are saturated throughout the year. That is, the pore spaces are always occupied with water. Both soil and groundwater are very important sources of water. Soil water is available for plants to extract and use. Groundwater is an important source of water for irrigation and drinking water supplies.

Surface water is stored in streams, rivers and lakes. One might expect, given the large rivers that flow across the Earth and the huge numbers of lakes, that this store would be rather large. Instead, streams, rivers and lakes only comprise 0.02% of all water in the Earth system. In the atmosphere, only about 0.0001% of the water in the hydrosphere is found.

The Oceans : The oceans are large, deep, open expanses of water, while seas are shallower and partly encircled by land. Both oceans and seas are comprised of salt water.

The Pacific is the largest oceans, being twice the size of the Atlantic. It covers about a third of the Earth's surface, and contains more than half the water on the planet. A range of underwater mountains form a ridge that lie 330m. Below the surface and rise to an elevation of about 2000 - 3000m. from the floor of the oceans. There are hundreds of volcanic islands scattered across the Pacific, many are inhabited. The world's largest coral structure, the Great Barrier Reef, is situated in the Pacific, off the coast of Australia.

The Second largest ocean, the Atlantic is widening at a rate of 2-4 cm per year along the submarine volcanic mountains that run roughly north to South. The ridge is up to 4000m high. The Sargosa Sea is an area of calm water in the Western North Atlantic. This water surface is covered by green-brown Sargassum seaweed.

The Indian Ocean comprises about a fifth of the total area covered by seawater. It is the third largest ocean. An ocean ridge stretches from the Red Sea to the Southern Limit of the Indian Ocean. The Red Sea lies over a spreading ridge and has been widening for the last 25 million years.

The Southern Ocean includes all water lying south of latitude 55 degrees south, and is the fourth largest ocean. In winter, more than half the surface is covered by ice. Information about the remote Southern Ocean is incomplete since Antarctic ice extends seawards hundreds of kilometers from the continent and observations from the ice-covered regions are sparse.

The Arctic Oceans is the smallest and shallowest ocean, containing just 1% of the Earth's salt water. A thick sheet of ice covers it for most of the year.

The Seas : Seas are subdivisions of oceans, especially where oceans are partly bounded by land. Seas are always salty. Large landlocked bodies of salt water such as Dead and Caspian Sea are more properly classified as lakes.

The Coral Sea is part of the Pacific Ocean, lying between Australia and New Caledonia. The China Sea is also part of Pacific Ocean. It has two areas: The East China Sea and the South China Sea.

The Bering Sea is part of the northern Pacific, lying between Alaska and Kamchatka. It is often frozen for several months each winter. Sea Okhotsk is an extension of the north-west North Pacific, off the eastern coast of Russia. The sea of Japan is part of the north Pacific, between Japan, Korea and Russia.

The Caribbean Sea, part of the Atlantic Ocean, and contains many islands. The Mediterranean Sea is almost landlocked. In 50 million years, if present plate motions continue to force Africa northwards, the Mediterranean will close up altogether.

The Andaman Sea is part of the Indian Ocean, lying between the Andaman Islands and Thailand.

Ocean Floor topography

The topography at the floor of the oceans (Fig.No.4.1) are divided into four sections : 1. The Continental Shelf 2. The Continental Slope 3. The Ocean Trough and 4. The Ocean Deeps.

1. The continental Shelf : The Continental Shelf is that part of an ocean that lies close to the continental margin. The depths of the shelves vary from 150 to 200 metres. Similarly, the width varies from place to place. Broad continental shelves are good fishing grounds because they contain suitable conditions for the growth of plankton. Plankton provides food for fish. For example, the broad continental shelves of Northwestern Europe and the coastal areas around Japan are the largest fishing grounds in the world.

2. The Continental Slope: The Continental slope lies beyond the continental shelf, where the ocean floor slopes downwards. The steep slope connects the continental shelf with the deep ocean floor. The average depth of the slope varies from 3000 to 6000 metres. The depth of the ocean floor suddenly increases where the shelf ends.

3. The Ocean Trough : The Continental slope ends at the ocean trough, which is like a deep, underwater plain. It consists of islands, mountain ranges, plateaus, deep valleys and plains. These features cover about 40% of the oceans' floors. Mid- Atlantic Ridge is the largest mountain

range in the ocean. This range is over 1400 km in length. This ridge has a deep valley where volcanic and earthquake disturbances are quite common. These volcanoes erupt underwater as they do on land. Islands like Hawaii in the Pacific Ocean and the Azores in the Atlantic Ocean were formed through volcanic activity under the ocean. The floor is carpeted with sediment formed by the minute remains of creatures and rocks.

4. The Ocean Deeps : Trenches are formed deep in the oceans. These trenches are very narrow and deep in nature. There are numerous trenches in the Pacific Ocean. The Mariana Trench, 11 033 metres in depth, is the deepest part of the world. Even Mount Everest (8848 metres) would be submerged completely in this trench.

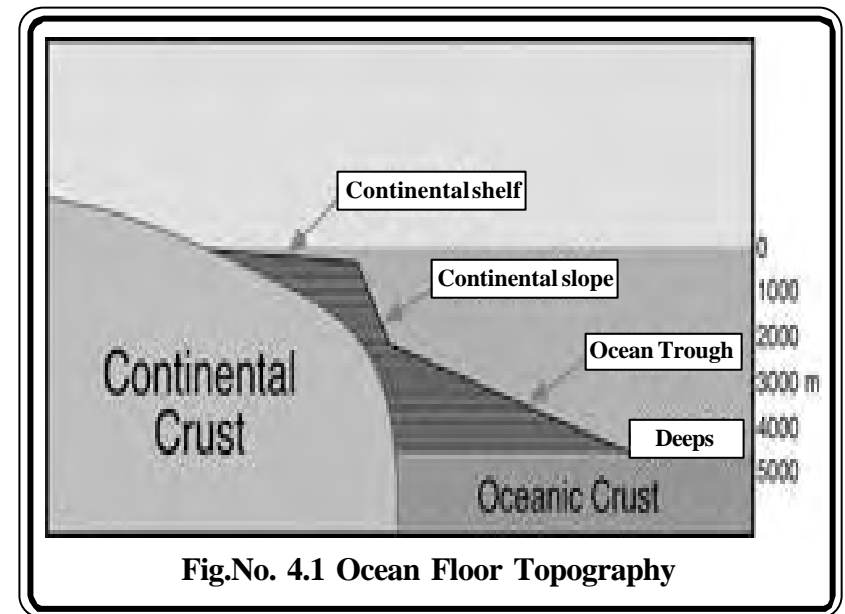


Fig.No. 4.1 Ocean Floor Topography

So far we learnt in detail about the salient features at the bottom of the ocean. The most important characteristic feature in that the ocean waters are always in a state of motion. The different kinds of motions are: waves, tides and currents.

Waves are up and down movements, caused by the action of winds on the water surfaces. Waves move in the direction of winds. When ocean levels rise and fall at regular intervals during the course of the day. This is referred to as the tide. **Tides** are caused by the gravitational attraction between the moon and the Earth. The horizontal and vertical circulation of ocean waters creates **currents**. Major causes of ocean currents are wind, friction, gravity, and variations in water density in different parts of the oceans. These currents modify local climates. They distribute the heat energy from one latitude to another. Let us learn now about the circulation of ocean currents.

The Currents :

An ocean current can be defined as a horizontal movement of seawater at the ocean's surface. Ocean currents are driven by the circulation of wind above surface waters. Frictional stress at the interface between the ocean and the wind causes the water to move in the direction of the wind. Large ocean currents are a response of the atmosphere and ocean currents are responsible for the flow of energy from the tropics to polar regions. In some cases, currents are transient features and affect only a small area. Other ocean currents are essentially permanent and extend over large horizontal distances.

On a global scale, large ocean currents are constrained by the continental masses found bordering the three oceanic basins. Continental borders cause these currents to develop an almost closed circular pattern called a gyre. Each ocean basin has a large gyre located at approximately 30° North and South latitude in the subtropical regions. The currents in these gyres are driven by the atmospheric flow produced by the subtropical high pressure systems. Smaller gyres occur in the North Atlantic and Pacific Oceans centered at 50° North. Currents in these systems are propelled by the circulation produced by polar high pressure centers. In the Southern Hemisphere, these gyre systems do not develop because of the lack of constraining land masses.

A typical gyre displays four types of currents : Two east - west aligned currents found respectively at the top and bottom ends of the gyre; and two boundary currents oriented north - south and flowing parallel to the

continental margins. Direction of flow within these currents is determined by the direction of the macro-scale wind circulation. Boundary currents play a role in redistributing global heat latitudinally. There are two gyres in the Northern Hemisphere and three in the southern Hemisphere.

Let us take **North Atlantic Ocean Gyre** as an example and understand the structure of a gyre. As shown in figure 4.2 North Atlantic Ocean Gyre consists of 1. North Equatorial Current 2. Gulf Stream 3. North Atlantic Drift and 4) Canaries Current.

1. North Equatorial Current : The warm water adjacent to the Equator in the Atlantic Ocean is called the North Equatorial Current. This current forms mainly because of the easterly winds. These winds blow from the sub-tropical high pressure belt to the Equatorial low-pressure belt. These winds are also called Tradewinds. Tradewinds move the North Equatorial Current towards the west. In the West, the American continents obstruct the current and it is diverted to the North. This northwards - flowing current is known as the Gulf Stream.

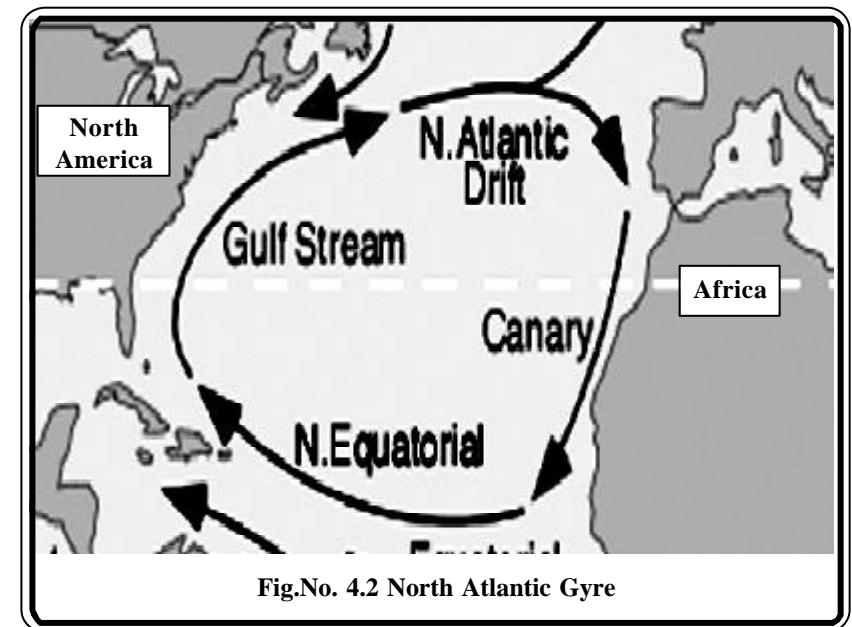


Fig.No. 4.2 North Atlantic Gyre

2. Gulf Stream : The Gulf Stream flows along the eastern coast of Central and North America. It is a warm current as it carries the north Equatorial warm water. The direction of the warm Gulf Stream is influenced by the Westerly winds at higher latitude. These winds blow from sub-tropical high pressure areas to sub-polar low pressure areas. The Westerly winds move the Gulf Stream towards east across the North Atlantic Ocean. This Eastwards-flowing current is known as the North Atlantic Drift.

3. North Atlantic Drift : In the east, Europe and Africa act as barriers and the North Atlantic Drift branches off into two: 1. The Canaries Current and 2. The Iberian Current. Among the two, the Canaries forms the fourth current in the North Atlantic gyre.

4. Canaries Current : In the east, the African continent obstructs the North Atlantic Drift, so it flows towards the south. This southwards-flowing current follows the west coast of African, and is called the Canaries Current. This is a cold current, as it carries cold waters from the North Pole. The Canaries Current flows towards the Equator. At the Equator, it flows as equatorial current and easterly winds once again push the waters towards the west. In the west, it becomes Gulf stream once again.

Of all the ocean currents the Gulf Current is a very strong warm current and the temperature is 25°C. This current protects England and Europe from severe cold. Otherwise, both the countries would suffer from a much colder climate like that of Canada, which is in the same latitude. But because of global warming there is a slight change in the direction of this current that has an impact on the local climates of England and Europe. But at global level, any modification in the circulation of the currents affects the natural climatic cycle. Let us understand this with an example of two currents in Pacific ocean as part of climatic cycles.

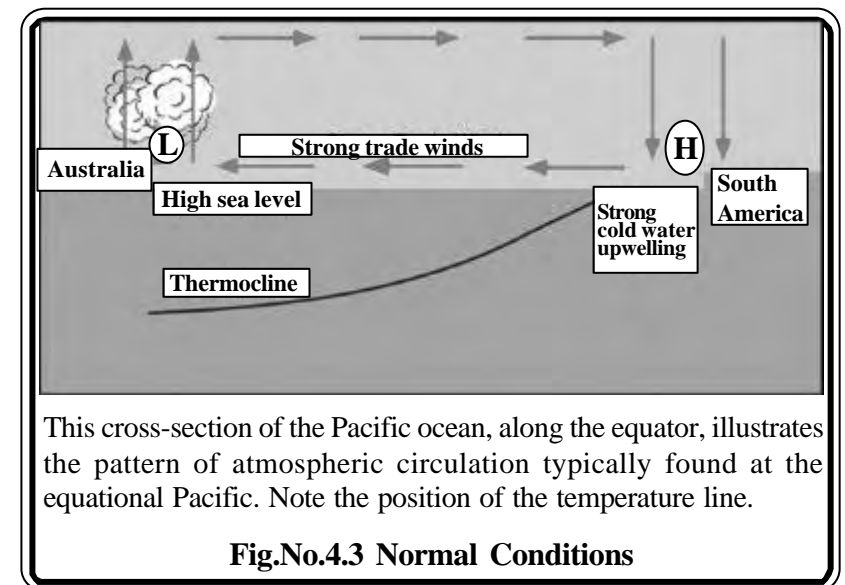
The Influence of Currents on Climatic Cycle :

E1 Nino and La Nina currents formed in the Pacific Ocean are part of the natural climatic cycle. E1 Nino and La Nina are Spanish words meaning

male and female child respectively. They are often referred as “Children of Pacific”. The formation of a warm current in the Pacific Ocean, on the western side of south America, and near the Equator, is called E1 Nino. Whenever E1 Nino forms those years are referred as E1 Nino years and the rest as Normal Years. Let us first understand the prevailing climatic conditions in a normal year.

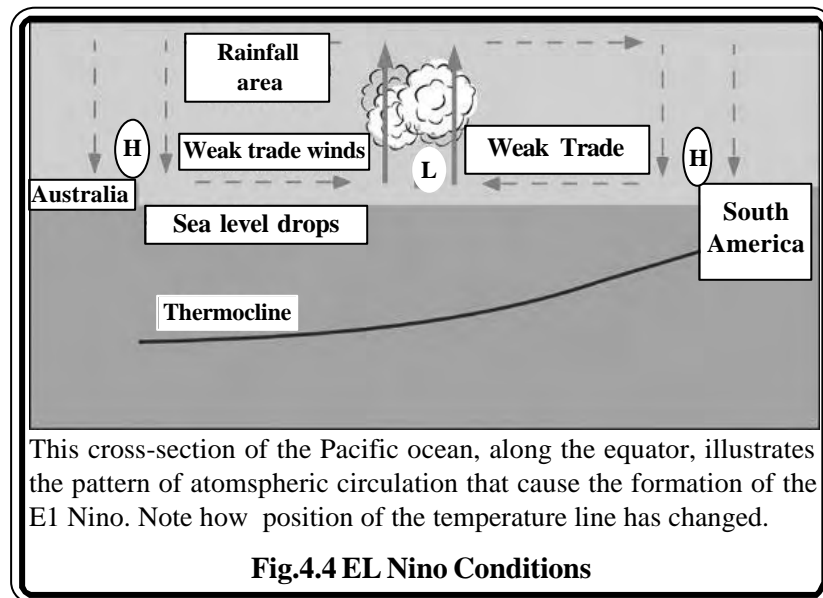
Normal Years:

In normal years, Easterly winds (Fig.No.4.3) push the warm surface waters westward across equatorial South Pacific, causing warm surface water to accumulate near Indonesia. This warm surface water helps in the formation of clouds, which give heavy rainfall to Northern Australia and Indonesia. At the same time, the Peru Current, which is a cold current, flows northwards along the South American coast, brings the cold water to the surface. This cold current carries oxygen and nutrients that sustain fish, and hence, a fishing economy flourish along south American coast. Now let us investigate the climatic conditions in an E1 Nino year.



E1 Nino years:

During E1 Nino years, Easterly winds (Fig.No.4.4) slacken or even reverse. Warm surface water flows from west to east, increasing the depth of warm water off the South American coast. Heavy rainfall follows the warm water, leading to flooding in Peru. This warm water suppresses the nutrient-rich Peru Current. Hence, fish and seabirds move away or die. E1 Nino can cause global climatic disturbances like rain and floods in one part of the world, and drought in another part. Every year a small E1 Nino occurs in December, usually lasting a few weeks. But in some years, exceptionally intense and persistent E1 Nino events occur. In 1982-1983 and 1997-1998 the E1 Nino was particularly severe. Prior to the 1980s and 1990s, strong E1 Nino events occurred on average every 10 to 20 years. In the early 1980s, the first of a series of strong events developed. The E1 Nino of 1982-83 brought extreme warming to the equatorial Pacific. Surface sea temperatures in some regions of the Pacific Ocean rose 6° Celsius above normal. The warmer waters had a devastating effect on marine life existing off the coast of Peru and Ecuador. Fish catches off the coast of South America were 50% lower than the previous year.



E1 Nino also influences the climate in Indonesia and Australia. The surface water near Australia and Asia becomes very cold and so rain bearing clouds donot appear, which leads to drought. Monsoon winds and jet streams are also affected. Vegetation becomes so dry that the slightest spark can ignite a fire. This can result in huge bush fires and in turn affects the nitrogen and carbon cycles. Ecological disturbances occur. Let us now investigate the climatic conditions when a La Nina current event.

La Nina Years:

After an E1 Nino event weather conditions usually return back to normal. However, in some years the trade winds can become extremely strong and an abnormal accumulation of cold water can occur in the central and eastern Pacific. This event is called a La Nina. A strong La Nina occurred in 1988 and scientists believe that it may have been responsible for the summer drought over central North America.

The most recent La Nina began developing in the middle of 1998 and have been persistent into the winter of 2000. During this period, the Atlantic ocean has seen very active hurricane seasons in 1998 and 1999. In 1998, ten tropical cyclones developed of which six become full-blown hurricanes. One of the hurricanes that developed, named Mitch, was the strongest October hurricane ever to develop in about 100 years of record keeping.

These cycles reveal that Earth is currently in a period in which a natural rise in global temperatures, combined with global warming effect, will push the planet through an era of rapid global warming. Strong oceanic tides are the engines behind this warming- cooling cycle. The current phase in the cycle suggests that a natural warming trend began a hundred years ago, increased in the 1970s, and should continue over the next five centuries.

In the following lesson, let us study how the atmosphere, a component of the Earth system, creates a complex and delicately balanced system that is crucial to the continuation of present lifeforms on Earth.

Exercises

I. Fill in the blanks

1. Soil water is held in _____ between soil particles.
2. Tides are caused by the _____ attraction between the moon and the Earth.
3. The largest ocean on the Earth is _____.
4. The _____ sea is an area of calm water in the western Atlantic.
5. The _____ ridge is the largest mountain range in the ocean.

II. Match the following

1. Gyre - Cold current
2. Mariana Trench - Warm current
3. Continental Shelf - Circular Pattern
4. Canary Current - Pacific Ocean
5. Gulf Stream - Japan

III. Write short notes on

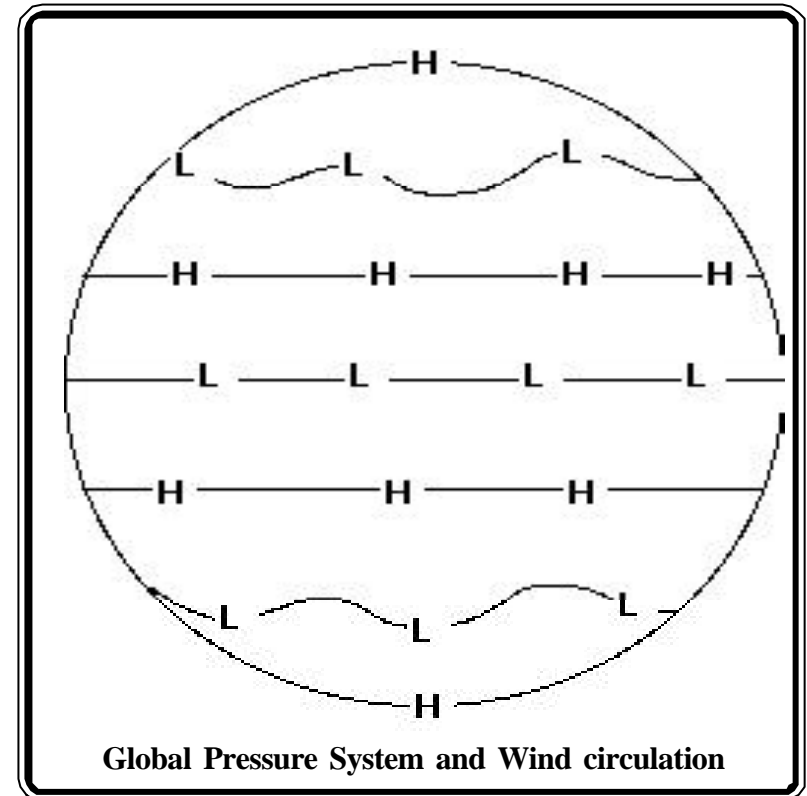
1. Southern Ocean
2. Continental Shelf
3. El Nino years
4. La Nino years

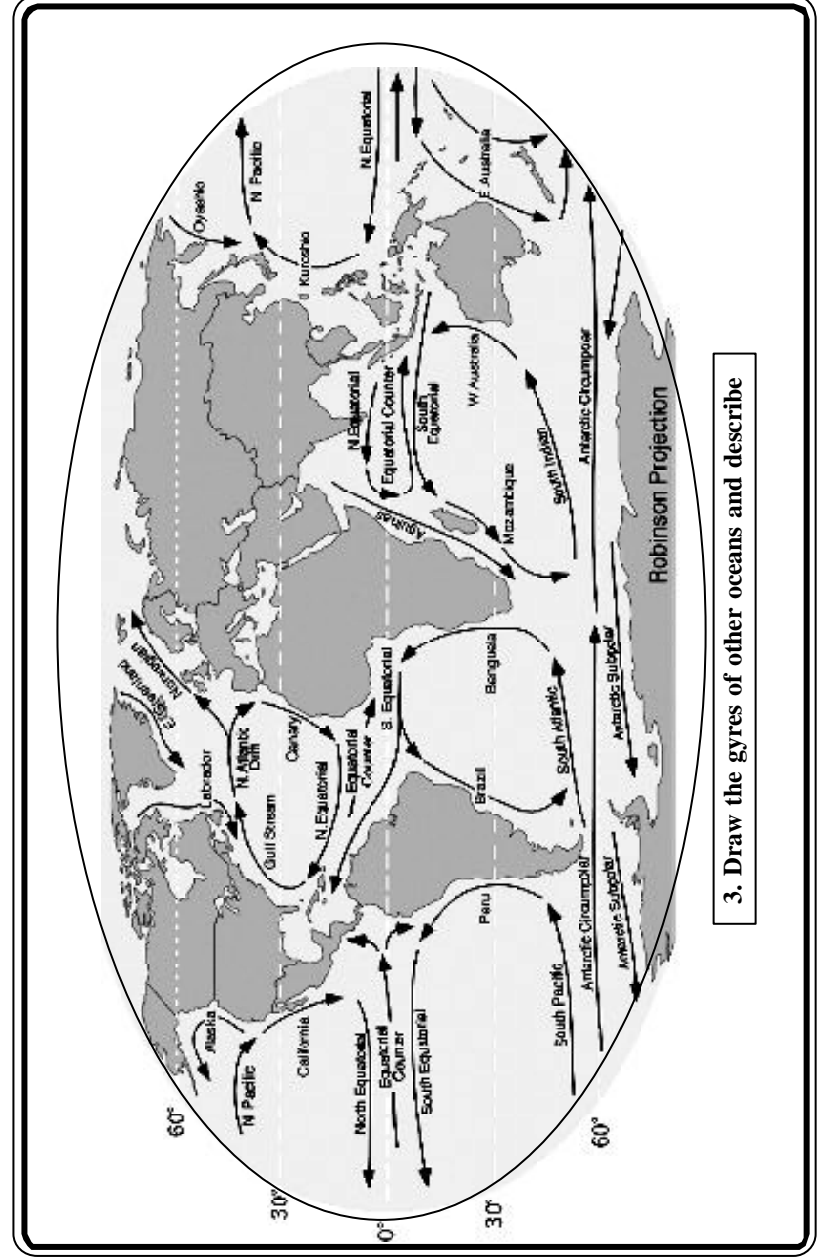
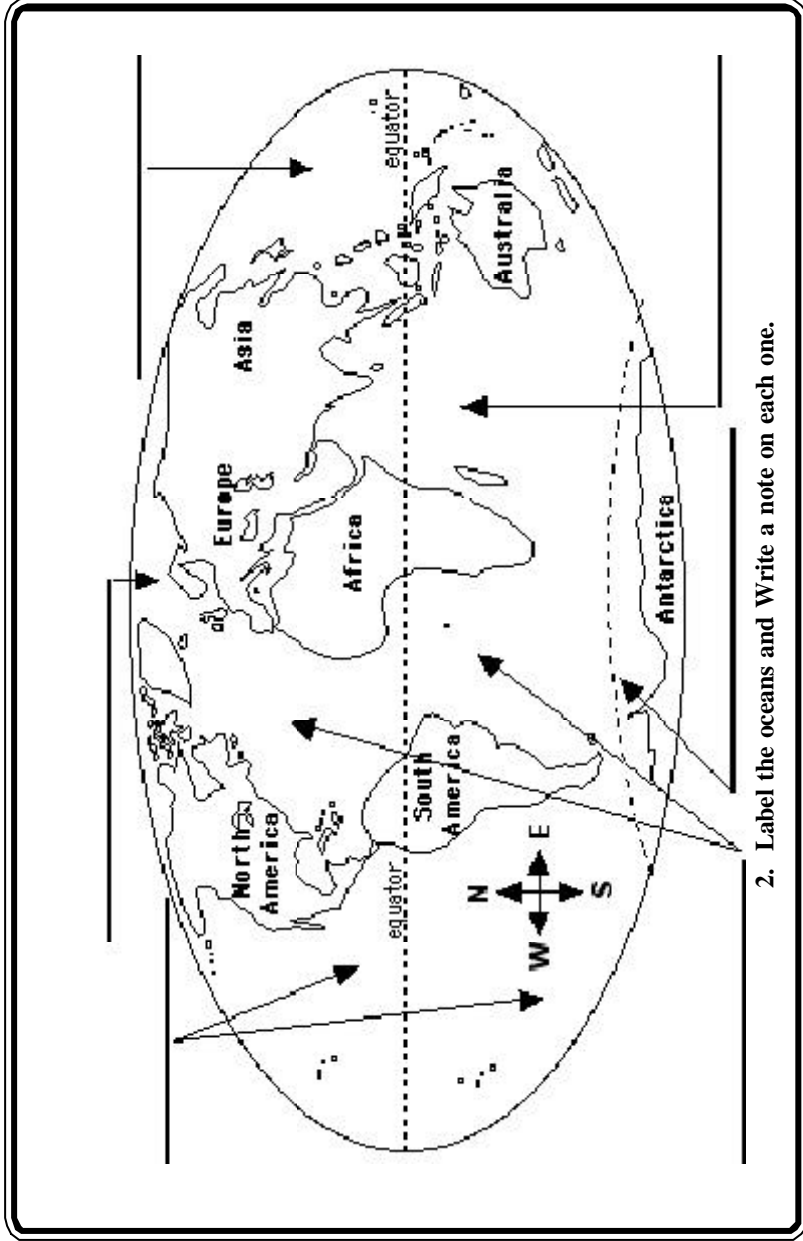
IV. Explain in detail

1. How are Gyres formed? Describe the North Atlantic Ocean gyre.
2. Write about the influence of ocean currents on local climate.

Activities

1. The following diagram describes the major pressure systems on the surface of the Earth. On this diagram sketch in the surface wind directions associated with these pressure systems on an Earth which is spinning clockwise from the north pole and compare with the currents.





5. ATMOSPHERE AND SOLAR RADIATION

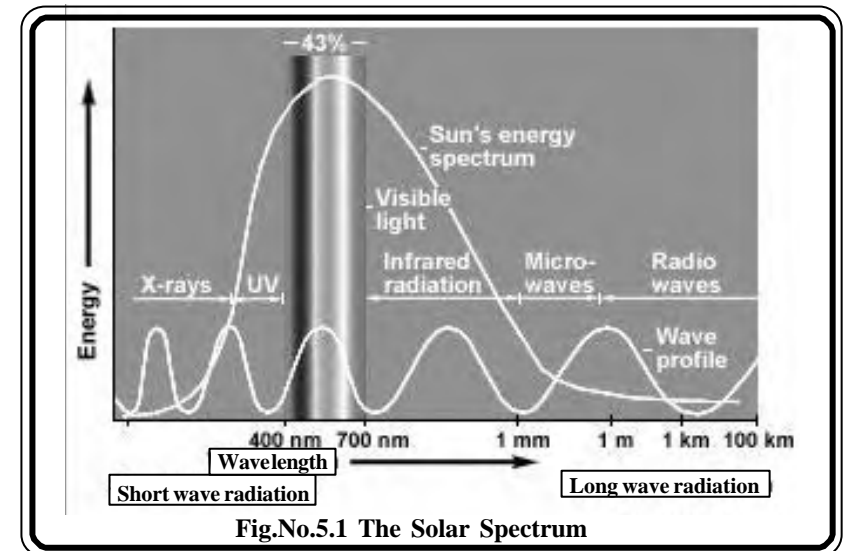
The Earth is surrounded by an atmosphere. It is a blanket of gases and has no definite outer edge. It gradually becomes thinner and it merges into space. Over 80% of atmospheric gases are held by gravity within 20 kilometers of the Earth's surface. The physical and chemical structure of the atmosphere, the way that the gases interact with solar energy, and the physical and chemical interactions between the atmosphere, land, and oceans all combine to make the atmosphere an integral part of the Earth system.

The Sun: The Sun is a star. It consists primarily of hydrogen at temperatures high enough to cause nuclear fusion. Some 120 million tons of matter, mostly hydrogen, are converted into helium on the sun every minute. The size of the Sun determines its temperature and the amount of energy radiated. This electromagnetic energy from the Sun comes to Earth in the form of radiation. The Sun radiates energy equally in all directions, and the Earth intercepts and receives part of this energy. The Sun's energy is the primary source of energy for all surface phenomena and life on Earth. This energy is the main reason for the immense diversity of life forms that are found on the Earth. We will now study in detail about the solar energy and its interplay with the composition of the Earth's atmosphere.

Solar Spectrum: The range of electromagnetic energy emitted by the Sun is known as the solar spectrum (Fig.No.5.1), and lies mainly in three regions : ultraviolet, visible, and infrared. While the Sun does emit ultraviolet radiation, the majority of solar energy comes in the form of "light" and "heat", in the visible and infrared regions of the electromagnetic spectrum. Light is special to humans and many other animals due to the evolution of the eye, a sensory organ that detects this part of the solar spectrum.

We are all familiar with the rainbow of colors, the range of different colors that makes up sunlight. The best way to visualize this concept,

and the most common scientific demonstration, is the image of a glass prism splitting up white light into the colors. When raindrops act as prisms, we see a rainbow. While the eye effectively perceives and distinguishes visible light, infrared is perceived as heat. This is also called "heat" radiation, because although we cannot see infrared, we can feel its presence as heat. The skin converts the heat into energy of the molecules. Infrared plays an important role in the temperature of the Earth and its atmosphere, and in turn, the climate of the Earth.



There are interactions occurring constantly in the atmosphere with the solar radiation. This results in a complex and delicately balanced system, which is crucial to the continuation of present life forms on Earth. The following two interactions that are crucial to the maintenance of life on Earth:

1. The atmosphere acts as a filter, absorbing and reflecting portions of the electromagnetic spectrum, such as the ultraviolet region, region, that are harmful to humans and other life forms.
2. The atmosphere provides a natural "warming effect", maintaining the temperatures and climates in which life forms on the Earth have evolved to survive.

The atmosphere controls the amount of solar radiation reaching the surface of the Earth, and regulates the amount of radiation from the Earth escaping into space. Thus a slight change in the concentration of certain gases could upset the balance of reactions and be detrimental to life on the Earth, as we all know. So, let us learn first about the composition of the atmosphere in detail and later discuss its relevance to two major environmental problems; stratospheric ozone depletion and global climate change.

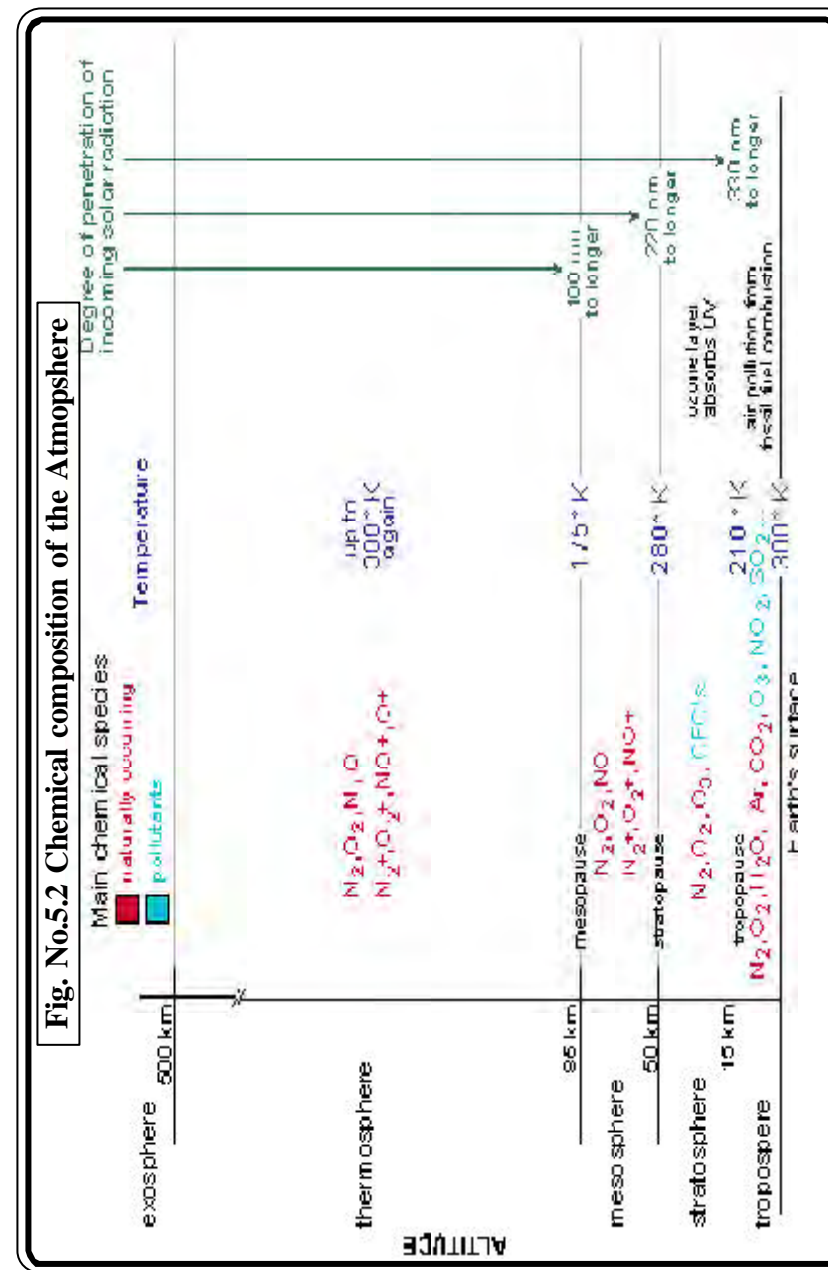
Chemical Composition of the Atmosphere

The major constituents are oxygen (O₂) and nitrogen (N₂). Other gases such as argon, carbon dioxide, nitric oxide and ozone are produced in minute quantities in natural processes. Numerous other gases circulate particularly in the troposphere in small quantities. Apart from these gases water vapour is also present in the atmosphere. The water fraction in the atmosphere varies from place-to-place and day-to-day. However, in the last century industrial and other technological activities have introduced gases such as carbon monoxide and chlorofluorocarbons into the atmosphere. CFCs are a family of chemicals that do not occur in nature. These chemically inert compounds rise into the stratosphere and cause disruptions in the ozone layer. This disrupts the natural balance of circulation and radiation absorption in the troposphere. Effects of these changes range from local atmospheric problems to global climate change.

Layers of the Atmosphere

The atmosphere consists of five layers (Fig.No.5.2): The troposphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere. The thickness of these layers is slightly different around the globe, and also varies according to temperature and season. In this discussion, we will focus primarily on the troposphere and the stratosphere because human-made pollutants affect the function of the lower layers.

The Troposphere: The troposphere is the layer closest to the Earth's surface. It is a layer of air approximately 10 to 15 kilometers thick. The conditions in this layer determine practically all of the global weather patterns. It consists of gases like nitrogen, oxygen and carbon dioxide. In addition to these gases, water vapour and dust are found in this year.



Consequently, weather phenomena such as clouds, lightning, thunder, storms and rain take place in this layer.

Carbon dioxide is much heavier than the other gases. So the amount of carbon dioxide is higher in this lower layer of the atmosphere. It tends to decrease as the altitude increases. Therefore the temperature decreases with the increasing altitude at the rate of 1°C per 165 metres. This ratio of decrease in temperature with the increase of altitude is called the **lapse rate**.

The stratosphere : The stratosphere is the layer just above the troposphere. It is approximately 40 kilometers thick. In contrast to the troposphere, water vapour is not found in this layer. Therefore weather changes do not take place in this layer. Pollutants tend to remain long periods of time in the stratosphere. Moreover, the wind blows horizontally and therefore the conditions are conducive for airplanes to fly with great speed and a long distance.

3. Thermosphere : The mesosphere spreads above the stratosphere from 50 kms to 80 kms. The meteors, which fall on the Earth due to the gravitational force, burn due to the friction with the wind at this level. This layer protects the Earth from the falling meteors, otherwise these meteors will damage the surface of the Earth.

4. Thermosphere : The thermosphere lies above the mesosphere. It extends approximately from 80 kms to 1600 kms. It contains hydrogen and helium in large amounts. Below this layer ions are found from 500 kms. We can enjoy radio programs that are broadcast from the radio station only because of the reflection done by the ions.

5. Exosphere : The exosphere extends from 1600 kms to 10,000 kms. Winds having very low density are found here. It mingles in the space and only vacuum is found above this layer.

Among the above said layers of the atmosphere, the stratosphere filters the ultraviolet rays and protects the Earth. Let us now learn the significance of ozone layer and its depletion.

Ozone layer and its depletion : Ozone is a form of oxygen. Ozone is made of three oxygen atoms (O_3). The oxygen (fig no. 5.3) we find in

the atmosphere is made up of two oxygen atoms (O_2). Because of its chemical formulation, a single atom of oxygen (O) is unstable. That is, it wants to combine with something else. That is why oxygen is almost always found in pairs, in its diatomic form, where it is more stable. O_3 is less stable than, because it wants to return to the diatomic state by giving up an oxygen atom. When enough ozone molecules are present, it forms a pale blue gas. Ozone has the same chemical structure whether it is found in the **stratosphere** or the **troposphere**.

In the troposphere, “bad” ozone is an air pollutant (Fig No.5.4). It damages human health and vegetation. It is a key ingredient of urban smog. In the stratosphere, we find the “good” ozone that protects life on earth from the harmful effects of the sun’s ultraviolet rays.

Ozone is constantly being formed in the earth’s atmosphere by the action of the sun’s ultraviolet radiation on oxygen molecules. Ultraviolet light splits the molecules apart by breaking the bonds between the atoms. A highly reactive free oxygen atom then collides with another oxygen molecule to form an ozone molecule. Because ozone is unstable, ultraviolet radiation quickly breaks it up, and the process begins again.

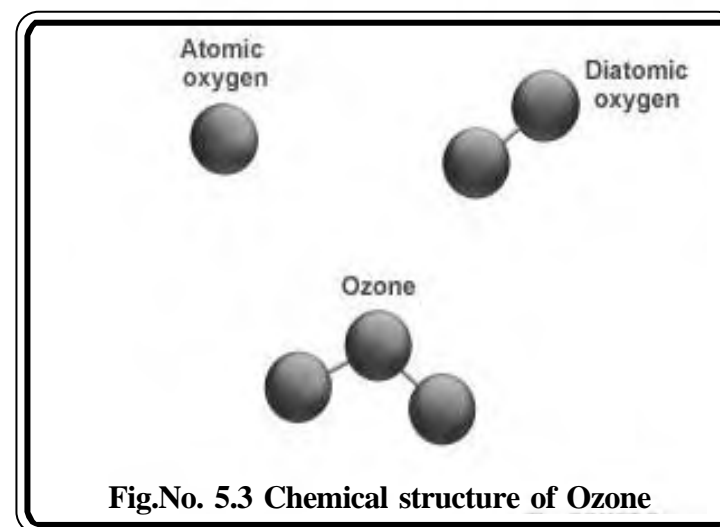


Fig.No. 5.3 Chemical structure of Ozone

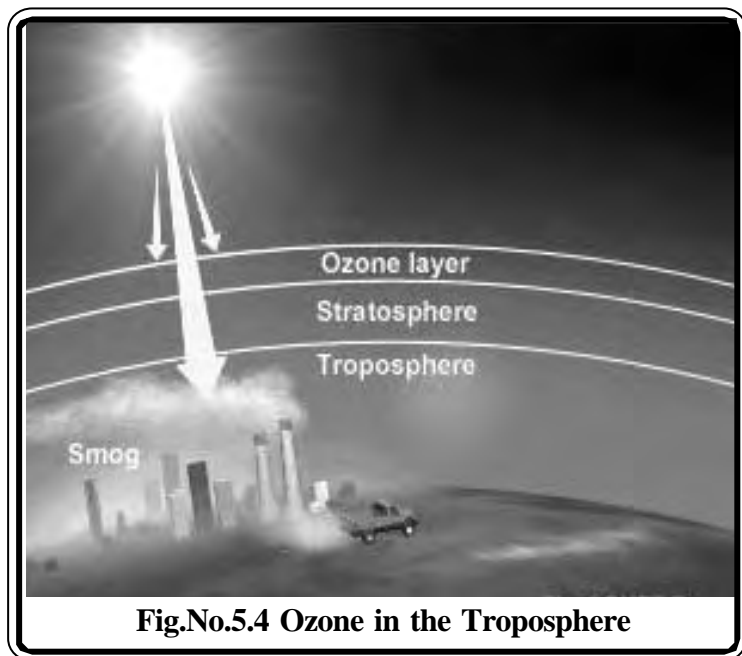


Fig.No.5.4 Ozone in the Troposphere

About 90% of the zone in the earth's atmosphere lies in the stratosphere. Ozone forms a very thin layer in the stratosphere, where it is more concentrated than anywhere else. While both oxygen and ozone together absorb 95 to 99.9% of the sun's ultraviolet radiation, only ozone effectively absorbs the most energetic ultraviolet light, which causes biological damage.

Ozone - Depleting Substances

A family of compounds known as chlorofluorocarbons (CFCs) have the most significant effect on the ozone layer. CFCs contain different proportions of three elements. carbon (C), fluorine (F) and chlorine (Cl). CFCs were produced and used extensively as refrigerants starting in the early 1930's after a scientist named Medgley discovered this gas. At that time, ammonia and sulfur dioxide were widely used as refrigerants. But ammonia was undesirable because it is a strong eye and respiratory

The cycle of ozone gas :

1. $O_2 + \text{UV radiation } (<175 \text{ nm}) \rightarrow O + O$
2. $O + O_2 \rightarrow O_3$ or $O + O \rightarrow O_2$
3. $O_3 + \text{UV radiation } (240 - 280 \text{ nm}) \rightarrow O^* + O_2 \text{ gas}$
4. $O^* + O \rightarrow O_2$ or $O^* + H_2O \rightarrow 2OH$ and so on.

This cycle repeats over millions of years and has reached a state of equilibrium. The net result of the above reactions is that O_2 and O_3 are constantly changing into each other. Each cycle takes up energy in the form of ultraviolet radiation, resulting in a large reduction of the amount of ultraviolet radiation reaching the troposphere. These reactions result higher concentration of ozone gas in the lower region of the stratosphere. The largest amount of O_2 is found between 20 and 26 km above the Earth's surface. This area is called the "ozone layer."

In general ultraviolet radiation damages the skin, and can initiate the process of skin cancer. Thus ozone layer forms a shield, protecting us from receiving large amounts of UV

irritant. Chlorofluorocarbons were seen then as the ideal compounds because they were thought to be harmless. They are chemical inert, non-toxic, and insoluble in water.

For the past seventy years, CFCs were used extensively in aerosols, refrigerants, and foams. Because of their non-reactive nature. CFSs are able to rise undisturbed into the atmosphere. When CFSs migrate high enough and are hit by enough ultraviolet radiation, they are broken down and release chlorine atoms. The chlorine atoms react with O_3 gas and make ozone molecules unavailable. One chlorine atom can destroy over 100,00 molecules of ozone.

On our planet, a temperature balance in nature is necessary to sustain living organisms. This balance occurs due to the absorption of short wave (visible) solar radiation by surfaces on the earth, and the subsequent transformation of that radiation into longer-wave infrared. Infrared is then absorbed and “trapped” by carbon dioxide, causing the troposphere to maintain a significantly warmer temperature.

Since the Industrial Revolution, there has been a high rate of increase in the concentration of carbon dioxide. This gas have risen by 30% since the late 1800s. Furthermore, scientists predict that CO₂ concentrations will continue to rise, likely reaching 2 to 3 times the pre-industrial level by 2100. The carbon dioxide effect can become a problem when the amount of heat-absorbing gases in the atmosphere rapidly rises far above the levels at present.

The warming of atmosphere is seen not only at global level but also at local levels. Local-Urban heat islands are one such example. “Urban heat islands” are a kind of localized enhanced warming phenomenon. They are simply built-up areas of a city that are significantly warmer than the surrounding area of country side.

Urban heat islands : The difference in temperature comes from the fact that buildings, paved surfaces, and other human-made structures absorb higher amounts of sunlight than most natural objects. This energy is re-radiated at longer wavelengths during the night. The atmospheric pollution in the form of carbon dioxide, a heat-absorbing gas, forms a “local” atmosphere, trapping in the heat (Fig. No.5.5).

Meteorologists have noticed that metropolitan areas are creating their own weather patterns at night due to the collision of cool air from the surrounding area with the warmer city air. It is important to note that urban heat islands are a localized effect, whereas the general atmospheric effect is global in extent. So far we have examined the atmospheric phenomena and found that the current state of the atmosphere is the result of increased industrial activities. In the last century especially, the atmospheric system that evolved over billions of years has been subject to rapid changes.

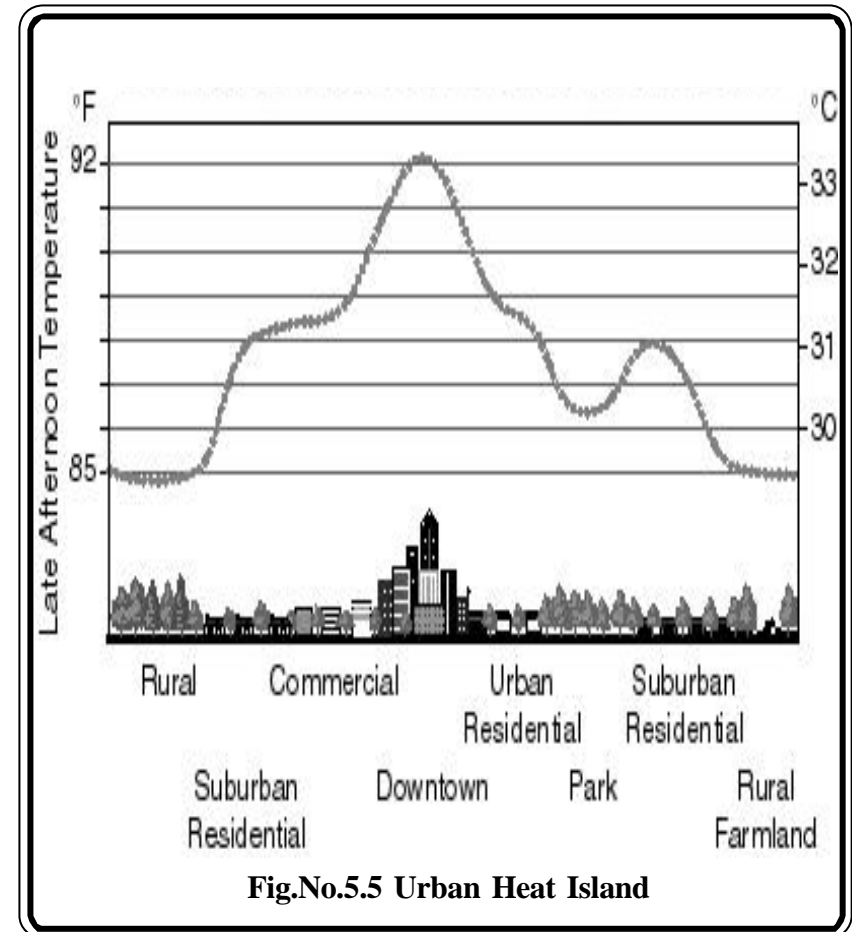


Fig.No.5.5 Urban Heat Island

James Lovelock, author of Gaia, proposes that the atmosphere owes its current composition to living systems. He remarks that life on Earth requires a particular atmospheric composition, and this composition is in turn maintained by the interactions between biological systems and the atmospheric system. Let us learn more about the biological systems in the next lesson.

Exercises

I. Fill in the blanks.

1. The _____ energy from the Sun comes to Earth in the form of radiation.
2. Infra red waves are perceived as _____ when the skin absorbs them.
3. The ratio of decreasing temperature with the increase of altitude is called as _____.
4. Human activities have introduced gases such as _____ and _____ into the atmosphere.
5. The _____ layer protects us from receiving large amounts of ultra violet rays.

II. Match the following

1. Ozone depletion - Sun's energies
2. Solar spectrum - Weather pattern
3. Troposphere - Local climate
4. CFC - Cataracts
5. Urban heat island - Non toxic

III. Write short notes on

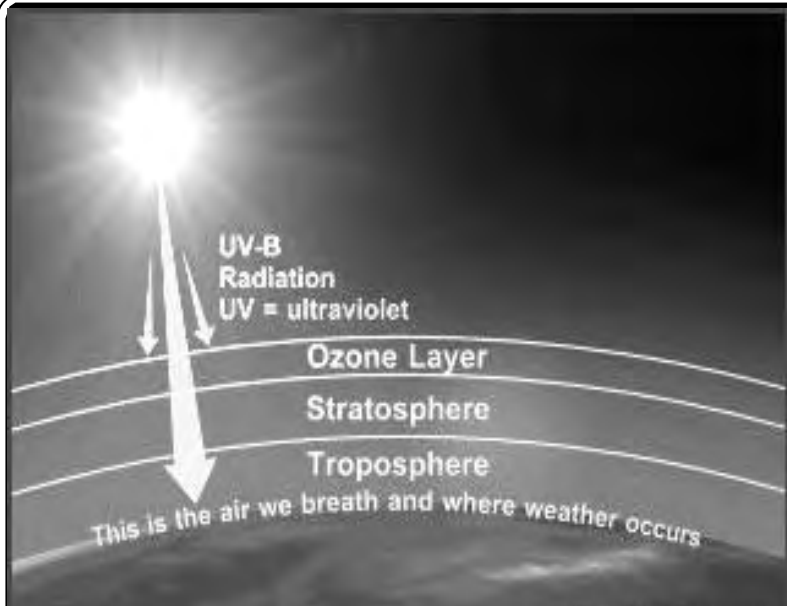
1. The solar spectrum
2. Urban heat island
3. Stratosphere
4. Troposphere
5. Chemical composition

IV. Explain in detail

1. Write about the importance of ozone layer.
2. The Sun's energy is the primary source of energy. Explain

Activities

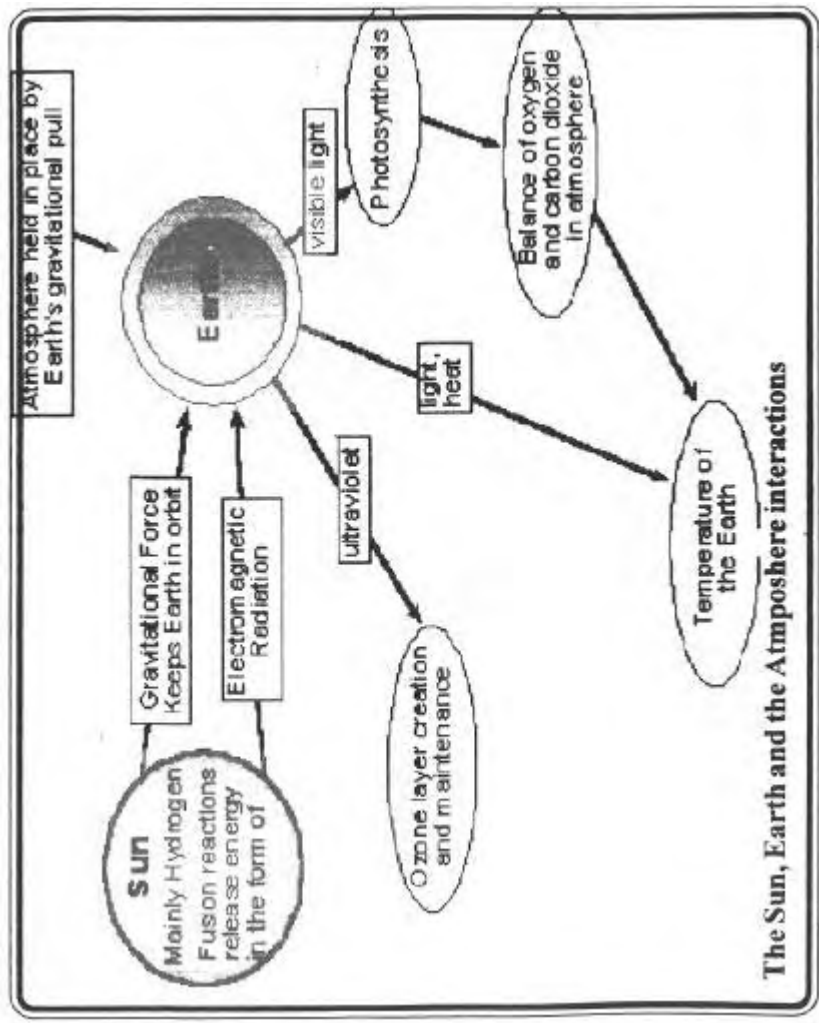
1. Collect informations about global warming and ozone depletion.
2. Draw a diagram to show the different layers of the atmosphere and describe them in your own words.
3. Notice the picture below and answer the following questions



The diagram illustrates the Earth's atmosphere with the Sun at the top left. A large arrow points from the Sun towards the Earth, labeled 'UV-B Radiation' and 'UV = ultraviolet'. The atmosphere is divided into three layers: the Ozone Layer, the Stratosphere, and the Troposphere. A smaller arrow points from the Ozone Layer towards the Troposphere. A text box at the bottom of the Troposphere reads 'This is the air we breath and where weather occurs'.

1. Ozone exists in both the troposphere and the stratosphere and explain that ozone in the stratosphere is important for filtering out damaging ultraviolet radiation.
2. Explain that ozone in the troposphere is a pollutant and it can damage respiratory tissue in living organisms.

4. Explain in few words about the interactions of the Sun, Earth and its atmosphere.



6. NUTRIENT CYCLES AND ECOSYSTEMS

Our planet is the only place in the universe that supports life. Life on Earth requires a variety of organic and inorganic nutrients. These nutrients continuously recycle through the interactions of organisms and their environments. Recycling chemicals essential to life involves both geological and biological processes. These pathways are called biogeochemical cycles and have three things in common.

1. Reservoirs : These are where the chemical is held in large quantities for long periods of time.
2. Exchange pools : This is where the chemical is held for only a short time.
3. Residence time : It is the length of time a chemical is held in an exchange pool or a reservoir.

For example, the oceans are a reservoir for water cycle, while a cloud is an exchange pool. Water may reside in an ocean for thousands of years, but in a cloud for a few days at best. The biotic community also serves as an exchange pool and also move chemicals from one stage of the cycle to another. For instance, the trees of the tropical rain forest bring water up from the forest floor to be evaporated into the atmosphere. Likewise, coral polyps take carbon from the water and turn it into limestone rock. The energy for most of the transportation of chemicals from one place to another is provided either by the sun or by the heat released from the mantle and core of the Earth.

Earth has a number of cycles. Of which only four are very important for living organisms. They are: water, carbon, nitrogen, and phosphorous. The water cycle will be discussed in the next year. The other three cycles are discussed in this lesson.

The Carbon Cycle

Respiration takes carbohydrates and oxygen, combines them to produce carbon dioxide, water, and energy. Photosynthesis takes carbon dioxide and water, produces carbohydrates and oxygen. The outputs of respiration are the inputs of photosynthesis, and the outputs of photosynthesis are the inputs of respiration. The reactions are also complementary in the way they deal with energy. Photosynthesis takes energy from the sun and stores it as carbohydrates; respiration releases that energy. Both plants and animals carry on respiration, but only plants can carry on photosynthesis.

The chief reservoirs for carbon dioxide are the oceans and the rocks. Carbon dioxide dissolves readily in water. Once there, it may precipitate as a solid rock known as calcium carbonate. Corals and algae encourage this reaction and build up limestone reefs in the process. On land and in the water, plants take up carbon dioxide and convert it into carbohydrates through photosynthesis. This carbon in the plants now has three possible fates. It can be liberated to the atmosphere by the plant through respirations; it can be eaten by an animal, or it can be present in the plant when the plant dies.

When an animal or a plant dies, two things can happen to the carbon in it. It can either be released by decomposers to the atmosphere, or it can be buried intact and ultimately form coal, oil, or natural gas. The fossil fuels can be mined and when burned releases carbon dioxide to the atmosphere. Otherwise, the carbon in limestone or other, sediments can only be released to the atmosphere when volcanoes erupt, or when they are pushed to the surface and slowly weathered away.

Humans have a great impact on the carbon cycle because when we burn fossil fuels we release excess carbon dioxide into the atmosphere. This means that more carbon dioxide goes into the oceans, and more is present in the atmosphere. This rise in the atmosphere causes global warming.

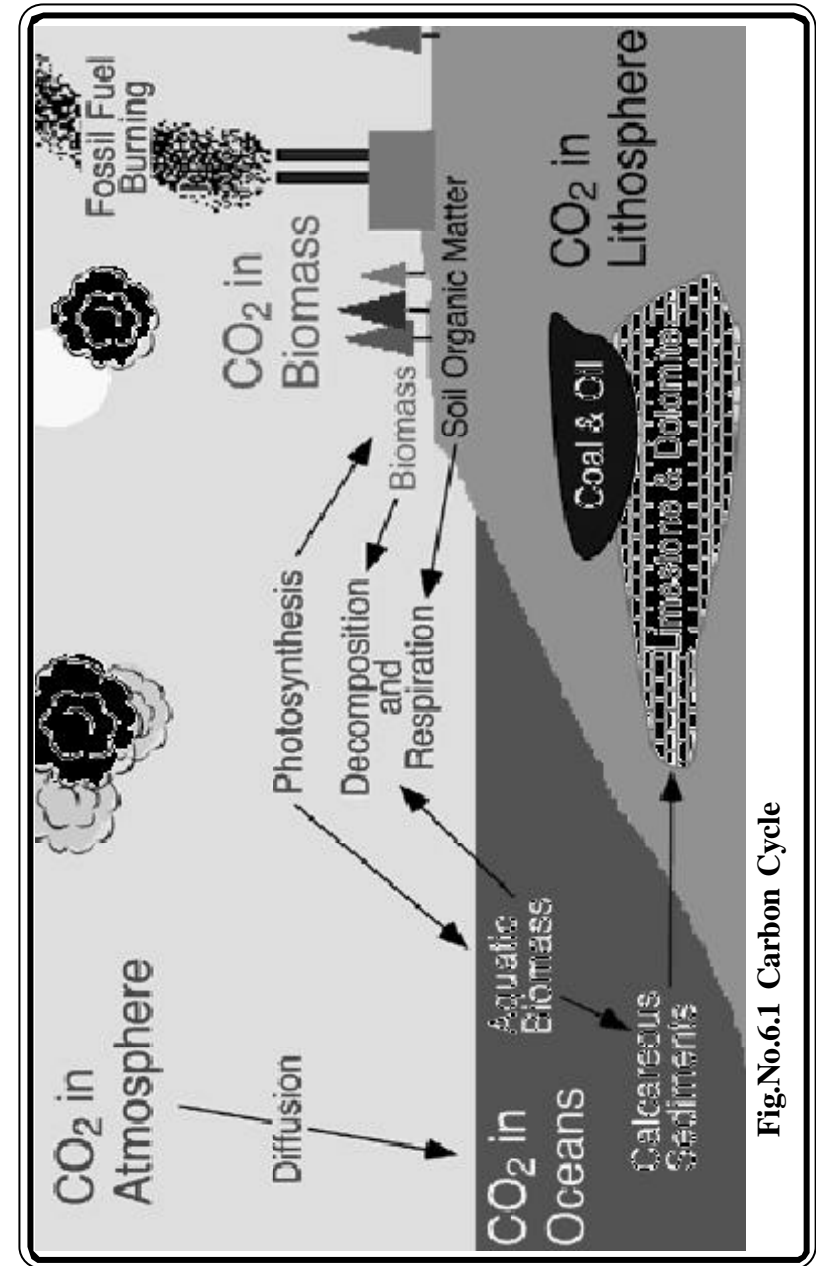


Fig.No.6.1 Carbon Cycle

The Nitrogen Cycle

The nitrogen cycle is one of the most difficult of the cycles to learn, simply because there are so many important forms of nitrogen, and because organisms are responsible for each of the interconversions. Nitrogen is critically important in forming the amino portions of the amino acids which in turn form the proteins of our body. Proteins make up skin and muscle, among other important structural portions of our body, and all enzymes are proteins. Since enzymes carry out almost all of the chemical reactions in our body, it's easy to see how important nitrogen is.

The chief reservoir of nitrogen is the atmosphere, which is about 78% nitrogen. Nitrogen gas in the atmosphere is composed of two nitrogen atoms bound to each other. It is a pretty non-reactive gas; it takes a lot of energy to get nitrogen gas to break up and combine with other things, such as carbon or oxygen.

Nitrogen gas can be taken from the atmosphere in two basic ways (Fig.No.6.2) First, lightning provides enough energy to "burn" the nitrogen and fix it in the form of nitrate, which is a nitrogen with three oxygens attached. This process is duplicated in fertilizer factories to produce nitrogen fertilizers. The second form of nitrogen fixation is by nitrogen fixing bacteria, who use special enzymes instead of the extreme amount of energy found in lighting to fix nitrogen. These nitrogen - fixing bacteria fix nitrogen either in the form of nitrate or in the form of ammonia.

Most plants can take up nitrate and convert it to amino acids. Animals acquire all of their amino acids when they eat plants or other animals. When plants or animals die or release waste the nitrogen is returned to the soil. The usual form of nitrogen returned to the soil in animal wastes or in the output of the decomposers, is ammonia. Ammonia is rather toxic, but, fortunately there are nitrite bacteria in the soil and in the water which take up ammonia and convert it to nitrite.

Nitrite is also somewhat toxic, but another type of bacteria, nitrate bacteria, take nitrite and convert it to nitrate, which can be taken up by plants to continue the cycle. There are denitrifying bacteria which take the nitrate and combine the nitrogen back into nitrogen gas.

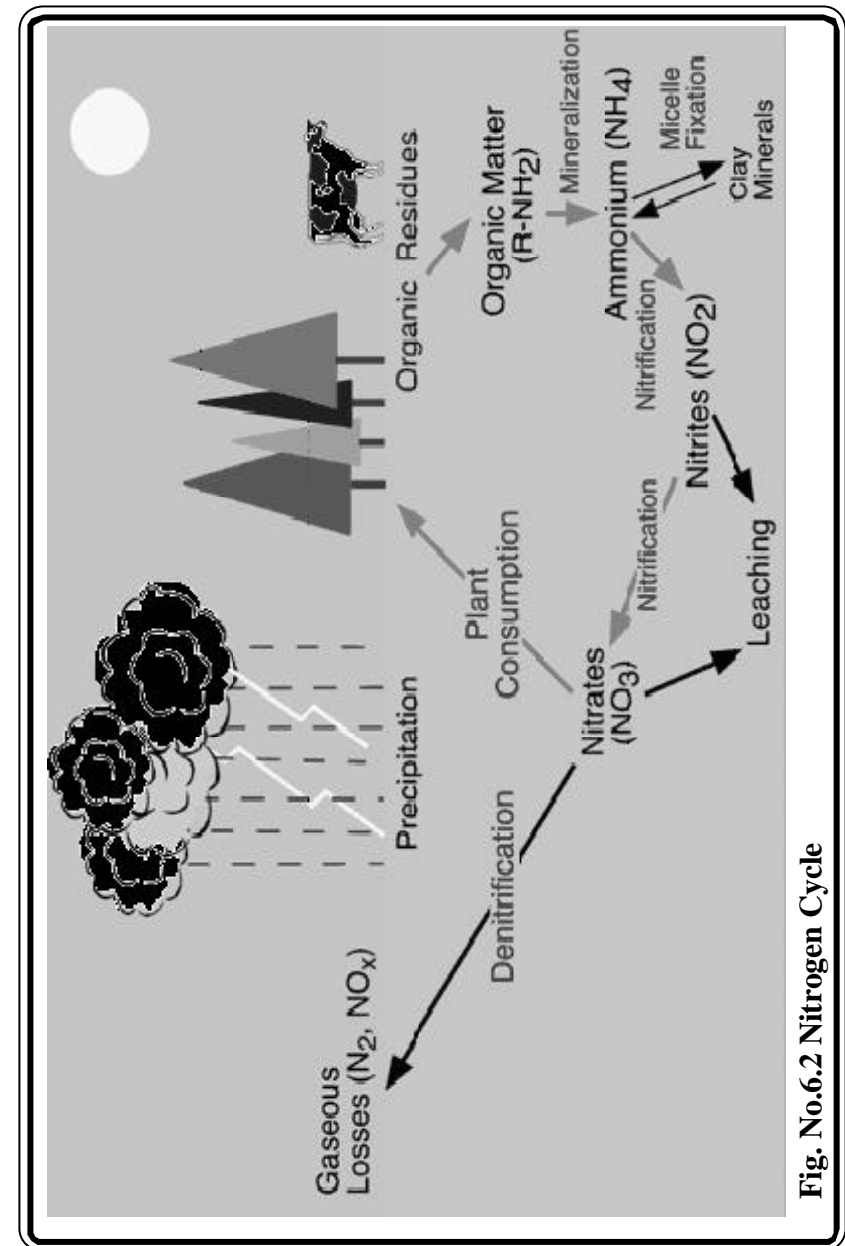


Fig. No.6.2 Nitrogen Cycle

The Phosphorous Cycle :

The phosphorous is the simplest of all cycles. Phosphorous has only one form, phosphate, which is a phosphorous atom with 4 oxygen atoms. This molecule never makes its way into the atmosphere, it is always part of an organism, dissolved in water, or in the form of rock. When rock with phosphate is exposed to water especially water with a little acid in it, the rock is weathered out and goes into solution. Plants take this phosphorous up through their roots and use it in a variety of ways (Fig.No.6.3).

It is an important constituent of cell membranes. Animals obtain their phosphorous from the plants they eat. Animals, by the way, may also use phosphorous as a component of bones, teeth and shells. When animals or plants die the phosphate may be returned to the soil or water by the decomposers. There, it can be taken up by another plant and used again. This cycle will occur over and over until at last the phosphorous is lost at the bottom of the deepest parts of the ocean, where it becomes part of the sedimentary rocks forming there. Ultimately, this phosphorous will be released if the rock is brought to the surface and weathered.

Two types of animals play a unique role in the phosphorous cycle. Humans often mine rock rich in phosphorous. For instance, in Florida, which was once sea floor, there are extensive Phosphate mines. The phosphate is then used as fertilizer. This mining of phosphate and use of the phosphate as fertilizer greatly accelerates the phosphorous cycle and may cause local overabundance of phosphorous, particularly in coastal regions, at the mouths of rivers, and any place where there is a lot of sewage released into the water. Local abundance of phosphate can cause overgrowth of algae in the water; the algae can use up all the oxygen in the water and kill other aquatic life. This is called eutrophication.

The other animals that play a unique role in the phosphorous cycle are marine birds. There birds take phosphorous containing fish out of the ocean and return to land, where they defecate. Their guano contains high levels of phosphorous and in this way marine birds return phosphorous from the ocean to the land. The guano is often mined and may form the basis of the economy in some areas.

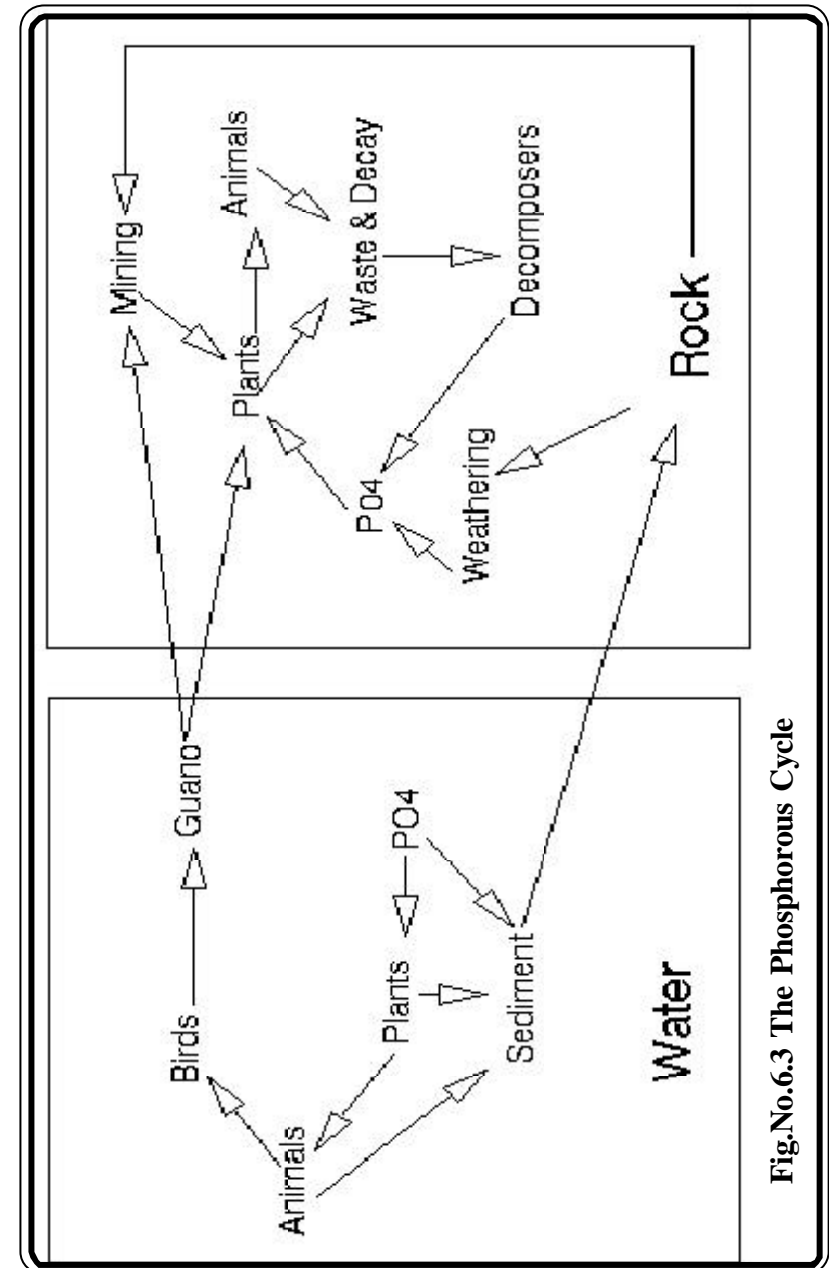


Fig.No.6.3 The Phosphorous Cycle

In the biosphere, a group of organisms with their total assemblage of components entering into the interactions through biogeochemical cycles is known as an ecological system, or more simply an ecosystem. A.G. Tansely, a botanist, introduced the ecosystem concept in the year 1935.

Major Components of an Ecosystem

Ecosystems are composed of a variety of abiotic and biotic components and they function in an interrelated fashion. Some of the important components are (Fig.No.6.4) : Soil, atmosphere, radiation from the sun, water, and living organisms.

Soils contain a mixture of weathered rock fragments, highly altered soil mineral particles, organic matter, and living organisms. Soils provide nutrients, water, a home, and a structural growing medium for organisms. The vegetation found growing on top of a soil is closely linked to this component of an ecosystem through nutrient cycling.

The atmosphere provides organisms found within ecosystems with carbon dioxide for photosynthesis and oxygen for respiration. The processes of evaporation, transpiration, and precipitation, cycles water between the atmosphere and the Earth's surface.

Solar radiation is used in ecosystems to heat the atmosphere and to evaporate and transpire water into the atmosphere. Sunlight is also necessary for photosynthesis. Photosynthesis provides the energy for plant growth and metabolism, and the organic food for other forms of life.

Most living tissue is composed of a very high percentage of water, up to and even exceeding 90%. The protoplasm of a very few cells can survive if their water content drops below 10%, and most are killed if it is less than 30 - 50%. Water is the medium by which mineral nutrients enter and are translocated in plants. It is also necessary for the maintenance of leaf turgidity and is required for photosynthetic chemical reactions. Plants and animals receive their water from the Earth's surface and soil. The original source of this water is precipitation from the atmosphere.

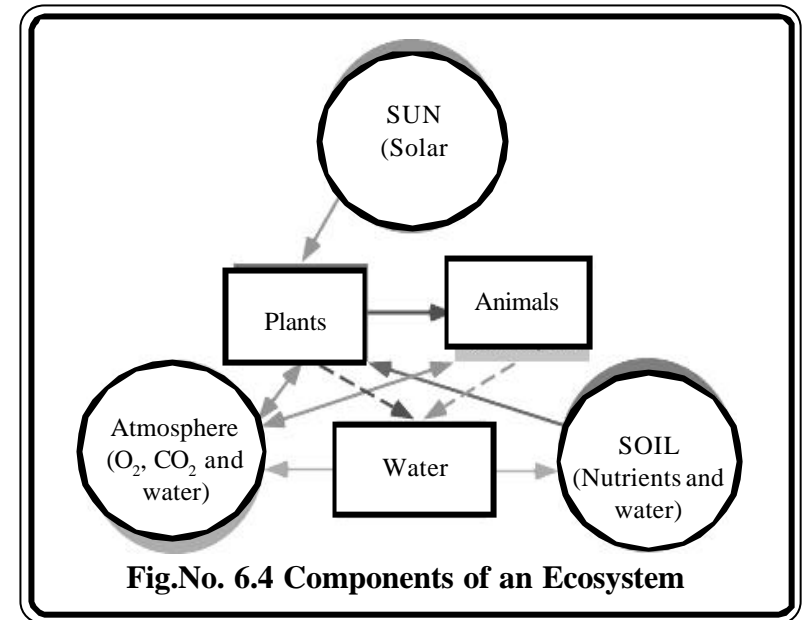


Fig.No. 6.4 Components of an Ecosystem

Ecosystem Types :

The ecological communities in the biosphere, interact with their environment and create a variety of ecosystems. These ecosystems fall into two groups : Water and Land.

Water ecosystems include life forms of the marine environments and the fresh water environments of the land. Marine ecosystems include open oceans, coastal estuaries and coral reefs. Freshwater ecosystems include lakes, ponds, streams and marshes. Let us learn about this in detail in the next year.

Land ecosystems consists of land plants, and animals spread widely over the upland surfaces of the continent. Land ecosystems are largely determined by climate and soil and, in this way, closely woven into the fabric of physical geography. The land ecosystems consists of two basic types such as natural and cultural.

The largest recognizable division of the natural ecosystem is the “Biome”. Although the biome includes the assemblage of plant and animal life interacting within the biosphere, the green plants dominate the biome physically as compared with that of other organisms.

In geography, the concept of natural vegetation represented by biomes; and the vegetation sustained in a modified state by humanity are like the two sides of a coin. Natural vegetation can still be seen over vast areas of the wet equatorial climate where rainforests are scarcely touched by humans. Much of the Arctic Tundra and the needle leaf forest of the subarctic zones is in a natural state. In contrast, much of the continental surface in the middle latitudes is almost totally under human control through intensive agriculture, organizing or urbanization.

Humans have influenced vegetation by moving plant species from their indigenous habitats to foreign lands and foreign environments. The eucalyptus tree is a good example. From Australia the various species of eucalyptus have been transplanted to such far-off lands as North America, North Africa and India.

Let us study more about the natural biomes and human made agricultural biomes in the following lesson.

Exercises

I. Fill in the Blanks

1. Ecosystems are composed of a variety of _____ and _____ components.
2. Recycling chemicals essential to life involves both _____ and _____ processes.
3. The ecological communities interact with their _____ and create a variety of ecosystems.
4. The Chief _____ for carbon dioxide are the oceans and rock.
5. Two types of animals play a unique role in the _____ cycle.

II. Match the following :

- | | |
|-------------------------|--------------|
| 1. Australia | - Medium |
| 2. Guano | - Eco system |
| 3. Biological Community | - Eucalyptus |
| 4. Interactions | - Bird |
| 5. Water | - Ecology |

III. Write short notes on

1. Phosphorus cycle
2. Carbon cycle
3. Nitrogen cycle
4. Eco system
5. Habitats

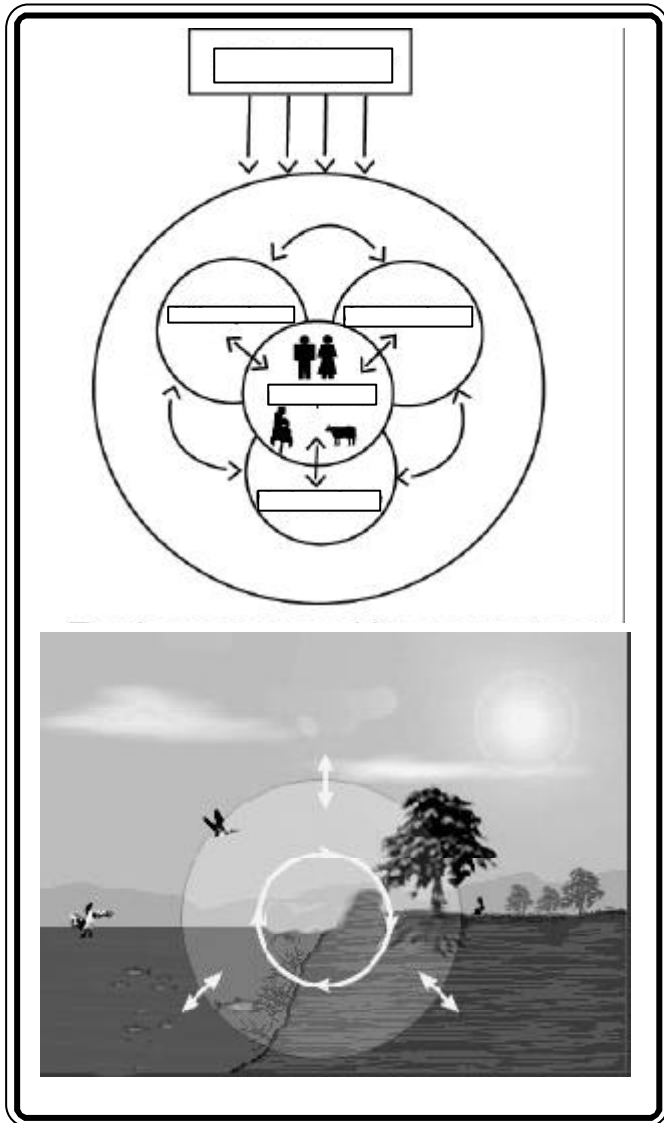
IV. Explain in detail

1. What are the basic components of an ecosystem? Describe.
2. Define biogeochemical cycles and describe any one of them.

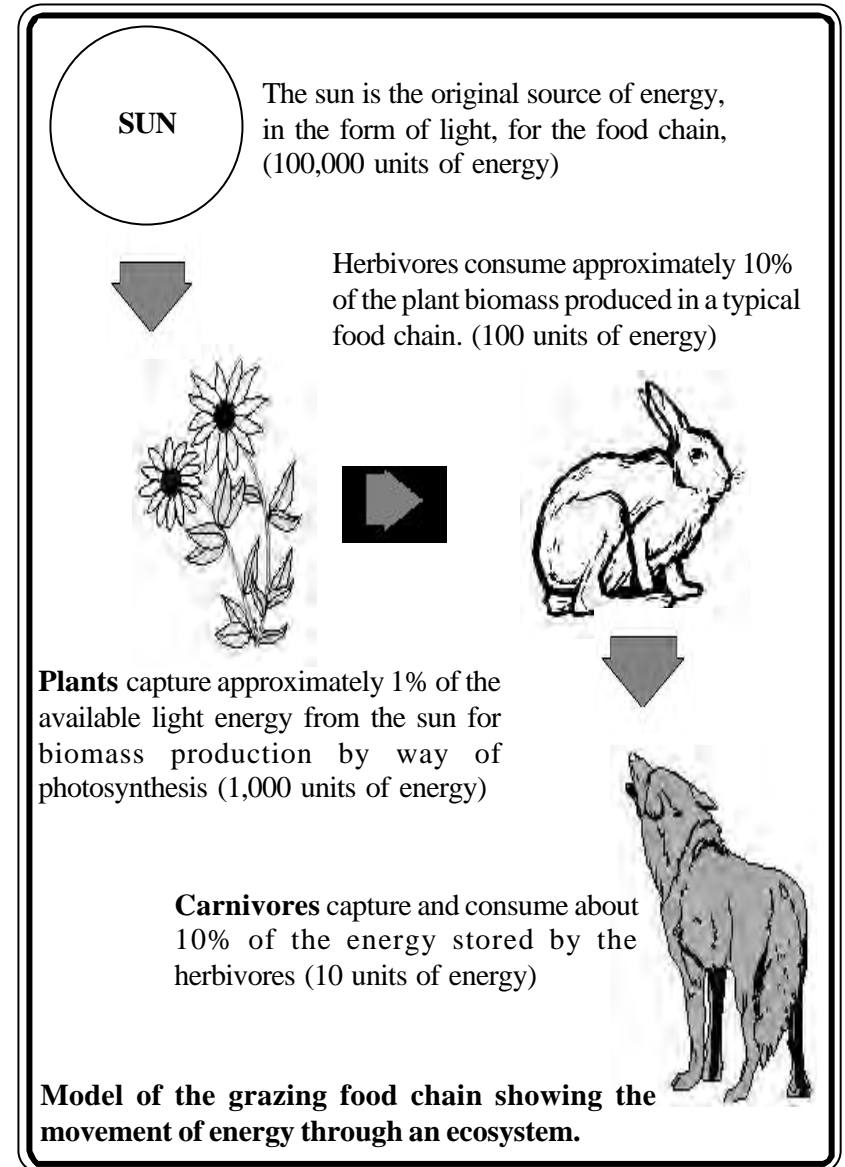
Activities

1. In your own words, define an ecosystem.
2. List three examples of ecosystems and explain in complete sentences the features that make them different from each other:
3. In paragraph form, identify an ecosystem that has been disturbed by humans or a natural event.

4. Explain the term global ecosystem and name four subsystem



5. Describe in your words the illustration given below.



7. THE BIOMES: NATURAL AND AGRICULTURAL

In the last 10,000 years, our ancestors have altered the natural ecosystems only slightly. However, scientific and technological development have paved the way to drastic changes in contemporary ecosystems. As a result, much land has been converted into agricultural and cattle farms. Vegetation that was originally propagated only by falling seeds is now cultivated by humans as crops in agricultural fields.

In this lesson we continue to investigate the biosphere, but with our focus on natural vegetation and agricultural crops of the lands.

1. Natural Biomes

The plants are stationary on the Earth's surface, as the other abiotic components such as landforms, soils, streams, and lakes. Plants are also consumable and renewable sources of food, medicines, fuels, clothing, shelter, and a host of other life essentials. There are many persistent themes in the writings of geographers about the ways that humans have used plant sources to their advantage, or have been hindered by the plants in their progress. A plant geographer classifies plants in terms of its lifeform, which is the physical structure, size, and the shape of the plant. These lifeforms are principally trees, shrubs, lianas and herbs. Most of them have life spans of many years.

As we travel through a hilly area, we observe that the vegetation is strongly influenced by landforms and soil. Landforms refers to the configuration of the land surface, including features such as hills, valleys, ridges, or cliffs. Vegetation on an upland, relatively high ground with thick soil and good drainage is quite different from that on an adjacent valley floor. It is because of the water that lies near the surface much of the time. Vegetation is often different in form on rocky ridges and on steep cliff, where water drains away rapidly and soil is thin or largely absent.

Similarly, these plant communities have an optimum temperature associated with each of its functions, such as photosynthesis, flowering, fruiting, or seeding germination. A plant's growth depends on overall optimum yearly temperature conditions. In general, the colder the climate, the fewer are the species that are capable of surviving. A large number of plant species cannot survive below freezing temperatures. In the severely cold Arctic and alpine environments of high latitudes and high altitudes, only a few species can survive. This explains why a forest in the equatorial has many species of trees, where as forest of the subarctic zone may be dominated by just a few.

Based on the dominant plant species, the following are the principal biomes, listed in order of availability of soil water and heat. 1. Forests (ample soil, water and heat), 2. Grasslands (moderate soil and water, adequate heat) 3. Deserts (extreme shortage of soil, water and adequate heat) and 4. Tundra (insufficient heat).

1. Forests:

About 420 million years ago, ancient plants began to occupy the land. Over the millions of years that followed, these plants developed and adapted to their new habitat. They were the first forests. In these forests, giant horsetails, club mosses, and ferns that stood up to 12 meters tall dominated. Later, gymnosperms developed and the first flowering plants appeared 144-165 million year ago. They evolved together with insects, birds, and mammals and flourished. Today, forests occupy approximately one-third of Earth's land area. There are three major types of forests, classified according to climatic conditions such as equatorial forests deciduous forests and tundra forests.

a. Equatorial forests: These are found around the Equator. This region has lots of sunshine and heavy rainfall. So the plants grow in large numbers, both quickly and densely. There are no seasons here, and so the trees remain green all through the year. Hundreds of species of trees and plants are found in evergreen forests. Some species include orchids, thorny plants, and creepers. Each tree has several roots and is broad-based, with an average height of 25-35 meters (Fig.No.7.1). Herbs,



Fig.No.7.1 Equatorial forests

bushes, and other kinds of plants also thrive in these forests. The forests are densely packed and do not let much sunlight through the foliage.

b. Deciduous forests: These are located in subtropical and temperate areas. Hot summers and cold winters exist in these areas. There is rainfall during some months of the year in both of these zones. Therefore these trees shed their leaves during summer in subtropical zones, and during winter in temperate zones. In countries like India, trees shed their leaves during the long, dry summer season. These subtropical forests are sometimes called monsoon forests.

c. Taiga forests: These are largest biome (Fig.No.7.3) located between 50 and 60 degrees north latitudes. Such forests can be found in the broad belt of Eurasia and North America: two-thirds are in Siberia with the rest in Scandinavia, Alaska, and Canada. Seasons are divided into short, moist, and moderately warm summers and long, cold, and dry winters. The length of the growing season in these forests is 130 days. These regions receive snow in the winter, and depending on their latitude, may have some in the summer. The trees of these forests have needle shaped leaves. More than 1700 species of trees are found in these forests. These species all have the ability to withstand severe cold.

2. Grasslands

Grasslands are big open spaces. About one quarter of the Earth's land is grasslands. There are not many bushes in the grasslands. We usually find trees only where there are rivers or streams. The grassland seems like an endless ocean of grass. Grasslands receive about 20 to 65 centimeter of rain per year. If they received more rain, the grasslands would become a forest. If they received less, they would become a desert.

Grasslands are often located between deserts and forests. Grassland soil tends to be deep and fertile. The roots of perennial grasses usually penetrate far into the soil. In South America, grasslands are called "pampas", in Europe, "steppes", in Africa, "savannas" and "prairies" in Canada and the USA. The grass lands are divided into two types. They are: Savanna Grasslands and Temperate Grasslands.

a. Savanna Grasslands: Savanna is a grassland (Fig.No.7.2.) with scattered individual trees. Savannas of one sort or another cover almost half the surface of Africa and large areas of Australia, South America, and India. Climate is the most important factor in creating a savanna. Savannas are always found in warm or hot climates where the annual rainfall is from about 50 to 127 cm per year. It is crucial that the rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur. If the rains were well distributed throughout the year, many such areas would become tropical forest.

Savanna has both a dry and a rainy season. Seasonal Fires play a vital role in the savanna's biodiversity. In October, a series of violent thunderstorms, followed by a strong drying wind, signals the beginning of the dry season. Fire is prevalent around January, at the height of the dry, season. Poachers who want to clear away dead grass to make it easier to see their prey often cause fires in savannas. The fires do not devastate the community. Most of the animals killed by the fires are insects with short life spans.

A fire is a feast for some animals, such as birds that come to sites of fires to eat grasshoppers, stick insects, beetles, mice, and lizards that are killed or driven out by the fire. Underground holes and crevices provide a safe refuge for small creatures. Larger animals are usually able to run fast enough to escape the fire. Although the dry stems and leaves of grasses are consumed by fire, the grasses' deep roots remain unharmed. These roots, with all their starch reserves, are ready to send up new growth when the soil becomes more moist. The scattered shrubs can also subsist on food reserves in their roots while they await the time to venture above the soil again.

A fire leaves scorched earth covered with a fine layer of powdery black ash in its wake. During March, violent thunderstorms occur again, this time heralding the rainy season. When the rains come, savanna bunch grasses grow vigorously. Some of the larger grasses grow an inch or more in 24 hours. The savannas experiences a surge of new life at this time.



Fig.No.7.2 Savana Grass Land Biome

b. Temperate Grasslands: Temperate grasslands are characterized as having grasses as the dominant vegetation. Trees and large shrubs are absent. Temperatures vary more from summer to winter, and the amount of rainfall is less in temperate grasslands than in savannas. The major temperate grasslands are the veldts of South Africa, the puszta of Hungary, the pampas of Argentina and Uruguay, the steppes of the former Soviet Union, and the plains and prairies of central North America. Temperate grasslands have hot summers and cold winters. Rainfall is moderate. The amount of annual rainfall influences the height of grassland vegetation, with taller grasses in wetter regions.

As in the savanna, seasonal drought and occasional fires are very important to biodiversity. However, their effects aren't as dramatic in temperate grasslands as they are in savannas. The soil of the temperate grasslands is deep and dark, with fertile upper layers. It is nutrient-rich from the growth and decay of deep, many-branched grass roots. The rotted roots hold the soil together and provide a food source for living plants.

3. Deserts

Deserts cover (Fig. No.7.4) about the fifth of Earth's surface and occur where rainfalls in less than 50 cm/year. Most deserts, such as the Sahara of North Africa and the deserts of the southwestern U.S., Mexico, and Australia, occur at low latitudes. Cold deserts, occur in the basin and range area of Utah and Nevada, and parts of western Asia.

The seasons are generally warm throughout the year and very hot in the summer. The winters usually bring little rainfall. Temperatures exhibit daily extremes because the atmosphere contains little humidity to block the Sun's rays. Desert surfaces receive a little more than twice the solar radiation received by humid regions and lose almost twice as much heat at night. Rainfall is usually very low and/or concentrated in short bursts between long rainless periods. Evaporation rates regularly exceed rainfall rates. Rainfall is lowest on the Atacama Desert of Chile, where it averages less than 1.5 cm. Some years are even rainless. Inland Sahara also receives than 1.5 cm a year. Rainfall in American deserts is higher, almost 28 cm a year.



Fig.No.7.3 Taiga Biome

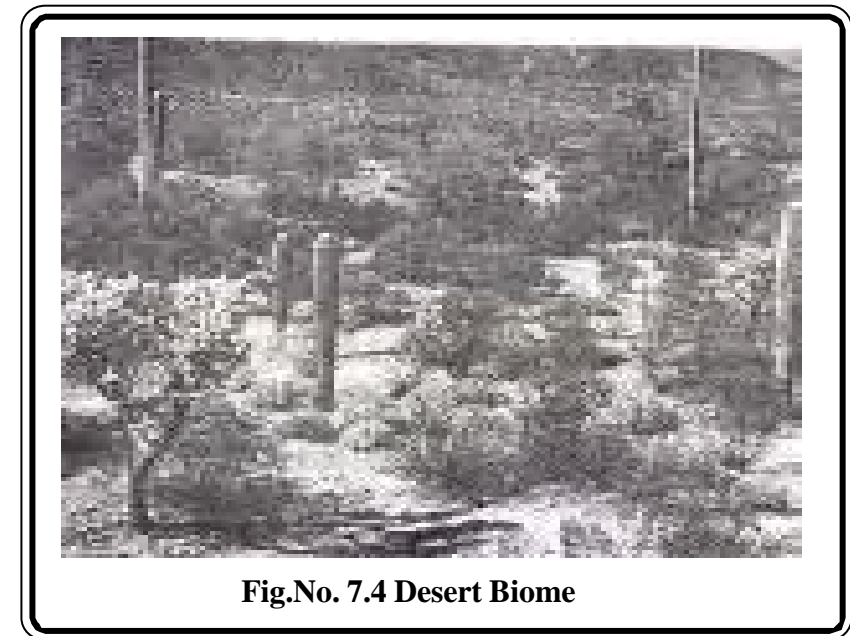


Fig.No. 7.4 Desert Biome

Most deserts have a considerable amount of specialized vegetation. Soils often have abundant nutrients because they need only water to become very productive and have little or no organic matter. Soils are coarse-textured, shallow, rocky or gravelly with good drainage and have no subsurface water. They are coarse because there is less chemical weathering. The finer dust and sand particles are blown elsewhere, leaving heavier pieces behind.

4. Tundra

The Tundra is the coldest of all biomes. “Tundra” comes from the Finnish word *tunturia*, meaning treeless plain. This biome has extremely cold climate, low biotic diversity, simple vegetation structures, a short season of growth and reproduction. Energy and nutrients are found in the form of dead organic material.

The Arctic tundra is located in the Northern Hemisphere, encircling the North Pole and extending south to the coniferous forests of the taiga. The Arctic is known for its cold, desert-like conditions. The growing season ranges from 50 to 60 days. The average winter temperature is 34°C but the average summer temperature is 3-12°C which enables this biome to sustain life. Rainfall may vary in different regions of the Arctic. Yearly precipitation, including melting snow, is 15 to 25 centimeters.

Soil is formed slowly. A layer of permanently frozen subsoil called permafrost exists, consisting mostly of gravel and finer material. When water saturates the upper surface, bogs and ponds may form, providing moisture for plants. There are no deep root systems in the vegetation of the Arctic tundra, however, seasons are short and most plants reproduce by budding and division rather than sexually by flowering. The fauna in the Arctic is also diverse. Still a wide variety of plants that are able to resist the cold climate. There are about 1,700 kinds of plants in the Arctic and sub arctic region.

Alpine tundra is located on mountains throughout the world at high altitude where trees cannot grow. The growing season is approximately 180 days. The nighttime temperature is usually below freezing. Unlike the Arctic tundra, the soil in the alpine is well drained. The plants are very similar to those of the Arctic.

Water is the common link among the five biomes and it makes up the largest part of the biosphere. Aquatic regions house numerous species of plants and animals, both large and small. In fact, this is where life began billions of years ago, when amino acids first started to come together. Without water, most lifeforms would be unable to sustain themselves and the Earth would be a barren, desert-like place.

II. Agricultural Biome

Large areas of the Earth’s land surface have been strongly impacted by humans through intensive agriculture, grazing and timber cutting. Current extensive logging in forest biomes and the conversion of natural grasslands resulted in the destruction of natural habitats of numerous species. Grassland teaches us about the impacts of human activities more than any other biome. The majority of the original grasslands have been converted into agricultural farmlands. These farmlands have become the “granaries of the world”. Widespread agricultural and industrial development are depleting natural resources and also modifying natural ecosystems.

In the biosphere, among human made ecosystems, the largest recognizable units are the agricultural biomes. In terms of structure and function, agricultural biomes are very simple. They usually consist of one genetic strain of one species. Agricultural crops are short and group together to resist the cold temperatures and are protected by the snow during the winter. They can also carry out photosynthesis at low temperatures and low light intensities.

Agricultural biomes are overly sensitive to attack by one or two well-adapted insects that can multiply very rapidly to take advantage of an abundant food source. Thus pesticides are constantly needed to reduce insect populations. Weeds, too, are a problem and they can divert much of the productivity to undesirable forms. Herbicides are often the immediate solution to these problems. Application of agricultural chemicals is one of the ways that humans use energy inputs to increase net primary productivity. Large increases in productivity are achieved by application of nutrient elements and compounds, usually of nitrogen and phosphorus that are in short supply in most soils.

In a natural ecosystem, these elements return to the soil following the death of the plants that store them. In agricultural ecosystems, this recycling is interrupted by harvesting the crop for consumption. Therefore nutrients are added each year in the form of fertilizers, and these are mined from fossil fuels. The input energy humans add to the managed ecosystems in the form of agricultural chemicals and fertilizers, as well as farm mechanization, boost greatly the net primary productivity of the land. The net productivity of a particular crop increases more than five times over through two types of energy inputs (Fig. No.7.5.).

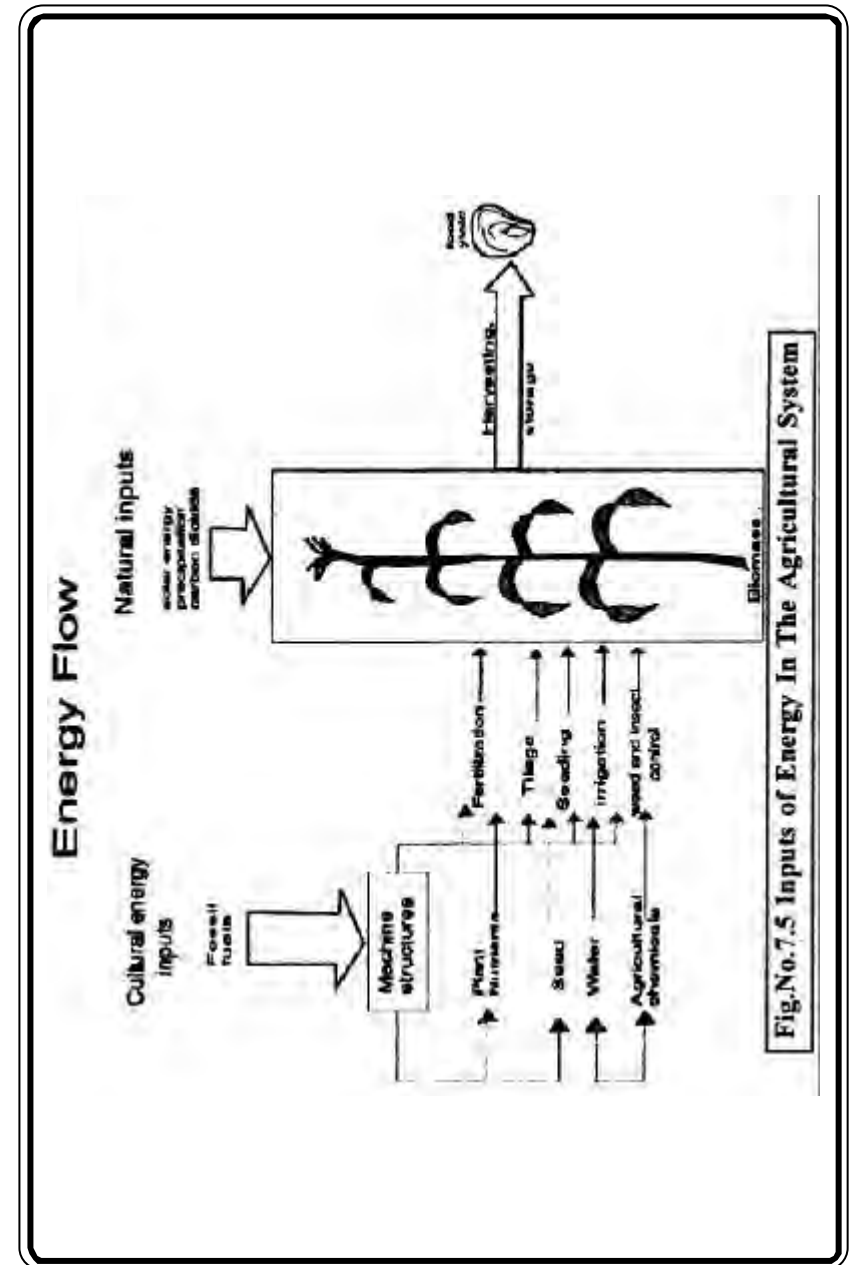
a. Natural Energy Inputs: Sunlight serves as the main source of natural energy in all ecosystems. In agricultural ecosystems photosynthesis from the sun's energy, carbon dioxide in the atmosphere and rainfall are "free" inputs. But, in order to be delivered to humans or animals for consumption, the raw food or feed product of this system requires fossil fuel energy.

b. Cultural energy: Excluding the solar energy of photosynthesis, the energy inputs expended upon production of food crops are referred to as Cultural Energy. They are:

1. Nutrients : Plant nutrients are necessary for crops to flourish. Nitrogen, potassium, phosphorus, calcium, magnesium and sulphur are the essential plant nutrients. Soil possesses excessive calcium, but crop production is dependent on nitrogen, potassium and phosphorus. These fertilizers are cultural inputs and they increase production. Since the 1950s, the use of these fertilisers have increased at a global level and crop production also increased tremendously.

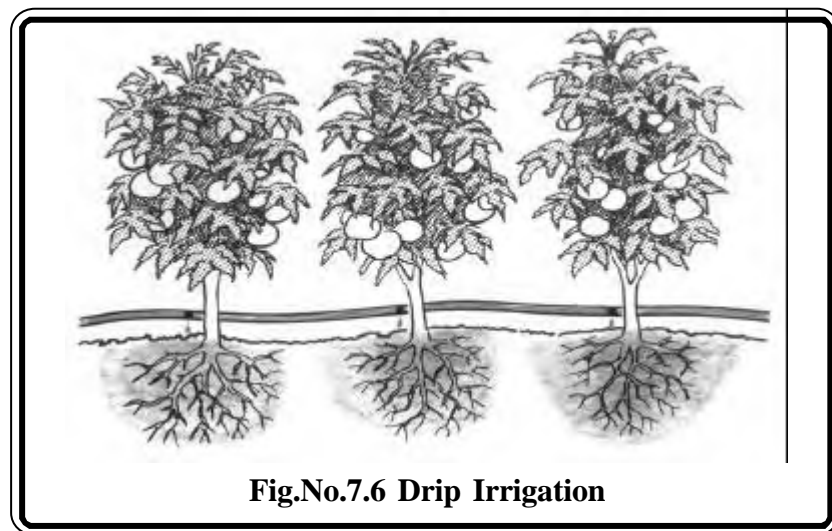
2. Seeds: In the human-made agricultural ecosystem, paddy, maize vegetables, oilseeds and so on do not germinate themselves. These crops grow only if the land is ploughed and the seeds are sown. Thus the crops and seeds need protection.

Let us examine this with an example. The research undertaken by Dr.Norman Borlaug and his co-workers has succeeded in bringing a dwarf wheat variety with strong stems. The new wheat moved Mexico



into the ranks of a wheat exporting country. Tried out in Pakistan and India, the new wheat increased the yield per acre. Dr. Norman Borlaug, leader of green revolution was awarded the Nobel Peace Prize. The green revolution spread next into improvement of rice yields, carried out at the International Rice Research Institute in the Philippines. Drawing more than 20,000 varieties of rice, new highly productive strains were developed and passed onto rice farmers.

3. Water: All plants need water to grow. Agriculture accounts for the largest single share of global water use. Some 73 percent of freshwater drawn from rivers, lakes, and ground water supplies is used for irrigation. Although estimates vary widely, about 18 percent of all crop lands worldwide are irrigated. Some countries are water-rich and can readily afford to irrigate farmland. Some are water-poor and must use water very carefully. The efficiency of irrigation is rather very low in most countries. High evaporative and seepage losses from underlined and uncovered canals often mean that as much as 80% of water withdrawn for irrigation never reaches its destination. Farmers tend to over irrigate because they lack the technology to meter water and distribute just the amount needed.



Water conservation techniques can greatly reduce the problems arising from excess water use. The most efficient way to water crop is drip irrigation (Fig.No. 7.6). In drip irrigation, a series of small perforated tubes are laid across the field at or just under the surface of the soil. The tubes deliver the amount of water that each plant needs, directly onto its roots where the water will do the most good, and with a minimum of evaporative loss or over soaking of the soil.

4. Agricultural Chemical Products : In our homes we use insecticides to control mosquitoes, cockroaches and other insects. Likewise, in an agricultural field, we use chemical products such as pesticides, herbicides and insecticides to control non-crop elements. These are agricultural chemical products. Certain pesticides not only destroy the harmful elements, but also harm other living organisms in the area. For example, pesticides like DDT diffuse into the food chain and reach humans also. The extensive use of pesticides is linked with cancer, birth defects, hereditary diseases and other prolonged physical illnesses.

So, crop productivity is determined by the amount of input energy supplied to an agricultural ecosystem. In an agricultural ecosystem a variety of crops are cultivated and harvested for consumption at a distant location. These crops are consumed as food products such as grains, flours or as processed food items. The solid, abiotic part of this system provides the raw materials and the supporting surface on which many of the processes of life depend.

By now you recognize the Earth and its biosphere make up complex, interactive system. The Earth system is sometimes compared to the human body. We are interested in how well our heart/lungs/muscles/nerves work, but we are most keenly interested in how well the components work together. So that we can improve our overall health. Similarly, the Earth has lithosphere, hydrosphere, atmosphere and biosphere as its component. Our health depends on how well our body interacts with its components. Likewise, the earth depends on its components and their interactions with each other. In the next lesson, let us investigate how to manage this interactive system and as well as planning for a sustainable future.

Exercises

I. Fill in the blanks

1. Plants are also consumable and _____ sources of food.
2. Evergreen forests are found around _____ .
3. Deciduous forests are located in _____ and _____ areas.
4. The largest terrestrial biome between 50 degrees and 60 degrees north latitude is the _____.
5. Seasonal fires play a vital role in the _____ biodiversity.

II. Match the following

1. Prairies - Europe
2. Pampas - Canada
3. Steppe - Treeless plain
4. Savanna - USA
5. Tundra - Africa

III. Write short notes on

1. Taiga forest
2. Temperate grass land
3. Desert
4. Deciduous forest

IV. Explain in detail

1. Name the cultural energy inputs in an agricultural biome and explain them.
2. Write in detail about the grassland biome.

Activities

1. Biome quiz : Using the four biomes listed below, answer the following :
Forest, Grass land, Desert, Tundra
 - a. Where would you want to go for a vacation ?
 - b. Where would you travel to see a polar bear ?
 - c. If you wanted to collect needle shaped leaves, where would you find them ?
 - d. You want to live where there are all four seasons, which biome is right for you ?
 - e. You are going on Safari in Africa. What biome has the most exotic animals ?
 - f. If you are a farmer planting crops, which biome is best for you?
 - g. You want to ride a camel in Egypt, what biome is that ?
 - h. You want to see a zebra, you travel to which biome ? It's summer and you want to see the leaves change color, where would you go ?
2. Which biome do you feel is the most important to India ? why ? Discuss this in the class and see if you can come up with a consensus.
3. Complete the given agricultural biome chart

Name of the crop	Natural Energy Temp. R.F. Soil	Cultural Energy Nutrients, water and Chemicals	Region
Paddy			
Wheat			
Cereals			
Planation crops			
Cotton			

4. A tropical Grassland biome - The drought zone of Sahel - Natural or Man - made? Debate



Famine in Sahel

8. ECOSYSTEM MANAGEMENT AND CONSERVATION

From the most arid desert to the dripping rain forest, from the highest mountain peak to the deepest ocean trench, life occurs. Scientists estimate that between 3 and 30 million different species inhabit Earth. They vary in sizes, colors, shapes, life cycles, and inter – relationships. Even obscure organisms contribute to essential ecological processes of the biosphere. Think, for a moment, how remarkable, varied, abundant, and important the other living creatures are with whom we share Earth.

In recent times, humans have become a serious threat to all other life-forms. Rapidly expanding human population and activities, amplified by the power of technology, threaten to eliminate much of the diversity of the biosphere. Humans have become a natural force, levelling mountains, diverting rivers into new channels, and causing soil erosion on the order of 25 billion metric tons worldwide per year. Humans destroy wildlife directly by over harvesting animals and plants for food and commerce. These impacts initiate species extinction and unique and complex characteristics of the biosphere may be permanently lost. Let us learn in this lesson, about extinction in general, how to manage and preserve the biosphere.

Extinction: Extinction is neither a new phenomenon nor a process caused only by humans. Studies of the fossil record suggest that more than 99 percent of all species that ever existed on the Earth are now extinct. Most of those species disappeared long before humans came on the scene. The geological record shows that a number of widespread biological catastrophes have caused mass extinctions from the Earth. The best known of these occurred 65 million years ago when dinosaurs disappeared, along with at least 50 percent of existing genera and 15 percent of marine animal families. An even greater disaster occurred at about 250 million years ago when two-thirds of all marine species and nearly half of all plant and animal families died out over a period of about 10,000 years.



Photo Plate No.8.1 Passenger Pigeon



Photo Plate No.8.2 African violet and Green Pitcher Plant

8.3.1 Siberian Tiger



8.3.3 Chimpanzee



8.3.4 Aya-Aye



8.3.4 Leonards



8.3.2 Black Rhinoceros



Photo Plate No.8.3 Endangered Species and Wonders of Nature

Extinct Species

8.1 Passenger Pigeon : The last member of this species died in Cincinnati zoo in 1947. Over hunting and habitat disruption caused their extinction.

8.2 Green pitcher Plant – Insectivorous plants : Only about 1000 plants remain because of habitat destruction.

8.2 African violet these familiar house plant have almost totally disappeared from their native habitat in South Africa

Endangered Species :

8.3.1 Siberian Tiger This Siberian large cats are endangered in the world

8.3.2 Black rhinoceros Originally there were about one million rhinoceros in Africa and now there are fewer than 4000 Poachers kill them for their horns.

Wonders of nature :

8.3.3 Chimpanzee This Chimpanzee is using a stick to trick tasty termites out of their nest. If it used its fingers instead, the termites would bite them.

8.3.4 Aya – Aye During the day, the rare aya – aye sleeps in a nest in the trees. It spends the night digging insects out of tree bark with its long third finger. To find out where the insects are, it has to listen carefully with its big ears.

8.3.4 Leopards They are covered with black spots, which help to hide them when they sit up in the shady jungle trees.

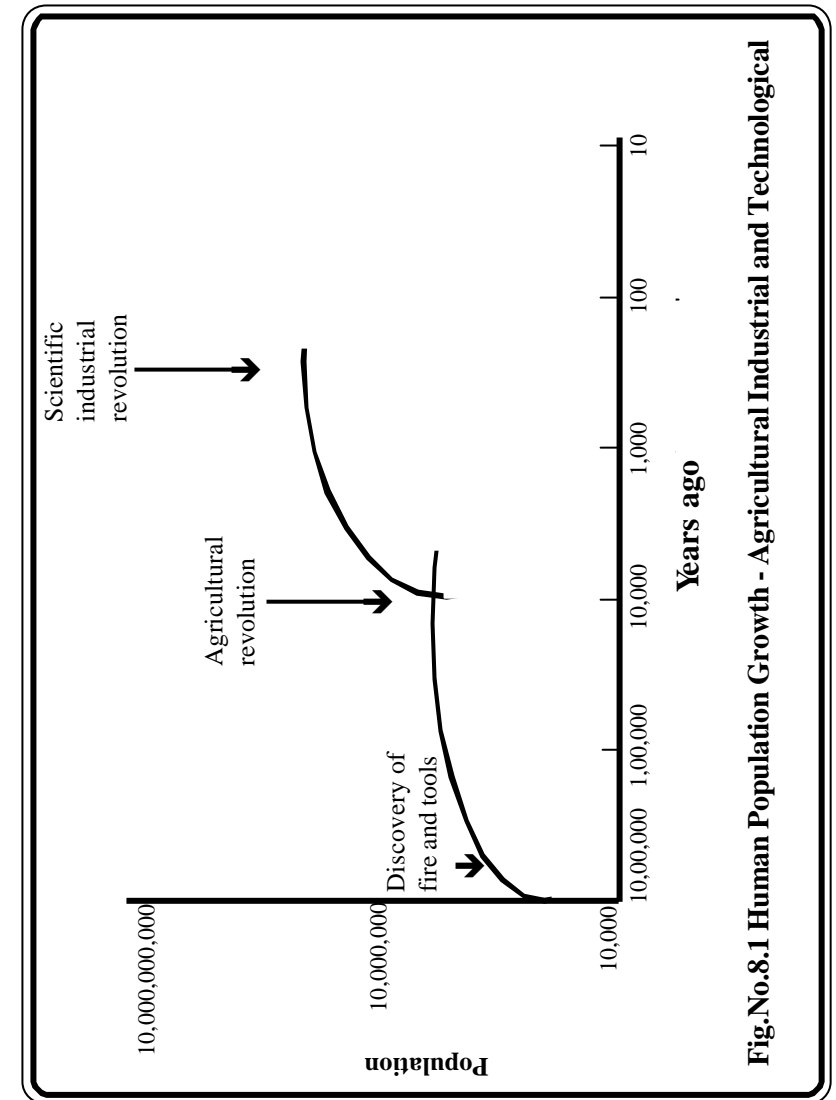
Current Extinction Rates

The rate at which species have been lost appears to have increased dramatically over the last one hundred years. Before humans became a major factor, extinction rates from natural causes appear to have been one species lost every five to ten years. Between 1600 and 1900 A.D., human activities seem to have been responsible for the extermination of about one species per year. During this century, especially since World War II, the rate of extinction appears to have accelerated to dozens or even hundreds of species per year. We cannot be absolutely sure of these rates because many parts of the world haven't been thoroughly explored and many species may have disappeared before they were studied and classified by biologists.

The main reason for the current increase in extinctions is habitat loss. Destruction of tropical forests; coral reefs, estuaries, marshes, and other biologically rich ecosystems threaten to eliminate millions of species in a human-caused mass extinction that could rival those of geologic history. By destroying habitat, humans eliminate not only prominent species, but also many not even be aware. It has been suggested that millions of species could be lost in the next few years if this destruction continues.

Let us now discuss, about how the growth of population and technological progress were responsible for the destruction of biological resources and extinction of very many species from the Earth.

As shown in the figure no. 8.1. the first population increase was about a million years ago, and the discovery of fire and the invention of tools that enabled our ancestors to be a more effective society. The second population increase corresponds to the domestication of plants and animals about ten thousand years ago. The third expansion of growth, of which we are a part, was stimulated by the scientific and industrial revolution. If the present trend continues, the world in 2100 will be more crowded, more polluted, less stable ecologically and more vulnerable to disruption. So the choices we make now determine what our lives and those of our children will be like in future.



There are three points worth making about the capacity which is fundamental to our understanding of current dilemmas in managing the Earth system.

1. We are animals, with the same basic biological limitations of birth, growth, reproduction and death of other animals, and with the same basic competitive drives towards the acquisition of material resources. In the natural animal world, co-operative behaviour occurs and is generally interpreted as behaviour most appropriate for individual survival.
2. In the human world, the competitive instinct, both at the individual level and at community and national levels, emphasizes short – term gain, threatening long – term survival. The consequences of over use and abuse may be overcome through technological development and better management and levels of co – operative behaviour in relation to the use of natural resources.
3. Human consciousness and achievements, apparently freeing us from the controls that the environment exerts over wild animals, seem to have endowed us with the idea that we are free to exploit the environment. The consequences of overuse and abuse may be overcome through technological development and better management.

Recognizing these three points and raising awareness of the implications for each of us and our children's children are essential prerequisites for enabling us to initiate the necessary action that will generate sustainable development. Unlimited growth of population in an environment of finite resources is impossible because growth will eventually deplete the available resources and the population will collapse. To save the Earth from such an event, one should understand the relationships of our Earth

system and its components. One way to help you to understand the relationships of our Earth system and its components, is to use concept maps.

Concept Maps :

Concept mapping is a visual representation of information that includes concepts and the relationship between concepts. The exercise can encourage overviews or systemic thinking. Such concept maps reveal the inescapable fact that humans are dependent upon the workings of the global ecosystem, or the biosphere. It is also obvious that the humans have developed a capacity to change the dynamics of ecosystems. There are certain specific task to be carried out before understanding the Earth systems through “**concept mapping**”.

Specific Tasks :

1. Rank the concepts by placing the basic theme at the top of the map and add more specific concepts.
2. Connect the concepts by lines. Label the lines with linking words that define the relationship between the two concepts so that it reads as a statement.
3. Look for cross links between concepts in different sections of the map, and label these. Specific examples of concepts can be attached to the concept labels.
4. The same set of concepts may be represented by many different map forms.

In this lesson, two concepts maps are drawn as examples. These maps are drawn with the following concepts.

1. Photographs from space show Earth dominated by water and shielded by a thin layer of atmosphere. Observations from space support a systematic approach to Earth science. The systematic approach will help us to understand how local activities might produce global effects.

2. The Earth system is composed of four interacting components : atmosphere, biosphere, lithosphere, and hydrosphere. Thus, features on the surface of the Earth modifies and evolves continuously.
3. Global studies utilize new and evolving technology such as satellites and remote sensing instruments.

Example 1 : Earth System Science

This is the science of Earth as system composed of interacting components. This approach emphasizes the interactive nature of the components. These components are : lithosphere, hydrosphere, atmosphere and biosphere. They are described as follows :

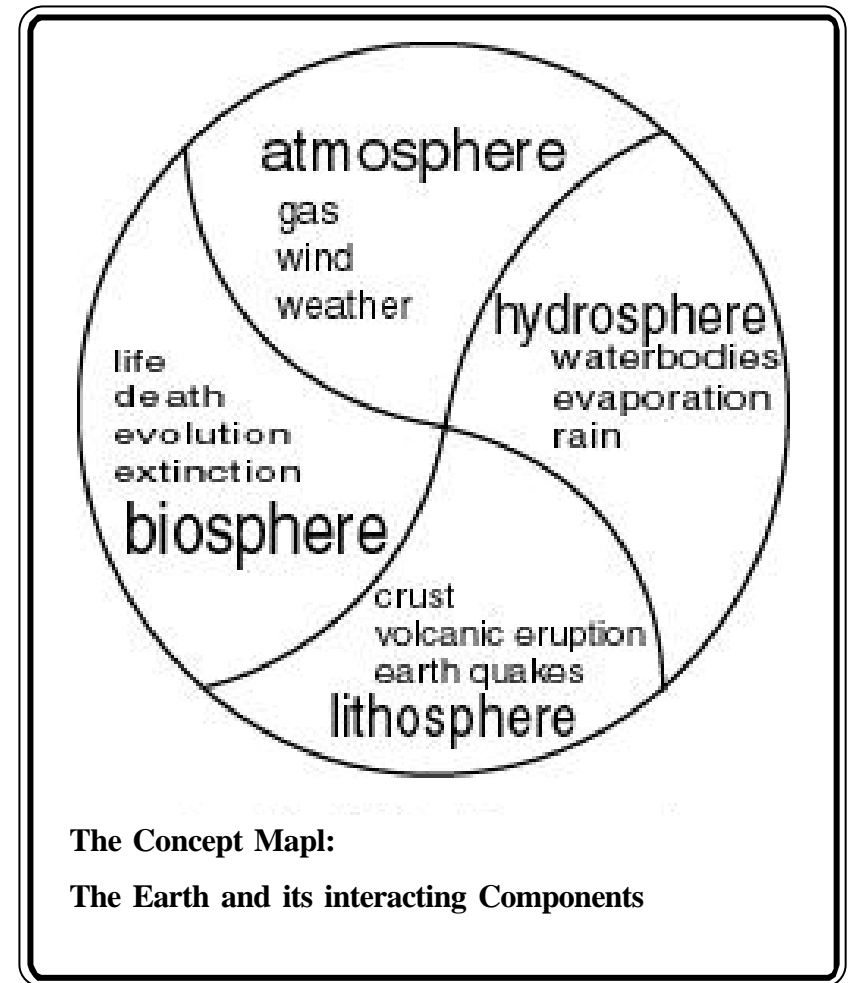
Lithosphere : This includes physical elements of the Earth's surface, crust, and interior. Processes in the lithosphere include continental drift, volcanic eruptions, and earthquakes.

Hydrosphere : This includes liquid, solid and gaseous form of water on or near the surface of the Earth. They are : water vapour in clouds; ice caps and glaciers; and water in the oceans, river, lakes, and aquifers. Processes in the hydrosphere include the currents. Flow of rivers, evaporation, condensation and precipitation.

Atmosphere : It includes thin layer of gas or air that surrounds the Earth. Processes in the atmosphere include winds, weather, and the exchange of gases with living organisms.

Biosphere : It includes the wealth and diversity of living organisms on the Earth. Processes in the biosphere include life and death, evolution, and extinction.

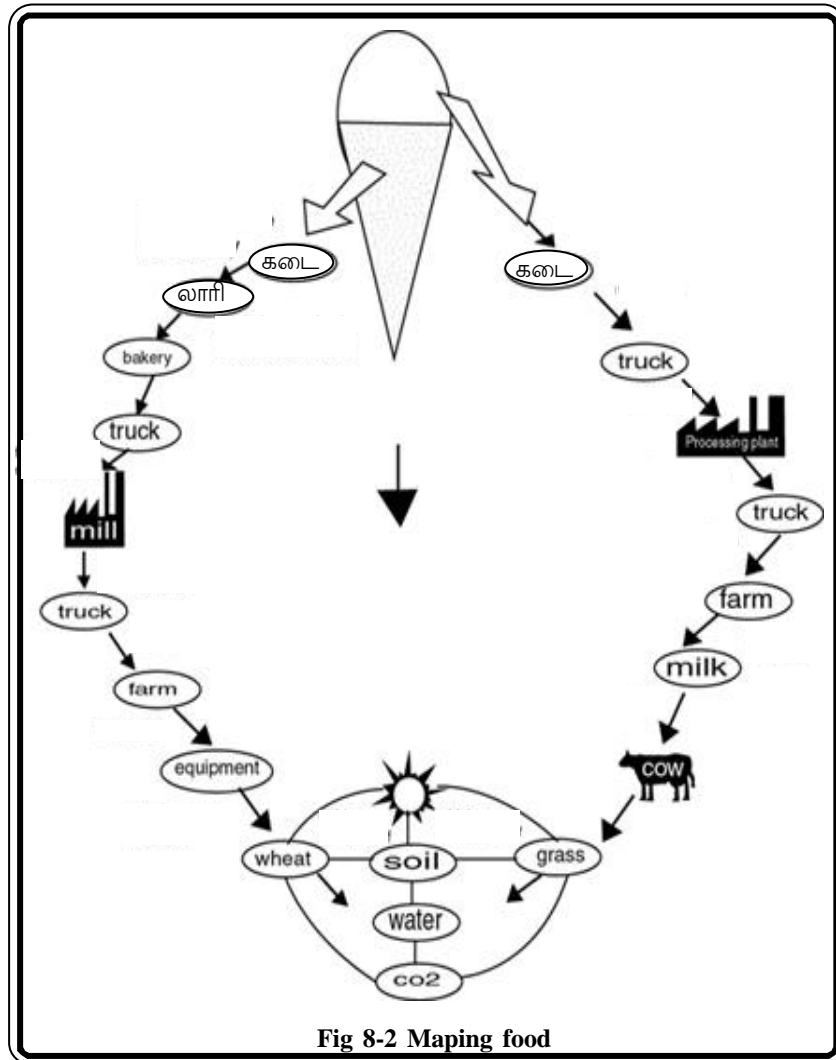
The concept map 2 explains that in the biosphere, humans developed an industrialized, technology-supported society on the abiotic environment. Economic development with a motive proved to be the link that allowed trade to take place. Trade is a part of the economic life of humans. This is because no two ecosystems are exactly alike. Every ecosystem, located on the Earth's surface is very unique, having its own climate, relief, products, culture, technology, transport facilities, and needs.



In the biosphere, humans are able to exercise their choice. So, the choices we make now determine what our lives and those of our children will be like in the future. For the future, you have to feel that you are capable of doing something, changing something. We must mobilize now to achieve the global possible. If we do, the future can be bright.

Example 2. Mapping Food

This concept map is drawn to trace a food from the consumer back to its origins. Just think a while **“What would happen if one of these connections was altered?”**.



We have sufficient knowledge, skill and resources. The well known phrase, **“think globally, act locally”** might be now be reframed to **“act globally, act locally”**. We all have to act locally because that is all, most of us can do. In essence, it will only be through local initiative that the international and intergovernmental efforts to manage ecosystems in a sustainable way, can be made to work.

Exercises

I. Fill in the blanks

1. By destroying _____ we eliminate not only prominent species, but also many not even be aware.
2. The third expansion of growth was stimulated by the _____ and _____ revolution.
3. Concept maps reveal the fact that humans are dependent upon the working of the _____ ecosystem, or the biosphere.
4. Global studies utilize new and evolving technology such as _____ and _____ instructions.
5. For the future, you have to feel that you are capable of _____ something, _____ something.

II. Match the following

- | | | |
|------------------------|---|-----------------------------|
| 1. Discovery of fire | - | Global ecosystem |
| 2. Population increase | - | Human activities |
| 3. Concept maps | - | Depletion of resources |
| 4. Extinction | - | the domestication of plants |
| 5. Economic growth | - | Effective society |

III. Write short notes on

1. Population Growth
2. Mass extinction
3. Earth system science
4. Concept maps

IV. Explain in detail

1. What are concept maps ? Illustrate with an example.
2. Ecosystem Management – Explain.

Activities

1. In paragraph form, give at least two reasons why concept map is an important learning skill, and two reasons why this skill is particularly important to students.
2. Walk around you school or a neighborhood and make note of the litter and describe in your own words how they affect the environment. Discuss with your classmates about how to manage the waste disposal.
3. Draw concept maps for the following :

How do You Control Your Surroundings ?

- a. Select two ecosystem and label them. Mark the links between the futures.
- b. Identify an ecosystem that has been disturbed by humans or a natural event.

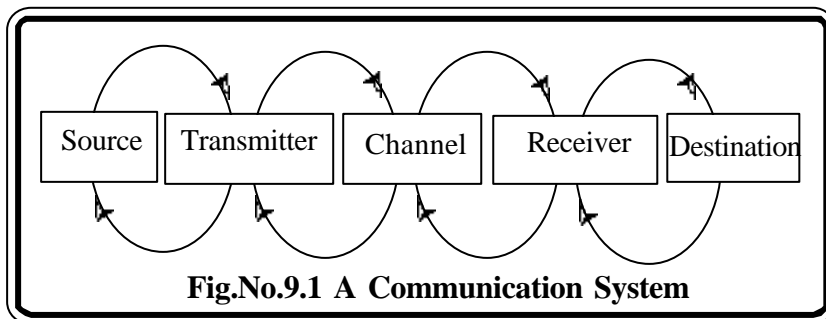
- c. If you live in a rural area, try to visit a field and try to know about how farmers use natural resources – soil, water, and sun – to grow crops and raise food crops.
- d. Make a note about how do they keep livestock from wandering off? How do they prevent crops from being eaten by birds or destroyed by disease?
- e. If you live in an urban area, try to visit an industrial area and try to know about how the industry use natural resources, raw materials, water, and sun to manufacture goods.
- f. Make a note about, how the waste generated is disposed ? How do they transport the raw materials from the source and market the goods from the factory?
- g. List the management strategies you feel is needed to improve your school environment

PRACTICAL GEOGRAPHY

9. CARTOGRAPHY

The world is full of strange, and wonderful places that we want to know more about. Do you remember thumbing through an atlas or encyclopedia as a student, imagining yourself as a world traveller on a safari in Africa, or boating up the Mississippi River, climbing the peaks of the Himalayas, or even visiting seven wonders of the world? Yes, we all do. Turning to such maps and atlases frequently lead students to design, their own “concept maps” of the world. This serves not only, to organize in their mind about the people, places, and things they see and hear in the news, but also to suggest why certain events unfold in particular places. Students who grow up around maps and atlases are more likely to get the “map habit” than students who do not.

All these maps must have certain basic ingredients like outline, relative location and important natural and cultural details of the Earth. The art of such map construction is called cartography and people who work in this field are called cartographers. There is no doubt that each map produced by cartographers is always a new product and incorporates new data. So, maps are one of the most important sources of cartographic information.



The ultimate purpose of cartography is to communicate facts and ideas clearly and forcefully through a combination of drawings, word and symbols. So maps are made to communicate facts and ideas in which people are interested. Viewed in this way map becomes a medium of communication and cartography a communication science. In general any communication system has five functional elements : source, transmitter, channel, receiver, and destination. Cartography is also considered to be a communication system and thus have functional elements (Table No. 9.1).

What is a map?

The word map is derived from the Latin word *mapper*. Mapper means tablecloth or handkerchief. The infinite nature of our universe makes it impossible to capture all of the complexity found in the real world. Therefore a map is a graphic representation of a portion of the earth’s surface drawn to scale, as seen from above.

There are innumerable things which can be shown on maps. But everything that exists on the Earth is not represented on all maps. Some maps do represent a variety of things about which people are more intimately concerned in their day-to-day life. These maps are called the general or reference maps. Most other maps give specialized information only. Such maps are called thematic maps. In these maps only a few details are given visual prominence. The other details are either not shown at all or are shown merely to produce a background effect. The map uses symbols, colors and labels to represent different features found on the Earth.

Components of a Map :

A map consists of several components. Each symbol on a map is a component by itself. Every component of a map is a symbol. Symbols are like words. As the words giving same meaning differ from language to language, so also the symbols differ from map to map. When several words are put together in a definite order, we get a sentence.

Table No.9.1 Cartography and its functional elements.

1. Information Source : All the natural and social science concerned with the study of earth and its surface features
2. Message : Ideas and facts about the earth and its surface features; also about the space and universe.
3. Transmitter : Cartographer who converts these ideas and facts into words, drawings and symbols. The signals of the transmitter are the words, drawings and symbols and their mutual arrangement.
4. Channel : Maps and other cartographic products. Poor design or drawing, cluttering of the symbols, incorporation of unnecessary facts to the detriment of the relevant ones, poor printing, and so on are considered as noise source.
5. Received signals : Symbols, etc., as perceived by the map used.
6. Destination : Map users the world over.

Similarly when several symbols are put together in a definite order, we get a map. These orderly arranged symbols give a meaning which individual symbols fail to give. Symbolization and the arrangement of the symbols in a map are, therefore, crucial processes in map design. No book can be popular if the choice of words is bad. So also no map can be popular if the choice of symbols is bad.

All maps must show a few common components. These are title, legend, direction, scale, and source and in some cases insets. The title of a map may be placed anywhere within the neat line. Most appropriate place is the top right of the frame. It can also be placed at the top left or bottom left or bottom right. The title should include the name of the area represented, and the nature of the data shown. If the data pertain to a given year this should also be given. The title should always be given in bold and simple letters. If necessary, it can be enclosed in a box (Fig. No. 9.2)

The legend of a map is usually placed in a corner within the neat line. The position of the legend is so selected that it does not interfere with other details. Every symbol and abbreviation used in a map should be explained in the legend.

Direction is shown in one of the corners by an arrow pointing to the north. Scales can be expressed as words or as graphics. The scale of a map should be placed at a prominent place. It can be placed just below the title or somewhere at the bottom.

Every map must give the source of the data used. Most of the maps we use, do not mention the source. The source should normally be given outside the frame of the map on bottom right. On the bottom left should be given the name of the author, publisher, etc.

So, a map provides information on the existence, the location of, and the distance between ground features, such as populated places and routes of travel and communication. It also indicates variations in terrain, heights of natural features, and the extent of vegetation cover.

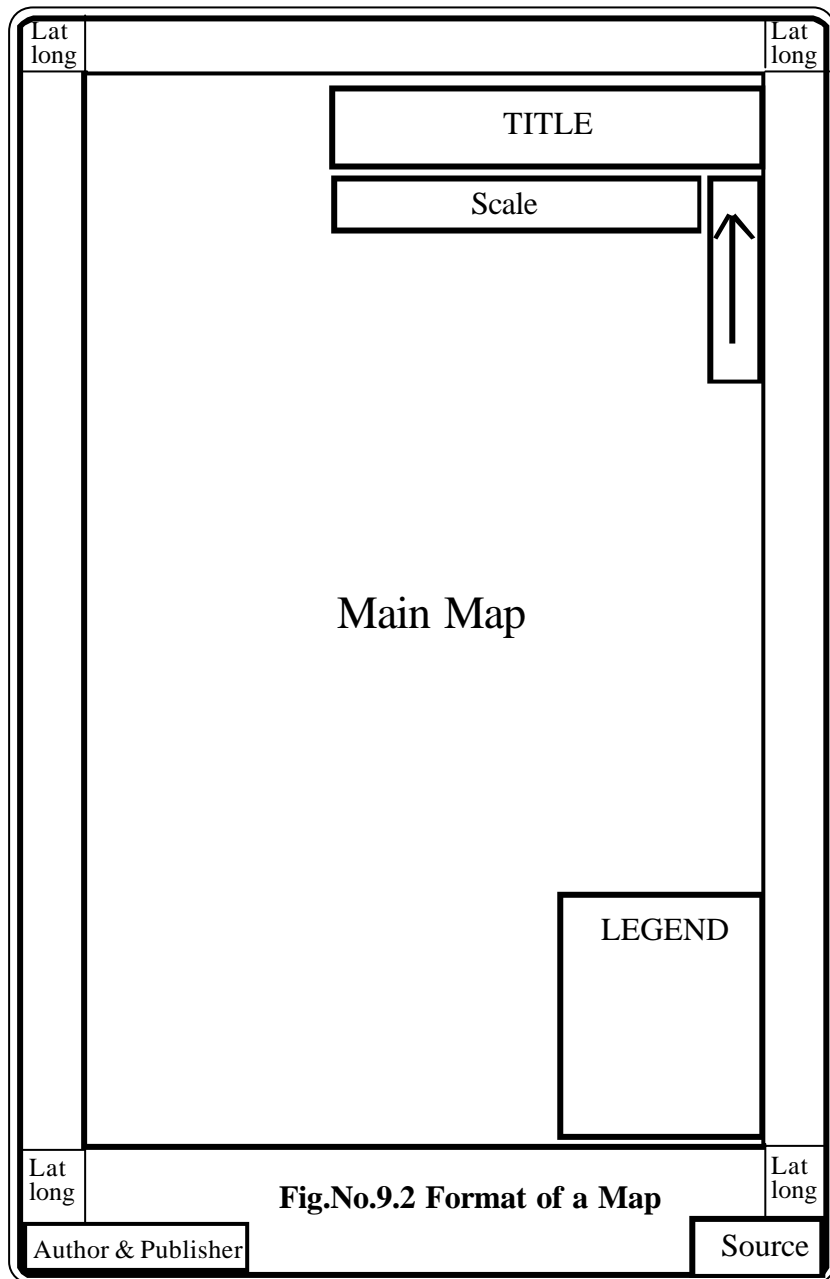


Fig.No.9.2 Format of a Map

The individual components get their meaning only with reference to the map as a whole. Map design involves the development of this integrated plan and style of the map and its individual components, and lay out involves the arrangement of these individual components on the paper.

Maps are documents printed on paper and require protection from water, mud, and tearing. Whenever possible, a map should be carried in a waterproof case, in a pocket, or in some other place where it is handy for use but still protected. Care must also be taken when using a map since it may have to last a long time. Special care should be taken of a map that is being used in a tactical mission, especially in small units; the mission may depend on that map. Much of the military plannings are done by using maps. So, it is necessary that the maps are to be transported, stored, and placed into operation all the proper time and place. Maps are certainly of great use to us. We should, therefore, know as such about maps as we can. But knowing maps involves knowing more about cartography – the science and art of making maps.

Practical Exercises

1. What are maps? And name the functional elements of cartography?
2. Format the following maps using Atlas of India / Tamilnadu
 - a. Political map of India
 - b. Physical map of Tamilnadu
 - c. Population map of India
 - d. Population map of Tamilnadu

3. Format the given map. The scale of the map is 1:6,000,000



10. SCALES AND THEIR FUNCTIONS

Earth has an average radius of 6,371 kilometers and an area 510,900,000 sq.km. This size and the shape of the Earth creates two basic problems for cartographers. One of them is how to shrink and draw such a large Earth into a suitable small size maps and to convert the spherical Earth in to a flat surface. Scales are used to reduce the whole or part of the Earth's surface.

A map is a scaled graphic representation of a portion or whole of the earth's surface. The scale of the map permits the user to convert distance on the map to distance on the ground or vice versa. The ability to determine distance on a map, as well as on the earth's surface, is an important factor in planning and executing military missions.

The Map Scale :

The scale is defined as the ratio between the distance of two points on the map and their corresponding distance on the ground. There are three ways of indicating scales on a map.

1. Simple Statement : Scale can also be described on a map by a verbal statement. In good old maps, scales were marked in miles in the British style. At present the maps are prepared using the metric system only. So most map scales are marked in meters.

Example : 1 centimeter = 10 kilometers

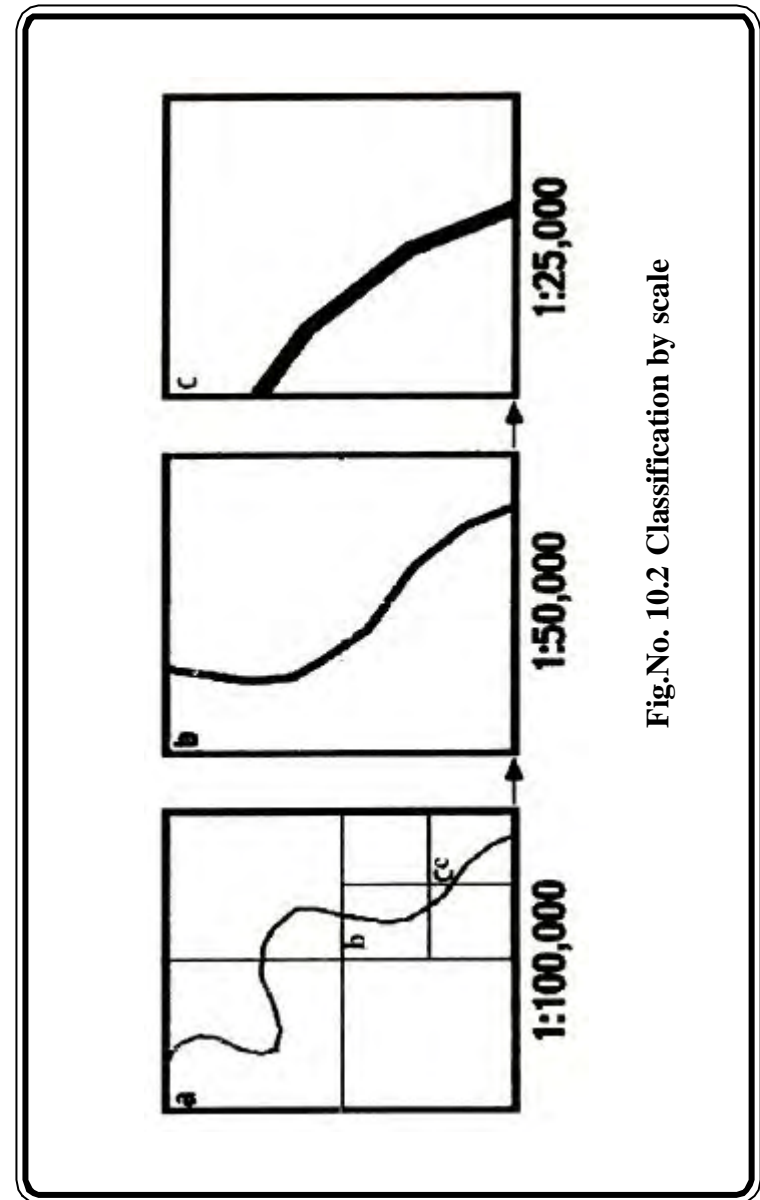
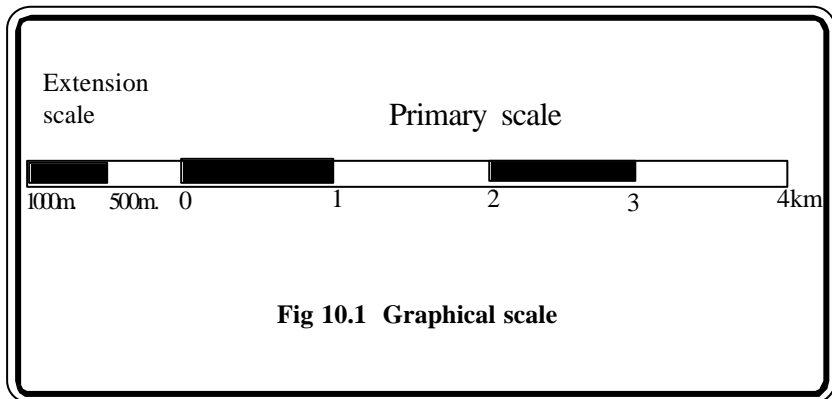
Simple statement has the following characteristics :

1. The numerator refers to map distance and the denominator refers to ground distance.
2. If the numerator is in centimeters, then the denominator is in meters and kilometers.

2. Representative Fraction : The numerical scale of a map indicates the relationship of distance measured on a map and the corresponding distance on the ground. This scale is usually written as a fraction and is called the representative fraction. The RF is always written with the map distance as 1 and is independent of any unit of measure. It could be yards, meters, inches, and so forth.

Example : RF : 1/50,000 or 1:50,000

3. Graphic (Bar) Scales : A graphic scale is a ruler printed on the map and is used to convert distances on the map to actual ground distances. In figure – 10.1, the graphic scale is divided into two parts. To the right of the zero, the scale is marked in full units of measure and is called the primary scale. To the left of the zero, the scale is divided into secondary scale and is called the extension scale. This is one to enable the map reader to measure distance in fractions also. If we want to measure full units we will begin with zero and use the right side or the primary scale. But if the distance we are trying to measure does not equal primary units, we will place the line to be measured with the right end on the last full unit that is applicable and read the remaining fraction on the extension to the left of zero.



Cartographers classify maps are scales and maps are rarely drawn at the same scale as the real world. Most maps are made at a scale that is much smaller than the area of the actual surface being depicted. The amount of reduction that has taken place is normally identified somewhere on the map.

Generally maps are classified by scale into three categories. They are small, medium, and large – scale maps (Figure – 10.2). The terms “**small scale,**” “**medium scale,**” and “**large scale**” may be confusing when read in conjunction with the number. However, if the number is viewed as a fraction, it quickly becomes apparent that 1 : 6000,000 of something is smaller than 1 : 75,000 of the same thing. Therefore, the larger the number after 1 : the smaller the scale of the map.

Small Scale :

Those maps with scales of 1:1,000,000 and smaller are used for general planning and for strategic studies. The standard small – scale map is 1:1,000,000. This map covers a very large land area at the expense of detail.

Medium Scale :

Those maps with scales larger than 1:1,000,000 but smaller than 1:75,000 are used for operational planning. They contain a moderate amount of detail, but terrain analysis is best done with the large-scale maps described below. The standard medium-scale map is 1:250,000. Medium scale maps of 1:100,000 are also frequently encountered.

Large Scale :

Those maps with scales of 1:75,000 and larger are used for administrative, and logistical planning. These are the maps that you as a soldier or junior leader are most likely to encounter. The standard large scale map is 1:50,000; however, many areas have been mapped at a scale of 1:25,000.

Determining the Scale of a map :

To determine the scale of a map first of all find out the ground distance between any two points shown on the map. Find out the map distance between the same points and compare the two. If the ground distance is two kilometers and the map distance is two centimeters, then 2 centimeters on the map represent 200,000 centimeters on the ground. Since, the scale ratios are always expressed with one as the base, we divide both, 2 and 200,000 to obtain the R.F. 1 : 100,000.

Reduction and Enlargement of scales

In the process of compiling maps cartographers are often required to reduce or enlarge maps. Reduction or enlargement involves change in the size. One simple way of illustrate what happens to the size of a map when it is reduced or enlarged is to fold a sheet of paper. Take a sheet of ordinary note book and assume it to be a map of a given scale. To show the same area reduced to 1/2 the original scale, fold the paper in half each way since any reduction is proportional in each dimension. Now we have one fourth of the paper area of the original, while the scale is 1/2 that of the original. Fold the paper once again in each direction to illustrate four times reduction which gives a paper having 1/16 the size of the original.

This paper folding can also be depicted mathematically. The ratio between the area of a map on one scale and its area to another scale is equal to the **square of the ratios** between the scales of the original and enlarged / reduced maps.

Example: 1. Reduce RF. 1 : 10,000 to RF. 1 : 50,000
(Original scale / Reduced scale)

$$\frac{1/10000}{1/50000} = \frac{10000}{50000}$$

$$= 5 \text{ times the original scale}$$

$$(5)^2 = 25 \text{ times of the original area}$$

(Ans) Reduce the area 25 times the original

Example: 2. Enlarge RF. 1 : 10,000 to RF. 1 : 20,000
(Original scale / Enlarged scale)

$$\frac{1/100,000}{1/20,000} = \frac{20,000}{100,000}$$

$$= 1/5 \text{ times the original scale}$$

$$(1/5)^2 = 1/25 \text{ times of the original area}$$

(Ans) Reduce the area 1/25 times the original

If we know the original scale of a map and want to find out the new scale of a reduced or enlarged version of it, we should use the **principle or ratios.**

Example: 3. Enlarge the given scale RF. 1 : 10,000 to 10 times

$$\frac{1}{100,000} = \frac{1}{X(10)}$$

$$10X = 100,000$$

$$X = \frac{100,000}{10}$$

$$X = 10,000$$

(Ans) Enlarged scale is 1 : 10,000

Example: 4. Reduce the given scale 1 : 10,000 to 5 times

$$\frac{1}{10000} = \frac{1}{X(5)}$$

$$X = \frac{10,000 \times 5}{50,000}$$

$$X = 10,000$$

(Ans) Reduced scale is 1 : 50,000

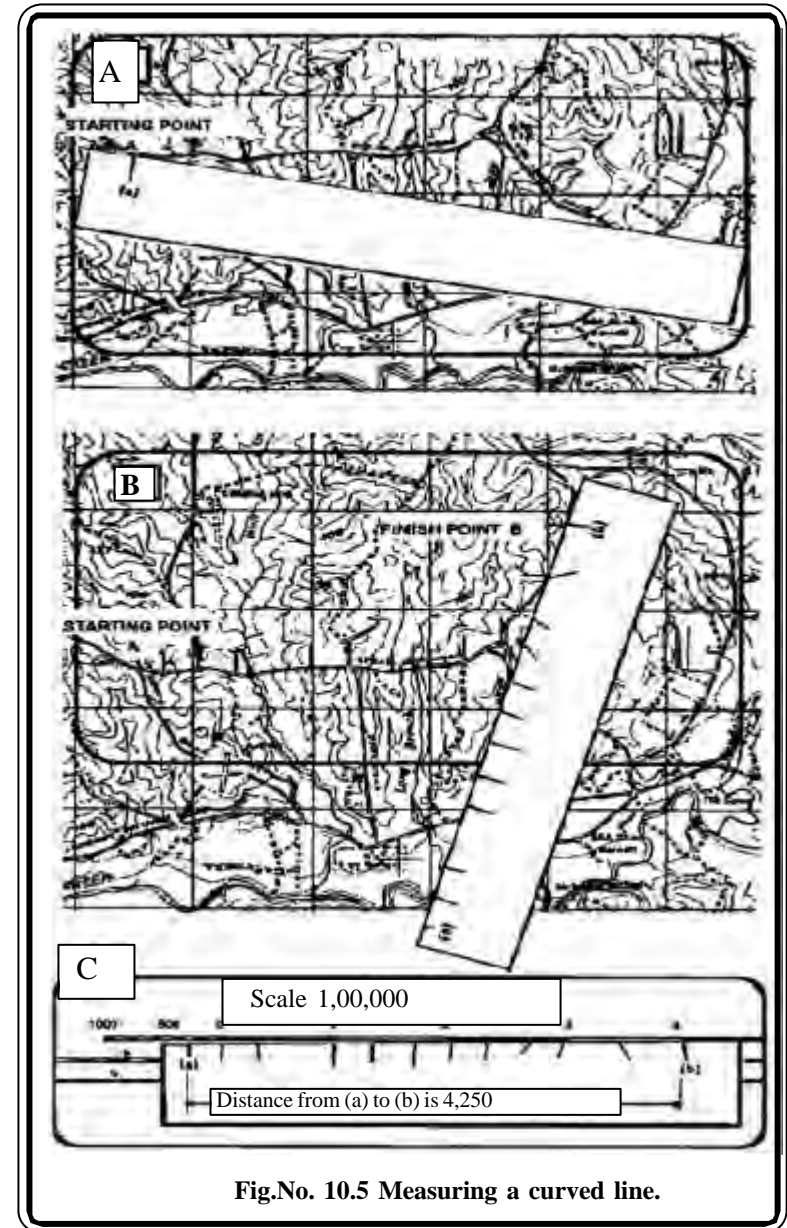
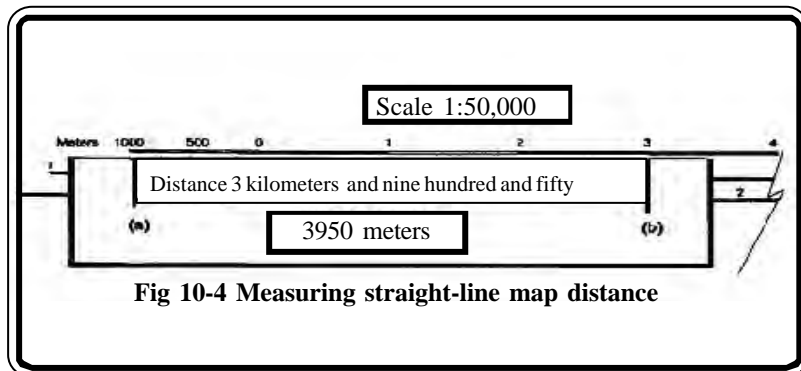
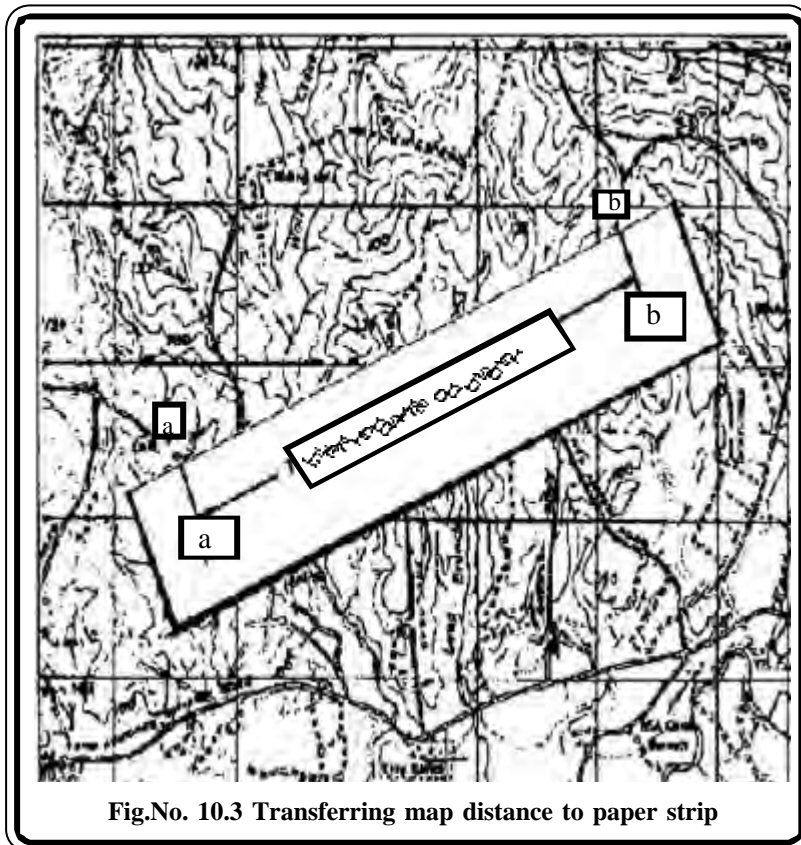
Let us now examine how to use the scales and to find the ground distances between any to points from the maps.

Example 1: To determine straight-line distance between two points on a map.

Step 1: Lay a straight-edged piece of paper on the map so that the edge of the paper touches both points and extends past them. Make a tick mark on the edge of the paper at each point (Fig 10.3).

Step 2: To convert the map distance to ground distance, move the paper down to the graphic bar scale, and align the right tick mark (b) with a printed number in the primary scale so that the left tick mark (a) is in the extension scale (Fig 10.4)

Step 3: The right tick mark (b) is aligned with the 3,000-meter mark in the primary scale, thus the distance is at least 3,000 meters and the left tick mark (a) is aligned with the 950-meter mark. Adding the distance of 3,000 meters determined in the primary scale to the 950 meters you determined by using the extension scale, we find that the total distance between points (a) and (b) is 3,950 meters.



Example 2 To determine curved – line distance between two points on a map.

Step 1: To measure distance along a road, stream, or other curved line, the straight edge of a piece of paper is used. Place a tick mark on the paper and map at the beginning point from which the curved line is to be measured. Align the edge of the paper along a straight portion and make a tick mark on both map and paper when the edge of the paper leaves the straight portion of the line being measured (fig 10.5a).

Step 2: Keeping both tick marks together (on paper and map), place the point of the pencil close to the edge of the paper on the tick mark to hold it in place and pivot the paper until another straight portion of the curved line is aligned with the edge of the paper. Continue in this manner until the measurement is completed (fig 10.5b).

Step 3: When you have completed measuring the distance, move the paper to the graphic scale to determine the ground distance as said in the previous example.

Practical Exercises

1. What are scales ? Describe small, medium and large scale maps.
2. Calculate the following
 - a. Reduce R.F. 1 : 50,000 to R.F. 1 : 75,000
 - b. Enlarge R.F. 1 : 25,000 to R.F. 1 : 10,000
 - c. Reduce R.F. 1 : 50,000 to 5 times
 - d. Enlarge R.F. 1 : 10,000 to 10 times
3. Find out the straight line and curved line distance between any two points using atlas maps (Minimum of three exercises)

11. CONTOURING AND CROSS SECTIONS

Contours on a map convey the shape of that part of the surface of the earth: its topography. Topography is made up of an assemblage of landforms. Landforms are the shapes of the individual and groups of natural features of the earth's surface. Common landforms are hills and valleys, plains and plateaus, continents and mountains ranges. Taken together, the landforms that are present in a region are the foundation of its landscape.

An important skill is the ability to transform the contours you see on a topographic map into a mental picture of the landscape they represent and then to turn that image into a written or verbal description so that you can convey your ideas to other people.

There are no 'formulas' for writing landscape descriptions; there are no unique 'correct' descriptions. How successful you are will depend upon your ability to 'read' contours, your powers of observation and your facility with languages..

A useful first step in gaining such ability is to observe and learn how to describe a single, common type of landform, such as a hill. When you have mastered that skill, you will be able to transfer what you have learned to other landforms and to landscape in general.

The cartographers use several methods to depict relief of the terrain. They are a. Layer tinting b. Form lines, c. Shaded relief, d. Hachures and e. Contours.

a. **Layer Tinting.** Layer tinting is a method of showing relief by color. A different color is used for each band of elevation. Each shade of color, or band, represents a definite elevation range. A legend is printed on the map margin to indicate the elevation range represented by each color. However, this method does not allow the map user to determine the exact elevation of a specific point, only the range.

b. **Form Lines.** Form lines are not measured from any datum plane. Form lines have no standard elevation and give only a general idea of relief. Form lines are represented on a map as dashed lines and are never labelled with representative elevations.

c. **Shaded Relief.** Relief shading indicates relief by a shadow effect achieved by tone and color that results in the darkening of one side of terrain features, such as hills and ridges. The darker the shading the steeper the slope. Shaded relief is sometimes used in conjunction with contour lines to emphasize these features.

d. **Hachures.** Hachures are short, broken lines used to show relief. Hachures are sometimes used with contour lines. They do not represent exact elevations, but are mainly used to show large, rocky outcrop areas. Hachures are used extensively on small-scale maps to show mountain ranges, plateaus, and mountain peaks.

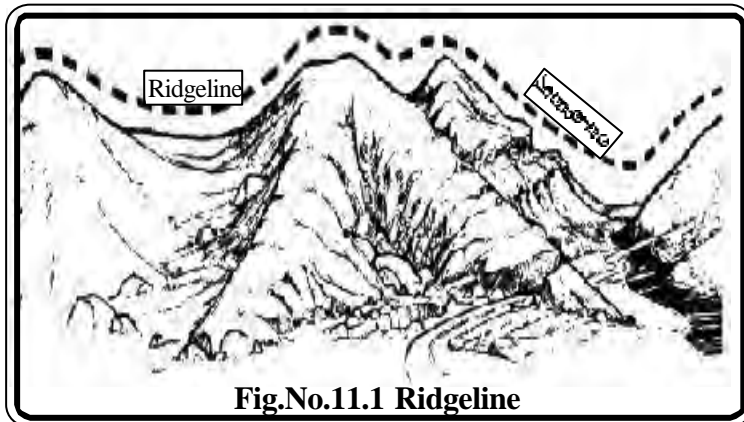


Fig.No.11.1 Ridgeline

e. **Contour Lines.** Contour lines are the most common method of showing relief and elevation on a standard topographic map. A contour line represents an imaginary line on the ground, above or below sea level. All points on the contour line are at the same elevation. The elevation represented by contour lines is the vertical distance above or below sea level. The three types of contour lines (Fig – 11.1) used on a standard topographic map are as follows:

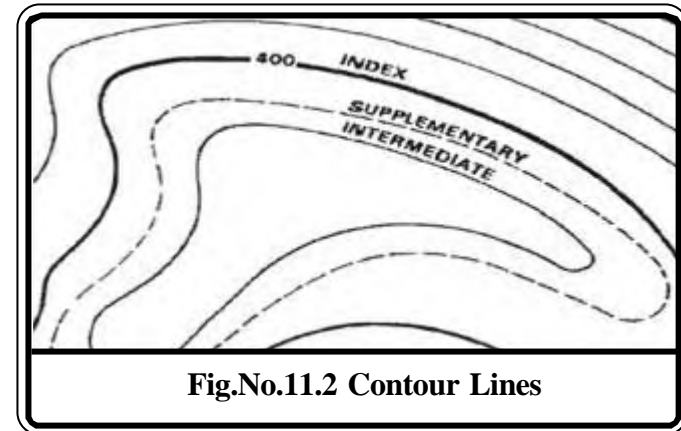


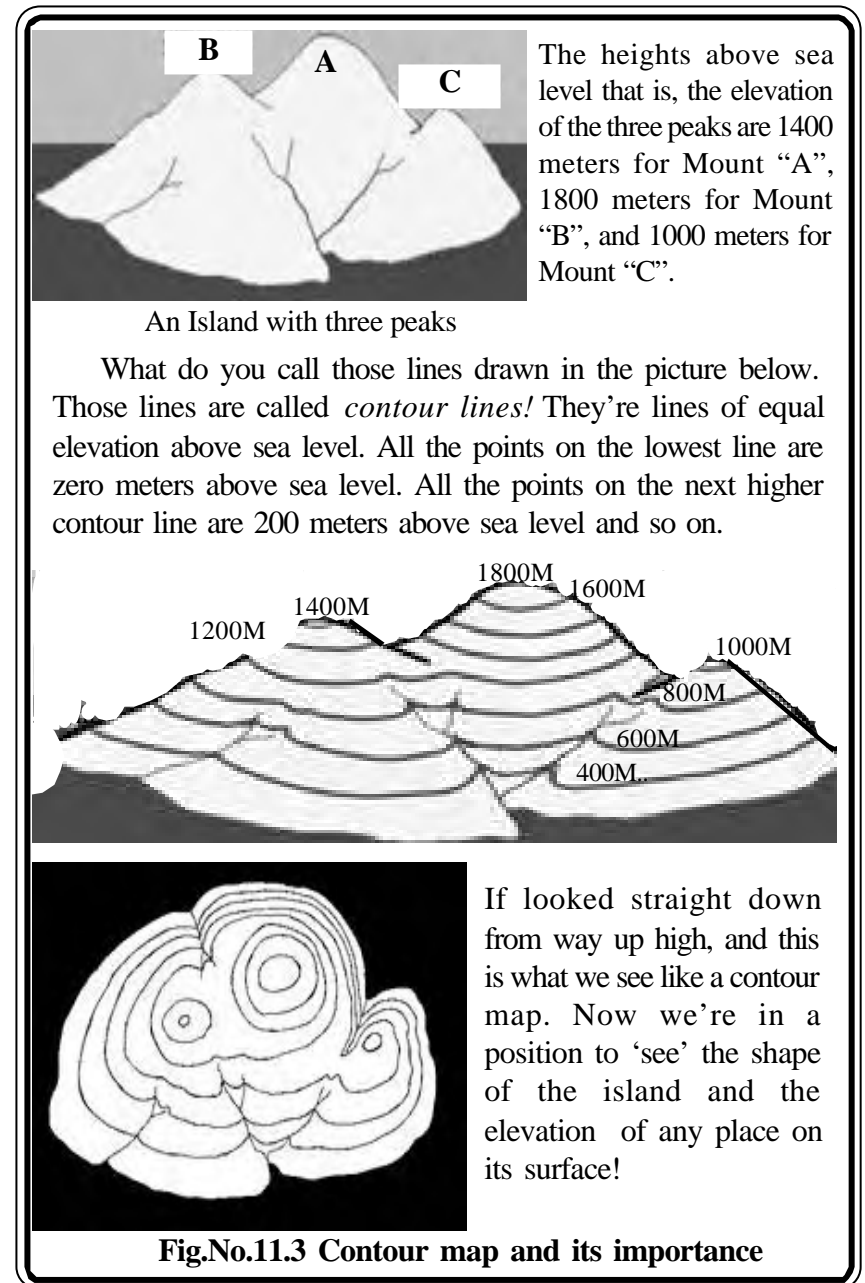
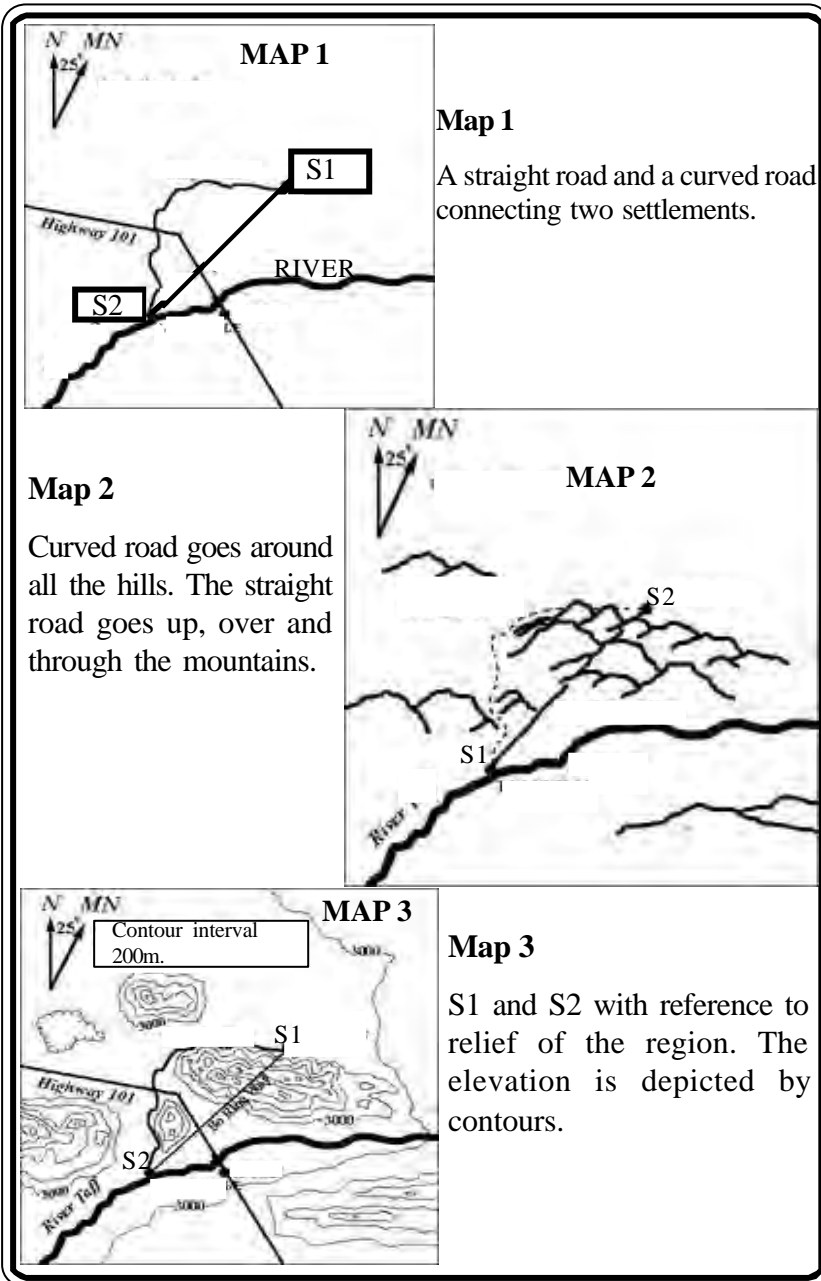
Fig.No.11.2 Contour Lines

(1) **Index.** Starting at zero elevation or mean sea level, every fifth contour line is a heavier line. These are known as index contour lines. Normally, each index contour line is numbered at some point. This number is the elevation of that line.

(2) **Intermediate.** The contour lines falling between the index contour lines are called intermediate contour lines. These lines are finer and do not have their elevations given. There are normally four intermediate contour lines between index contour lines.

(3) **Supplementary.** These contour lines resemble dashes. They show changes in elevation of at least one-half the contour interval. These lines are normally found where there is very little change in elevation, such as on fairly level terrain.

Contour Map : Look at the maps from 1 to 3 How come there are two roads in between (S1 and S2) settlements? Why would anyone bother to build a curvy, indirect route when a straight road is so much shorter? The maps drawn have their good points but it doesn't tell us how high or steep the mountains are and we can't see what's going on the sides of the mountains facing away from us. Whereas in a contour map (Fig.No.11.2) we're in a position to 'see' the shape of topographic features and their elevation and the nature of the slope.

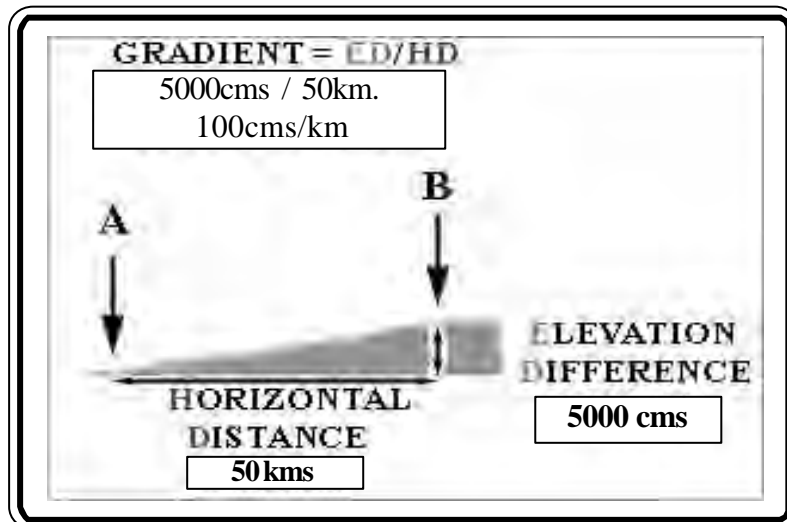


Gradient : Gradient tells you how steep your route is ! Gradient can be expressed numerically in many ways. One common way to describe the average steepness or gradient between two points is to state the difference in elevation (ED) divided by the horizontal distance (HD):

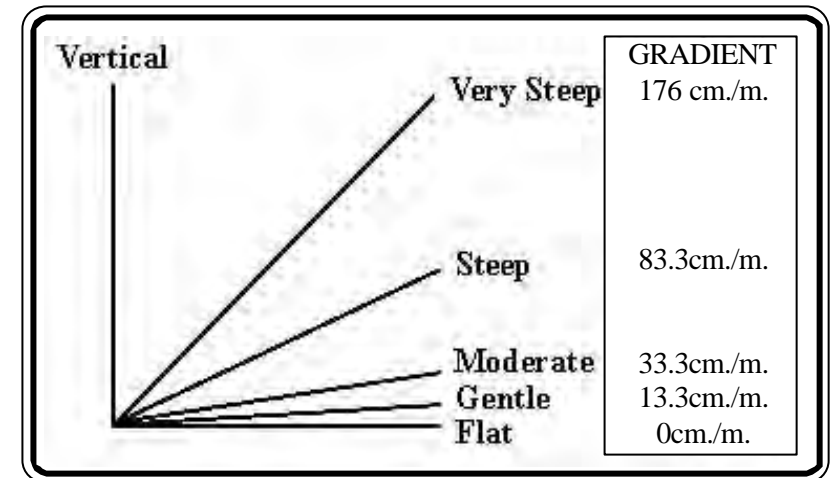
$$\text{GRADIENT} = \text{ED} / \text{HD}$$

Take a look at this example

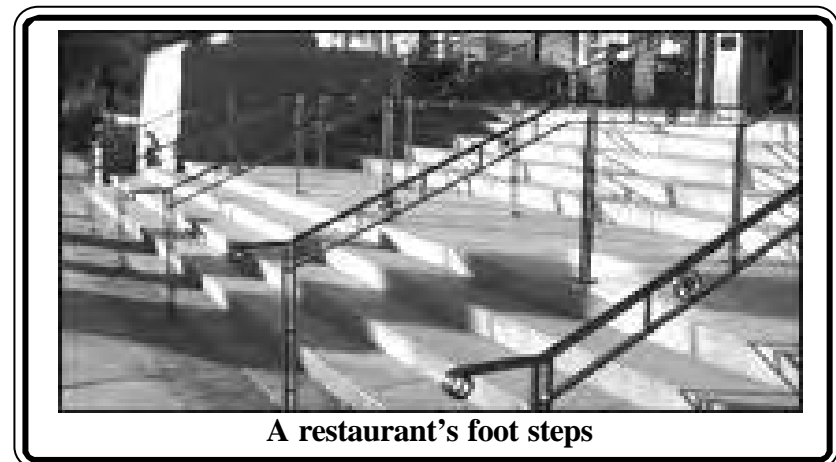
- The vertical distance (here, the difference in elevation between points 'A' and 'B') = 5000cms.
- The horizontal distance from 'A' to 'B' = 50 kms.
- Gradient = vertical distance (elevation difference (ED)) divided by horizontal distance (HD)
- The GRADIENT is 100 centimeters per kilometers (5000 cms divided by 50 kms.)



Elevation difference may also be expressed in inches, meters or some other convenient unit; similarly, horizontal distance may be expressed in feet, kilometers, etc. Thus, the gradient may be stated as inches / foot, feet/mile, meters/kilometer, etc. The diagram in the following page shows some slopes and their approximate gradients in cms/kms.



Let's look at an example like a small restaurant. When you enter into the dining hall using the steps, how steep these steps are? The gradients can help you to find how steep is the steps. Here's a photo of the steps. "And here's a sketch of the steps! If you look carefully, you'll see that to get from the ground to the level of the doors to the building (Platform 2), you have to go up nine 'risers', and across seven treads and Platform 1. The risers are 15 cms high, the treads are 30 cms across, and platform 1 is 2 mts across. Now let us calculate the vertical distance and horizontal distance.



A restaurant's foot steps

Vertical Distance

One riser 15 cms. X 9 raisers = 135 cms.

Horizontal Distance

One tread 30 cms X 7 treads = 210 cms. Or 2 meters

Horizontal distance = 2.1 + 2 mts. (Platform 1)

Total horizontal distance = 4.1 mts. Or 4 mts.

The gradient

Vertical / horizontal = $135 / 4$

= **33.75m cms / mt.**

So, for every one meter there is a rise of 33.75 cms.

Let us now learn about measuring a gradient from a contour map.

Map 1 : Calculate the gradient of the slope from point A to Point B,

'A' falls on the 2500 m. contour; 'B' falls on the 1250m. contour. So the vertical distance is 1250 m..

The horizontal distance from 'A' to 'B' can be taken from the scale that is one centimeter is equivalent to 5 kilometers on the ground.

So, the gradient is 1250m/ 5 kilometers. The gradient is 250 meters per kilometers.

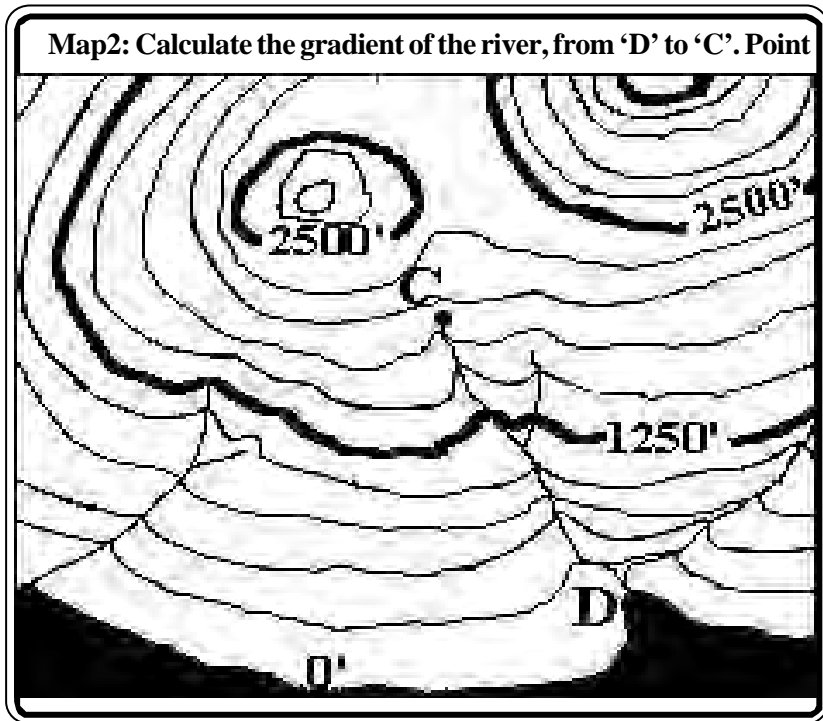
Map1: Calculate the gradient of the slope from point A to Point B.

1cm=5kms. C.I. 250mts

Map 2 : Calculate the gradient of the river, from 'D' to 'C'. Point.

'C' lies half way between the 1750 mts. and 2000 mts. contours, so we can estimate its elevation as midway between the two contours; 1875 mts. The elevation of 'D' is '0', because it lies at sea level.

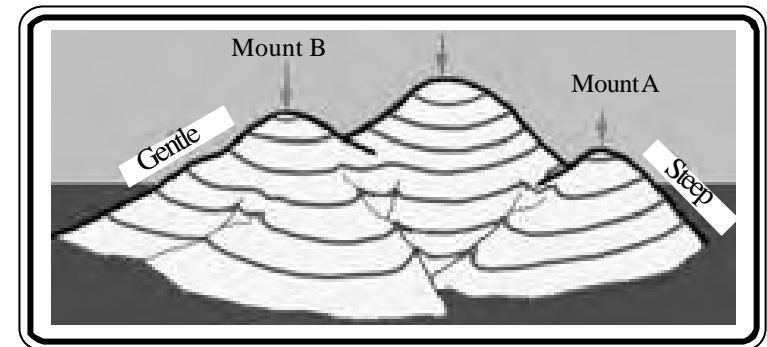
So, the elevation difference between C and D is 1875m minus 0' = 1875 mts. The horizontal distance along the river is about twice the length of the scale bar.



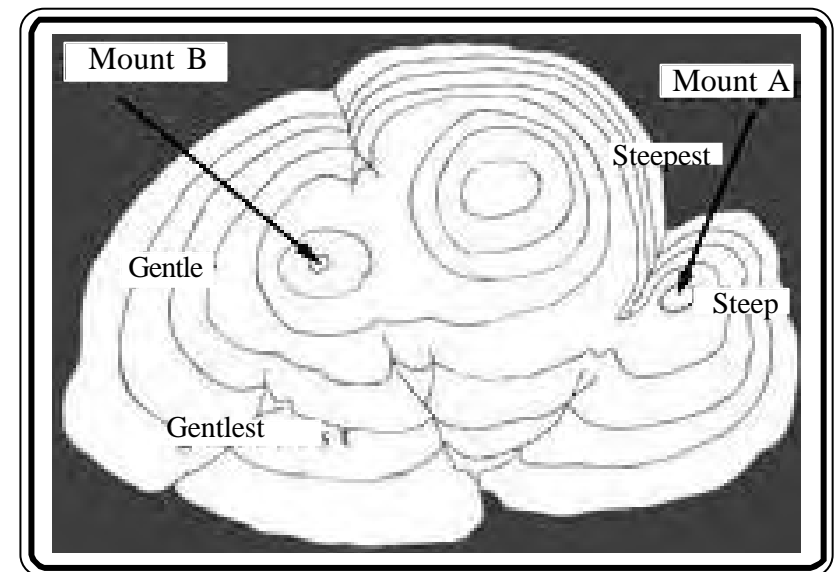
Since the scale bar is 5 kilometers, twice its length is ten kilometers. So, the gradient along the river is 1875m. / 10 kilometers is about 188m. per kilometer.

The gradient you get this way is only the average gradient. Also, there's no way of knowing what the gradient is between contours. The contour interval is 250', so there could be a hundred meters waterfall and then a fairly level stretch between two of the contours and they wouldn't show on the map! But it gives you a *general idea* of what you'll encounter.

Contour Spacing and Steepness:

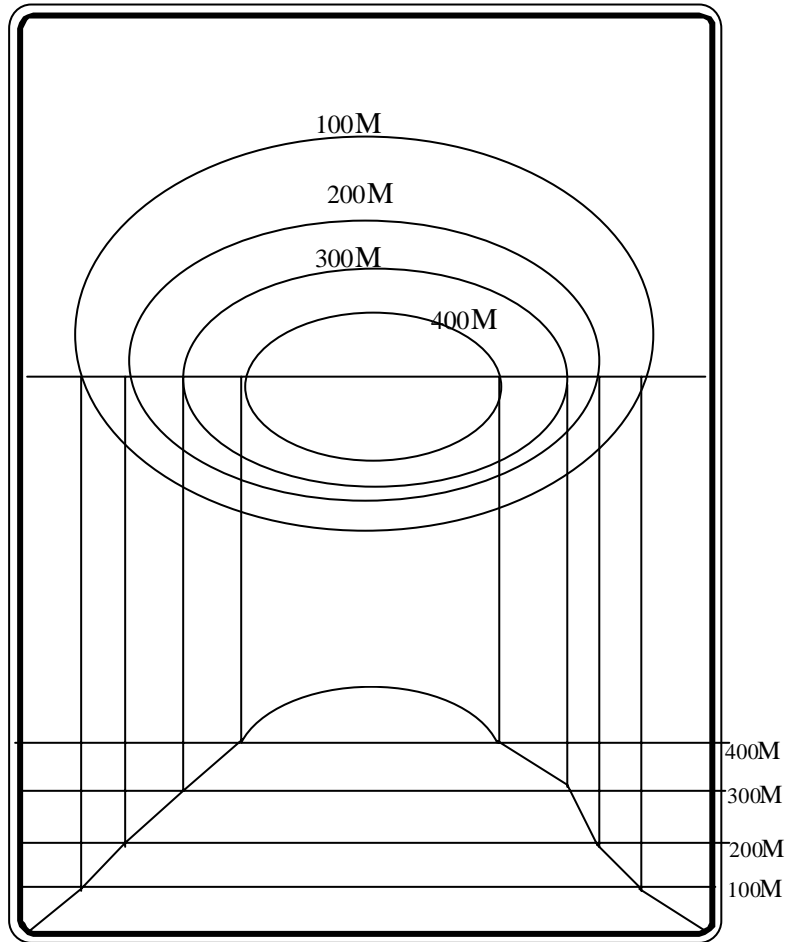


Take a look at the picture above and notice how the slope from the top of Mount A down to the sea is much steeper than the slope from the top of Mount B down to the sea. Now look at the contour map below, where the slopes are steeper, the contour lines are closer together and where the slopes are gentler, the contours lines are further apart.

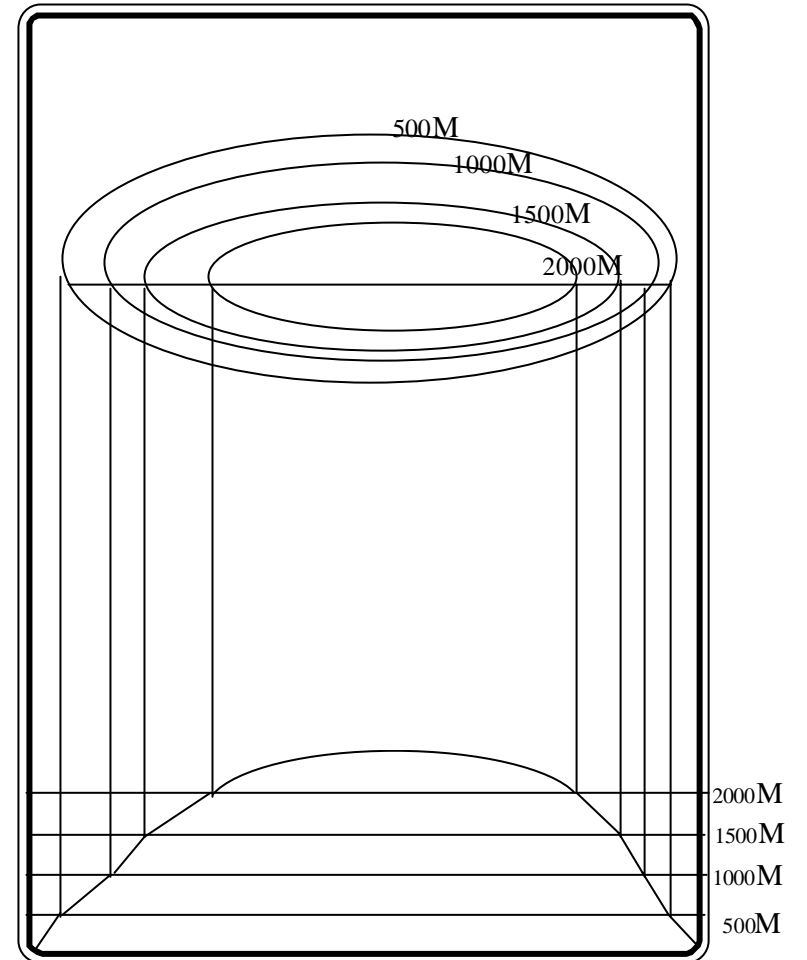


Some examples of the common landforms represented by contours and their cross sections are given below.

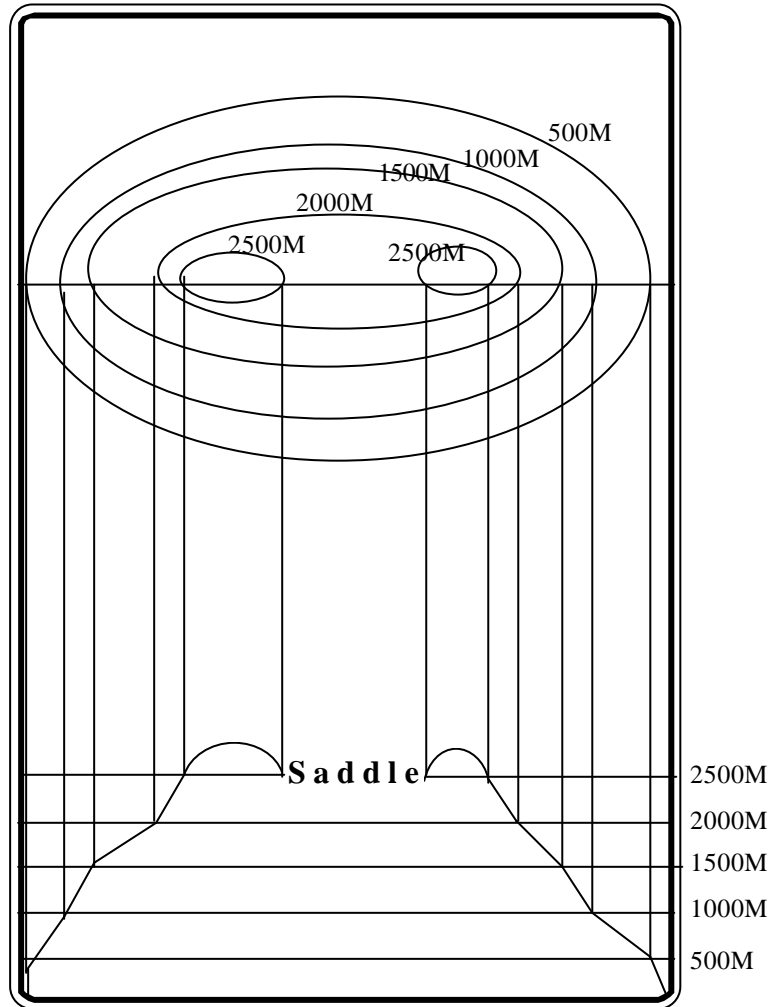
1. Conical Hill



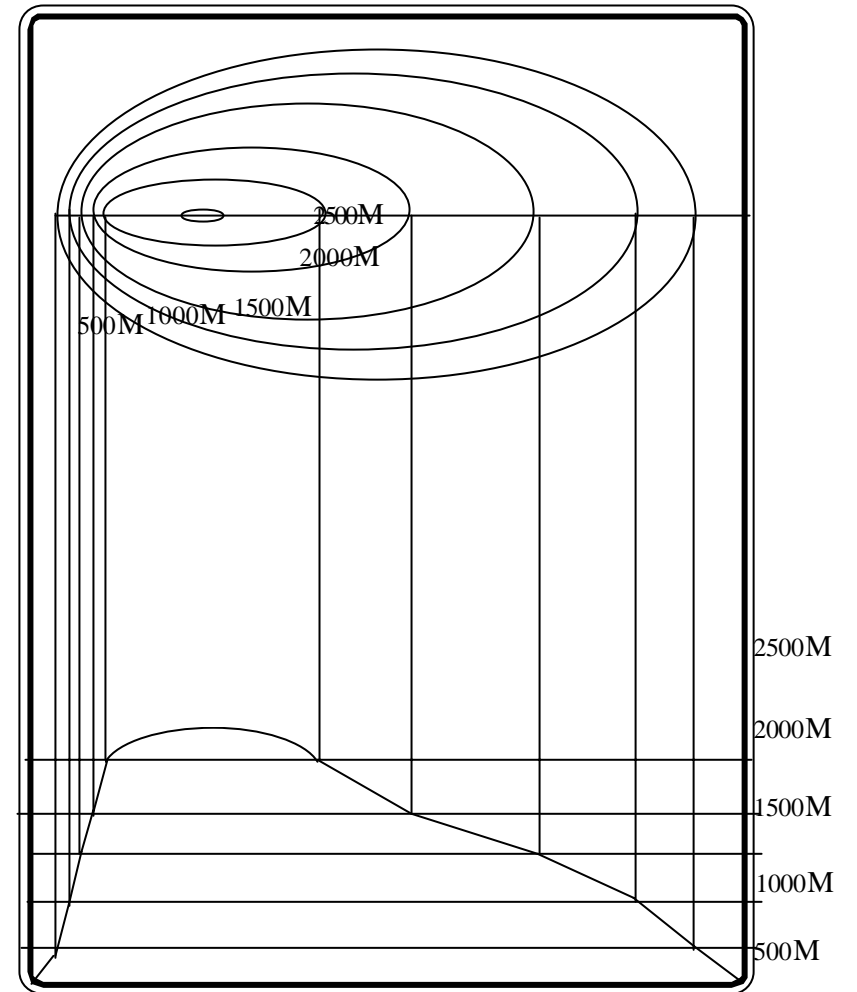
2. Plateau



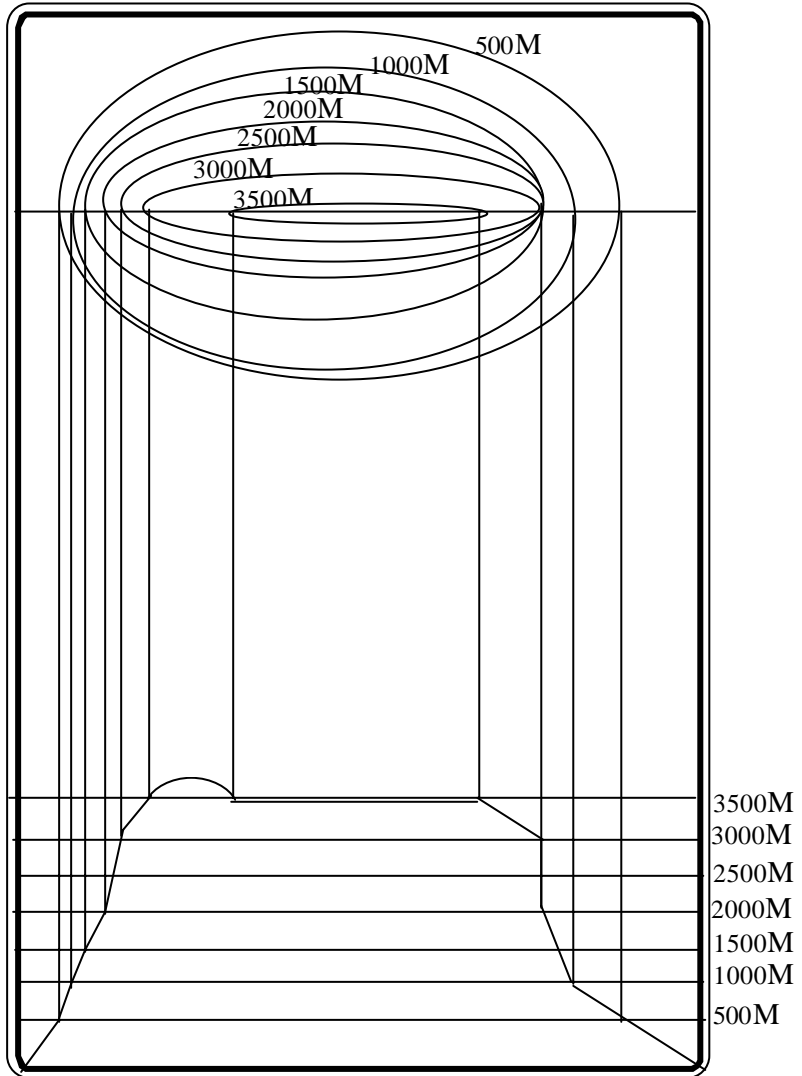
3. Saddle



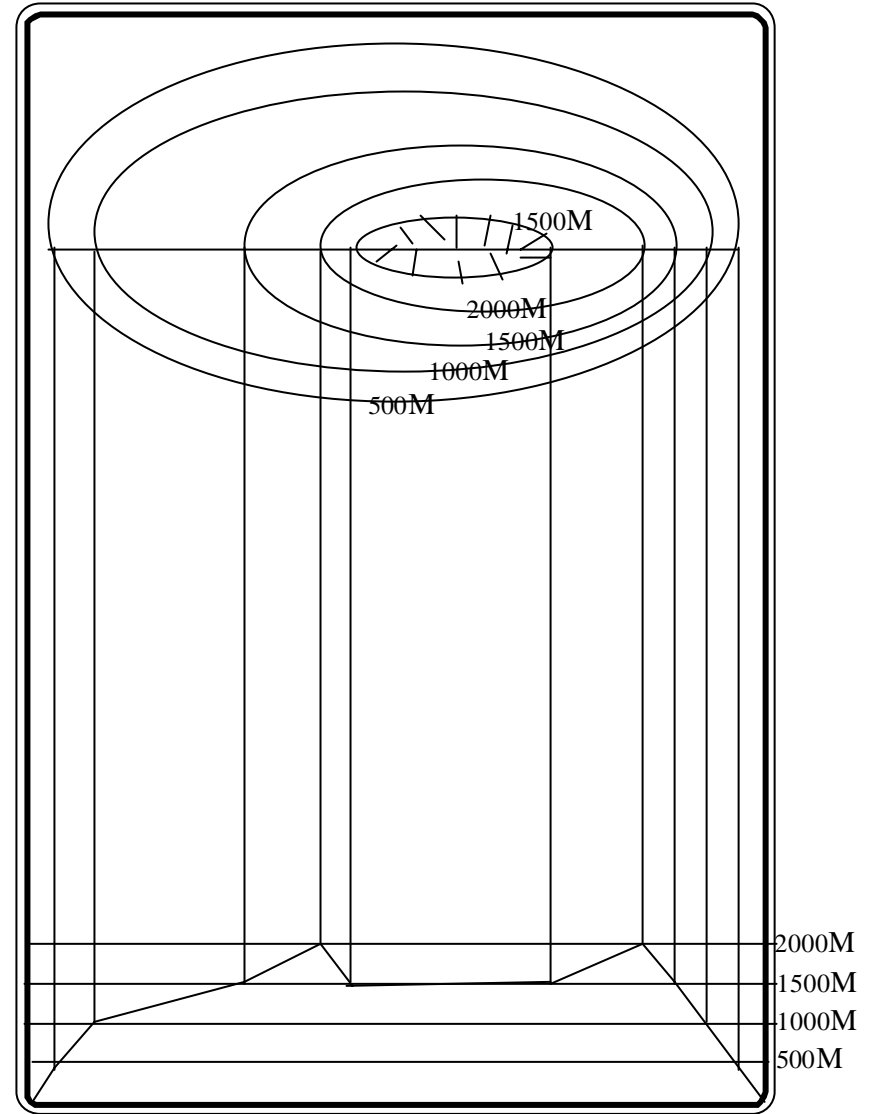
4. Escarpment



5. Waterfall



6. Volcanoe



Practical Exercises

1. Find out the gradient of the steps in any one of the building at your school campus.
2. Draw cross sections along the given line and briefly describe the terrain features.

12. TOPOGRAPHIC MAPS: INFORMATIONS AND SYMBOLS

Whether on paper or on a computer screen, a map is the best tool available to catalog and view the arrangement of things on the Earth's surface. Maps of various kinds such as road maps, political maps, land use maps, and maps of the world, serve many different purposes. One of the most widely used of all maps is the topographic map. The feature that most distinguishes topographic maps from maps of other types is the use of contour lines to portray the shape and elevation of the land. Topographic maps render the three dimensional ups and downs of the terrain on a two dimensional surface.

Topographic maps usually portray both natural and manmade features. They show and name works of nature, including mountains, valleys, plains, lakes, rivers, and vegetation. They also identify the principal works of man, such as maps, boundaries, transmission lines, and major buildings. The wide range of information provided by topographic maps make them extremely useful to professional and recreational map users alike. Topographic maps are used for engineering, energy exploration, natural resource conservation, environmental management, public-works design, commercial and residential planning and outdoor activities like hiking, camping, and fishing.

Topographic Map Symbols

In cartography, symbols are everything. The very nature of a map as an abstracted representation of the Earth requires symbols to perform the abstraction. To not have symbols is to not have maps. When we first think of symbols, we tend to think of graphics representing elements that appear points, like bridges and houses. Symbols can also be linear, representing such features as roads, railways and rivers. However, we also need to include representations of area, in the case of forested land or cleared land, this is done through the use of colour.

Conventional Signs and Symbols ; Every component of a map is a symbol (Fig No.12.1) Map itself is nothing but a symbol. It is a symbol of symbols. Symbols are like words. As the words giving same meaning differ from language to language, so also the symbols differ from map to map. Except for a few conventionalized symbols, a cartographer has far greater freedom to develop the symbols for the users. Symbols take their meaning given by the cartographers.

When several words are put together in a definite order, we get a sentence. Similarly when several symbols are put together in a definite order, we get a map. Many sentences make a paragraph. Orderly arranged symbols give a meaning which individual symbols fail to give. Symbolization and the arrangement of the symbols in a map are, therefore, crucial processes in map design. No book can be popular if the choice of words is bad. So also no map can be popular if the choice of symbols is bad. For most purposes we can classify symbols into three types: 1. Point symbols, 2. Line Symbols and 3. Area Symbols.

1. Point Symbols : Point symbols are those which give the location of an object or the quantitative value represented by it exactly at the point of its location. Point symbols are of two types (a) qualitative and (b) quantitative.

a) Qualitative symbols : They are used to suggest the existence of an object. For Example, a dot is put for a town and a cross for a hospital. Such symbols do not represent any quantitative data. For example everything on a road map is a word, a number or a symbol. The usual symbol for a city is a circle. If there is a star inside the circle, the city is a capital. Some symbols are small pictures. An airplane, for example, may stand for an airport. Even the lines are symbols. Some line symbols show the kind of road surface. Others represent canals railways, or boundaries. Colour also have a meaning. All maps do not use exactly the same symbols. On every road map you will find a key that explains what each symbol means.

b) Quantitative symbols : They can be used to indicate the presence the length, the size or the volume. Uniform dot symbols can be used to represent the existence of a certain phenomenon in partially quantitative terms. The amount by which an object or idea is characterised can be

represented either by bars or circles or spheres depending upon the type of data to be represented. Representation by bars indicates the length or height; by circle or squares, the size and by cubes or sphere, the volume. In this connection it may be noted that the cubes and spheres are three dimensional and hence, they take less space than squares and circles.

2. Line Symbols : Like point symbols the lines symbols are also used to indicate both qualitative and quantitative nature of the data. In the first category fall the latitudes, longitudes, boundaries, lines of transport and symbols is not dependent on quantitative measurement of the object represented on the ground. In fact certain objects like geographic coordinates and coastlines do not exist in reality. The width of the transport and communication lines as well as of the streams and boundaries are highly exaggerated. They are not drawn to scale.

We do have, however, line symbols which represent quantitative values. The iso-lines of various types used to represent the physical or social data do represent quantitative values. Similarly the flow lines show the amount of the object represented moving from one place to another.

3. Area Symbols : Area symbols use the point and line symbols to give combined effect of areal spread of the object represented. These symbols indicate the areal distribution of a given phenomenon without showing its density. The swamps, forests, deserts, political units or soil types given on a map are mostly qualitative in nature. When symbols are used to give the relative density of the occurrence of a phenomenon whether by administrative units or by isolines, they acquire quantitative values.

The purpose of a map is to permit one to visualize an area of the earth's surface with pertinent features properly positioned. Every map has its own legend. The map's legend contains the symbols most commonly used on that map. A legend on the topographic map contains the symbols used to depict the details (Fig No. 12.2) of that map area. Therefore, the legend should be referred to each time when topographic map is used. Every effort is made to design standard symbols that resemble the features they represent. If this is not possible, symbols are selected that logically imply the features they portray. Ideally all the features within an area would appear on a map in their true proportion, position, and shape these are grouped as marginal information on a topographic map.

.. unmetalled; do. do. bridge		
Cart-track. Pack-track and pass. Foot-path with bridge		
Bridges: with piers; without. Causeway. Ford or Ferry		
Streams: with track in bed; undefined. Canal		
Dams: masonry or rock-filled; earthwork. Weir		
River banks: shelving; steep, 3 to 6 metres; over 6 metres		
.. dry with water channel; with island & rocks. Tidal river		
Submerged rocks. Shoal. Swamp. Reeds		
Wells: lined; unlined. Tube-well. Spring. Tanks: perennial; dry		
Embankments: road or rail; tank. Broken ground		
Railways, broad gauge: double; single with station; under constrn		
.. other gauges: do. do. distance stone; do.		
Light railway or tramway. Telegraph line. Cutting with tunnel		
Contours, with sub-feature. Form-lines. Rocky slopes. Cliffs		
Sand features: (1) flat; (2) sand-hills (permanent); (3) dunes (shifting)		
Towns or Villages: inhabited; deserted. Fort		
Huts: permanent; temporary. Tower. Antiquities		
Temple. Chhatri. Church. Mosque. Idgah. Tomb. Graves		
Lighthouse. Lightship. Buoys: lighted; unlighted. Anchorage		
Mine. Vine on trellis. Grass. Scrub		
Palms: palmyra; other. Plantain. Conifer. Bamboo. Other trees		
Boundary, international		
.. state: demarcated; undemarcated		
.. district: subdivn, tahsil or taluk; village, forest		
Boundary pillars: surveyed; unlocated; village trijunction		
Heights, triangulated: station; point		
Bench-mark: geodetic; tertiary; canal		
Post office. Telegraph office. Combined office. Police station. PO TO PTO		
Bungalows: d&k or travellers; inspection. Rest-house		
Circuit house. Camping ground. Forest: reserved; protected		
Spaced names: administrative; locality; tribal		

Fig.No.12.1 Conventional Signs and Symbols

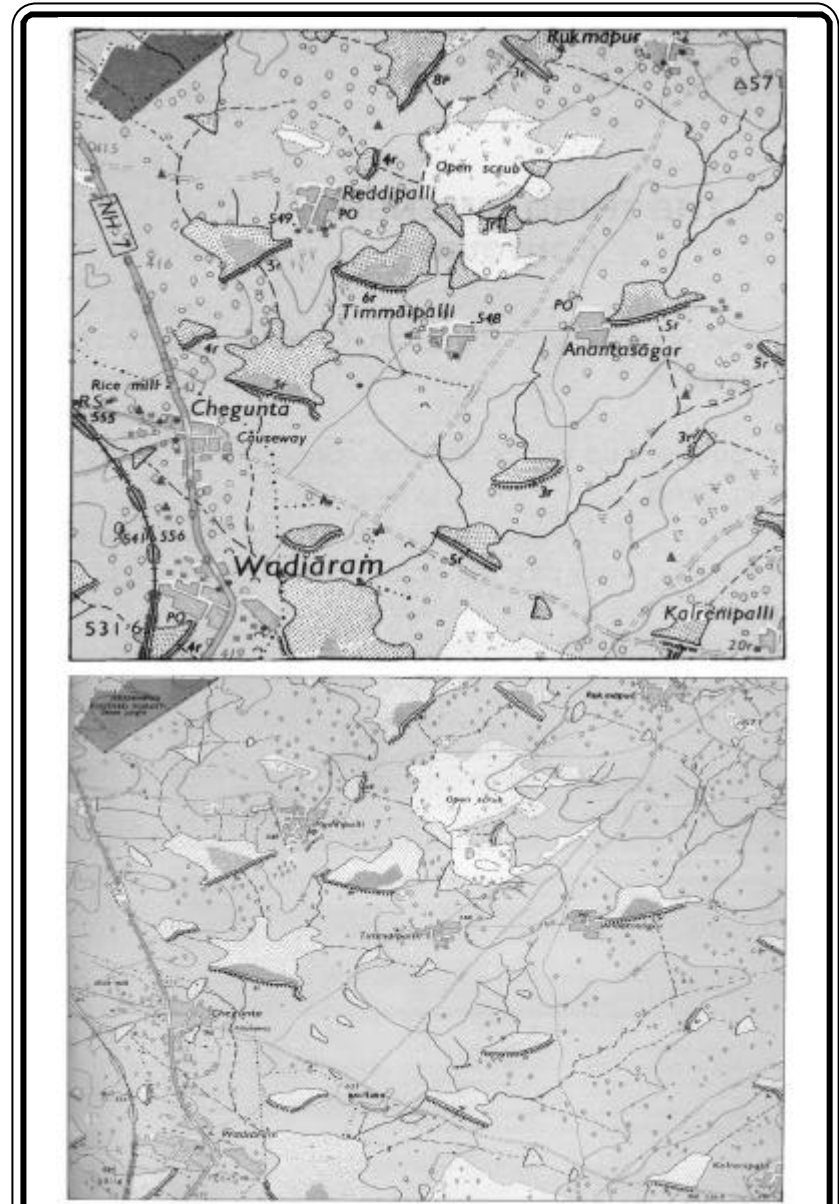


Fig.No.12.2 A Section of the Indian Topographic Map

Marginal Information :

Marginal Information (Fig.No,12,3) on a topographic map shows information that the map user needs to know. Marginal informations are classified into: 1. Extra marginal 2. Intra marginal, 3. Inter marginal.

Extra marginal information describes the serial number, name of the state and district and other general information. The intra marginal information consists of the grid information, contour values and names of the next place and the distance in kilometers. The Inter marginal information depicts the topography by using the various signs and symbols. Let us learn about the inter marginal next year in detail. Extra marginal information is explained in detail and the numbers indicate the items of the marginal information that the map user needs to know.

1. Extra Marginal Information :

Sheet Name (1) : The sheet name is found in bold print in the upper left corner of the margin. The name given to the series is generally that of a major political subdivision, such as a district of a state designed to cover a particular geographic area.

NAME OF THE DISTRICT

Sheet Year (2) : The sheet year is found next to the sheet name in Top and the left area of the map margin. The surveyed year is printed in small letter.

YEAR OF SURVEY

Series Name (3) : The series name is found in bold print at the center of the top of the map margin. A map is generally named by the political boundary within which the area found at the time the map was drawn.

NAME OF THE STATE

Edition Number (4) : The edition number is found in bold print in the upper right area of the top margin. Editions are numbered consecutively, therefore, if you have more than one edition, the highest numbered sheet is the most recent. Below the edition number, the magnetic variation from true north in a particular year is given.

Edition Number And Magnetic Variation

Sheet Number (5) : The sheet number is found in bold print in the upper right corner area of the margin, which indicates the series number. It is used as a reference number for the map series.

REFERENCE NUMBER

Legend (6) : The legend depicts physical features, is located in the lower left (6) and depict cultural features is located in the right margin (6b). It illustrates and identifies the topographic symbols used to depict some of the more prominent features on the map. The symbols are not always the same on every map. Always refer to the legend to avoid errors when reading a map.

LEGEND

LEGEND

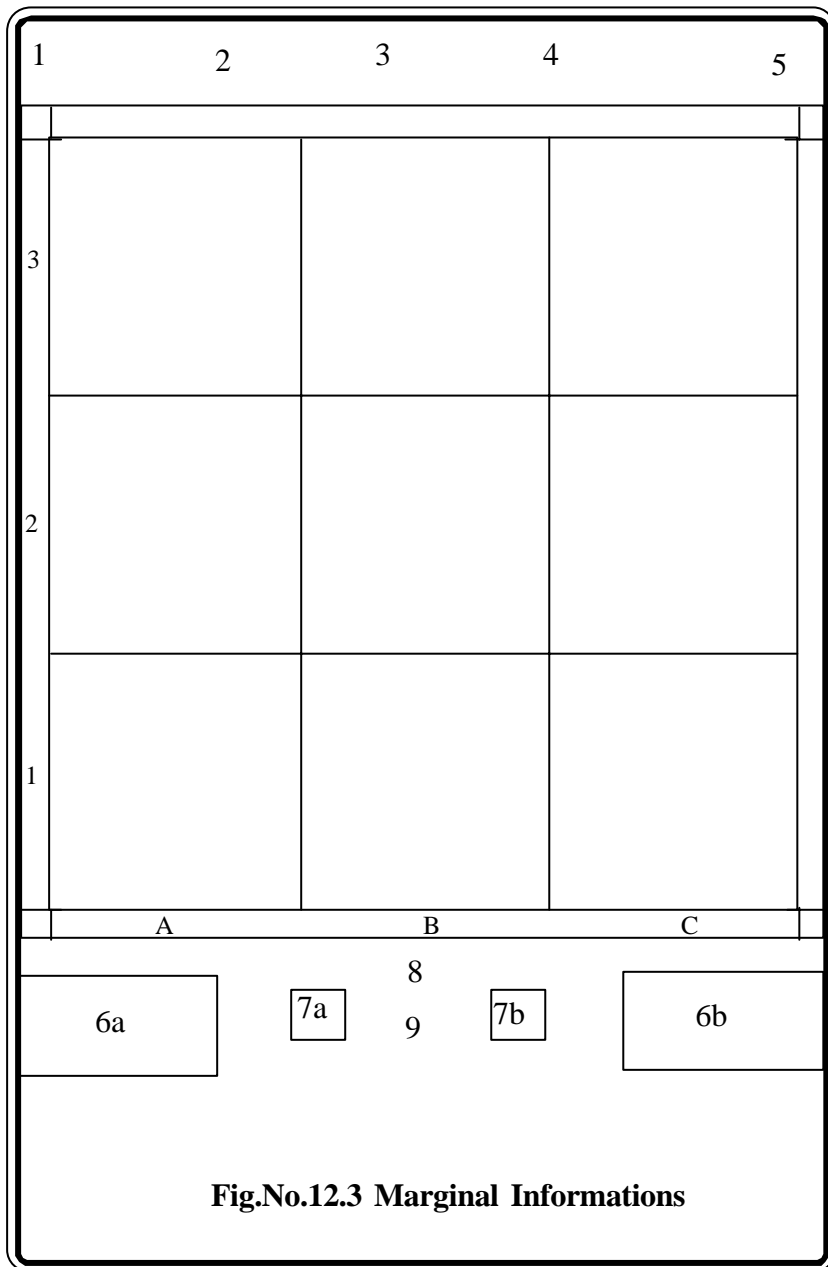
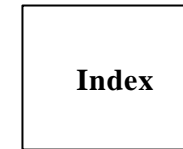


Fig.No.12.3 Marginal Informations

Index to sheet (7) : The index to boundaries diagram appears in the lower, left margin indicates the map index (7a) and right margin indicates the administrative index (7b) of adjoining sheets. This diagram, which is a miniature of the map, shows the boundaries that occur within the map area, such as district lines and state boundaries.



Control Note (8) : This note is located in the centre of the lower margin. It indicates the special agencies involved in the control of the technical aspects of all the information that is disseminated on the map.



Scale (9) : The scale is found below control note, in the center of the lower margin. The scale note is a representative fraction and graphical that gives the ratio of a map distance to the corresponding distance on the earth's surface. For example, the scale note. 1,50,000 indicates that one unit of measure on the map equals 50,000 units of the same measure on the ground.



Colours used on a Map : Profile drawings of mountains and hills were shown in brown, rivers and lakes in blue, vegetation in green roads in yellow, and special information in red. A look at the legend of a modern map confirms that the use of colours has not changed much over the past several hundred years. To facilitate the identification of features on a map, the topographical and cultural information is usually printed in different colors. These colors may vary from map to map.

Practical Exercises

1. Classify the symbols used in a
Tourist map of Tamilnadu/India
Physical map of Tamilnadu / India
Political map of Tamilnadu / India
Natural vegetation map of Tamilnadu / India
Indian Topographical map
2. Using conventional signs and symbols chart published by survey of India classify the symbols.
3. Illustrate the extra marginal informations and symbols using Indian topographical sheet.

13. WEATHER INFORMATION

In the modern world there is an ever-increasing demand for more accurate weather forecasts. From factories to farms, from satellite launching stations to commerce and industries, and even from general public there is a persistent demand for more reliable weather information. In the field of agricultural planning the importance of weather prediction cannot be over emphasized. It is undoubtedly true that all human activities are directly or indirectly affected by the vagaries of weather elements. In most cases, accurate weather forecasting happens to be the ultimate target of atmospheric research.

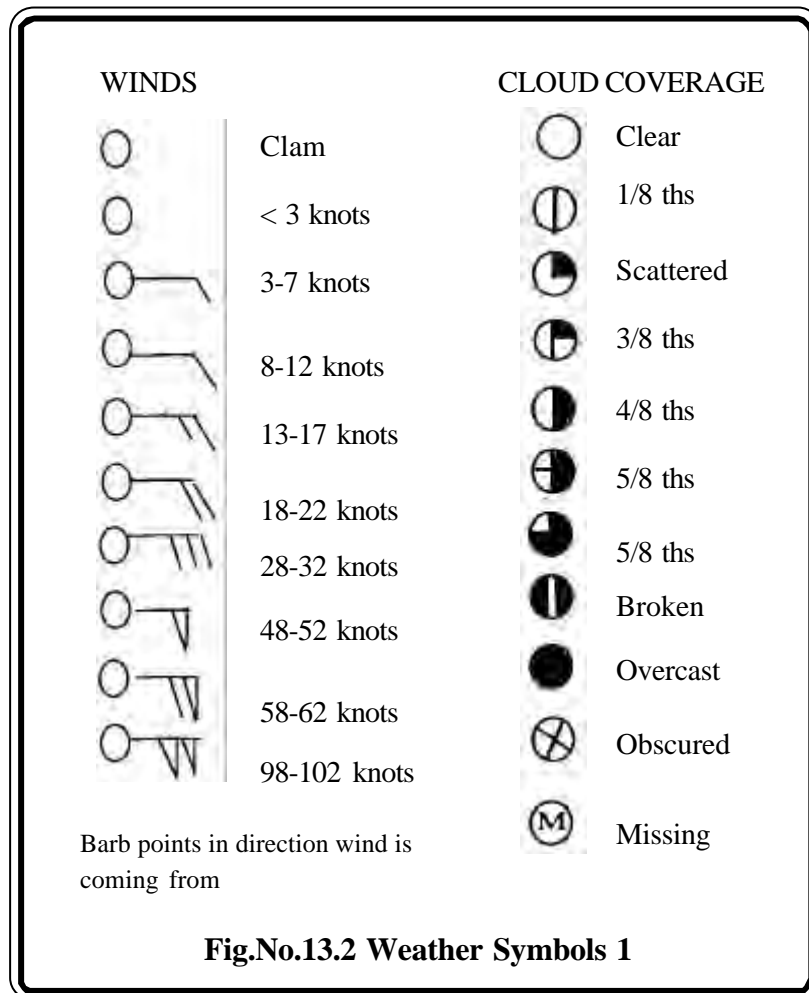
Weather forecaster's job is highly technical and involves numerous steps. Collecting, transmitting, and compiling weather data of the entire world are the most essential steps in weather forecasting. Let us know about this aspect next year. In this lesson, how to map weather and climatic data is discussed in detail.

Mapping the weather data

The day-to-day weather observations are used to prepare synoptic charts and a variety of other diagrams. Synoptic charts give a composite picture of the weather conditions as observed at a particular time. Synoptic means "seen together".

Synoptic charts : In order to have an average view of the changing pattern of weather, a modern meteorological center prepares a series of synoptic charts every day. Such a synoptic charts form the very basis of weather forecasts. In the synoptic weather forecasting there was no scientific basis and there was little quantification. The data received from various weather stations are so much that they all cannot be incorporated in a single chart unless they resort to coding. These codes are called meteorological symbols.

Weather symbols : A meteorologist must convey a lot of information without using a lot of words. When looking at a weather map, a meteorologist needs to know where the cold air is, where the warm air is, where it is raining, what type of clouds are in the area, and many more things.



The reason for this is that forecasts need to be accurate. But, they also need to be timely. If too much time is spent making the forecast, it will be late. Not many people want to know what the weather was doing twenty minutes ago. Most people want to know what the weather is going to do in the near future. Because of this, weather symbols were invented so that weather maps could be looked at in a short amount of time.

There are a large number of weather symbols is existence. Some are used for weather like rain, snow, and lightning. There are also symbols representing the speed of the wind, types of clouds, air temperature, and air pressure. All of these symbols (Fig No.13.2 & 13.3) help meteorologists forecast the weather in a timely manner.

At present, according to the world meteorological organization (WMO) there are at least 9,525 land-based observatories, 7, 424 ships sending weather date from over the seas, 664 radar stations and 2306 upper-air observing stations which are engaged in collecting weather data and transmitting the same to their respective Centers. After the information is collected, it is transmitted to three World Meteorological Centers located in Melbourne (Australia), Moscow (former U.S.S.R), and Washington, D.C. Besides, there is a continuous flow of 15 million weather data by telecommunication system. It may be noted that weather data are shared internationally through the World Weather Watch (WWW) system. This was inaugurated by the World Meteorological Organization in 1965.

In India the National meteorological Center is located in Pune (Maharashtra). India Meteorological Department was established in 1875. It is the National Meteorological Service in India and is the principal government agency in all matters relating to Meteorology, Seismology and allied subjects. For administrative convenience and technical control, six Regional Meteorological Centers (RMCs) function with their headquarters at Calcutta, Chennai, Guwahati, Mumbai, Nagpur and New Delhi.

Regional Meteorological Centre at Chennai was started on April 1945 to supervise and coordinate meteorological services in the Southern Region. It covers the states of Tamilnadu, Andra Pradesh, Karnataka,

Drizzle	Freezing Rain	Miscellaneous
□ □ Light	⊖ ⊖ Light	△ Ice Pallets
□ □ Moderate	⊖ ⊖ Moderate	↔ Ice Crystals
□ □ Heavy	Freezing Drizzle	△ Snow Grains
Rain	⊖ ⊖ Light	↕ Blowing Snow
□ □ Light	⊖ ⊖ Moderate	— Fog
□ □ Moderate	Thunder Strom	∞ Haze
□ □ Heavy	⚡ Light	☁ Smoke
Rain Showers	⚡ Heavy	D Dust
▽ Light	⚡ Lightning	
▽ Moderate		
Snow	Tropical	
xx Light	Ⓢ Hurricane	
x ^x Moderate	Ⓢ Strom	
x ^x _x Heavy		
Snow Showers		
▽ ^x Light		
▽ ^x Moderate		

Fig.No.13.3 Weather Symbols 2

Pilot Balloon Observatory. Until then Madras observatory was supplying the time signal through out the Indian Telegraph system and issuing the Madras Daily Weather Report which had commenced in October 1893.

Remember that all the weather stations, whether located on land or on ships, report the atmospheric conditions 4 times each day at 0, 06, 12 and 18 hrs Greenwich Mean Time. Then the surface weather charts are produced by first plotting the data procured from selected weather charts are produced by first plotting the data procured from selected weather stations. By international agreement the data must be plotted by using the symbols illustrated in figure 13.4 Generally the plotted data include the following weather elements: temperature, dew – point, pressure and its tendency (whether falling or rising), cloudiness (height, type and amount), wind speed and direction, and both current and past weather. It is worth while to note that the data are always plotted in the same position around **the station model** (Fig.No.13.4) so that their reading may be easier.

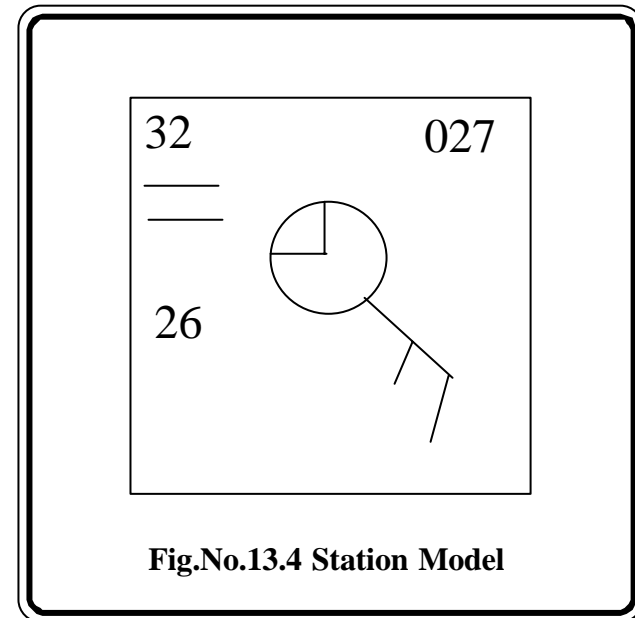


Fig.No.13.4 Station Model

Interpreting Surface Observation Symbols

32

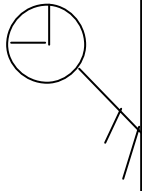
Temperature : The value highlighted located in the upper left corner is the temperature in degrees **Celsius**. In this example, the reported temperature is 32 degrees.

—
—

Weather Symbols : The weather symbols indicates the type of weather occurring at the time the observation is taken. In this case, fog was reported. If there were thunderstorms occurring when the observation was taken, then the symbol for thunderstorms would have appeared instead.

26

Dew Point Temperature : The value highlighted located in the lower left corner is the dew point temperature in degrees Celsius. In this example, the reported dew point temperature is 26 degrees.



Cloud Cover : The symbol highlighted indicates the amount of cloud cover observed at the time the observation is taken, in this case, broken clouds were reported.

027

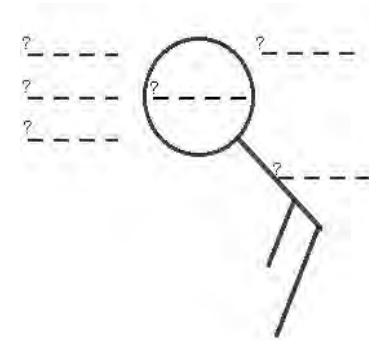
Sea level Pressure : The value highlighted in yellow located in the upper right corner represents the last three digits of the sea level pressure reading in millibars (mb).



Wind Barb : The symbol highlighted is known as a Wind Barb. The wind barb indicates wind direction and wind speed.

Practical Exercises

- Fill in the blanks of the diagram to indicate what type of meteorological data is represented by each position. Then circle the position of the weather symbols.



- Collect meteorological data and draw station models for the following stations.
 - Delhi,
 - Kolkotha,
 - Mumbai and
 - Chennai

14. FIELD WORK AND REPORT WRITING

Geography is a study of earth's surface where humans live. There are several phenomena on the surface of the earth. There are several attributes, too. Although the human beings are the first and foremost of the characteristics, the nature, landscapes and others of relative importance have their own roles, too. The changes that occur in (notably, wind, land and water) are all learned as the physical geography / Humans, their lives, industries, growth, development, welfare, ideas and perceptions are learned in human geography. Hence, physical and human geography are considered as the two broad divisions of geography and the two are also considered as the fields of human educational endeavor, its realities and behaviors. We should keep in mind three features as the most important geographical characteristics.

1. The first characteristic is 'location'. How are the physical and human factor changes depending on the locations?
2. The second characteristic is that of society – land relations. The interdependencies between the earth phenomena and the nature of physical and human environments are made explicit.
3. The third characteristic is that of integration of the two above. Here, region is much more closely studied and learned using spatial and ecological approaches.

For those who are geographers, 'areal differentiation' is the basic idea of geography. On the basis, there are means to learn both physical and human geography.

Field work in geography

It is, in general, a collective of methods/techniques adopted by way of gathering primary data. These methods include mapping, sketching, observation, measurements in terms of land used and urban morphologies and interviewing concerned individuals. But when the conditions arose

favorably for using secondary data in geography, the dependence on fieldwork decline. In the midst of some geographers, fieldwork was being treated as a method of teaching only. This is primarily because of the fact that during the 1950s and the 1960s, the secondary statistics began to be used in a large measure. But there are still a number of geographers who carry out field study, believing in the efficacy of the method in research and teaching. Its importance is increasing day by day. It is being used in social surveys, while remaining the most important in the primary surveys. Through this method, the day-to-day life is keenly observed both directly and through participatory observation, and the primary data are thus collected.

Fieldworkers are now engaged in data collection for gathering information on the human behaviour and the events and activities as they occur. Their complete understanding is possible through observation, interviewing and statistical evidences. But, mostly, the fieldwork methods/ techniques would depend very much on the purpose of the study and the kind of questions are researcher is expected to answer.

In and field work, there are some precautionary steps. They must be taken keeping in view the following:

1. Purpose and nature of conduct of field work
2. Welfare and health of the participants in the fieldwork.
3. Intimation and information to parents, school or administrative authorities.
4. Conservation of fieldwork sites.
5. Rapport with the people towards gaining their confidence and cooperation.

Learning from fieldwork may be considered as a 'Classroom without walls'. In the briefing of boys and girls to be involved in fieldwork, how the classrooms without walls can be fun and can create a happy occasion for learning must be elaborated. There are three major activities in fieldwork. They are :

1. Planning the Fieldwork
2. Conducting the Fieldwork
3. Documenting what is gathered for Fieldwork

In geography, environment plays a vital role. We can differentiate environments in different ways. They can be physical, social, economic and task environments. None of these can act independently of each other. But we can do research on each of them. Physical environment is researched in various ways in geography. We learn about the physical environment in geography through land; water and air. They provide opportunities for doing field work. The following six steps may be taken in the completion of field work :

1. Making a list activities to be carried out, depending on the purpose of the field work.
2. Pre – planning of the field work.
3. Making arrangements for travel and stay at the field work.
4. Collecting materials and instruments in respect of fieldwork.
5. Choosing correct methods of analysis of data, if primary data are to be collected from the field work.
6. Travel to field work site and conduct of field work.

In some field work exercises, there is no need for analytical methods. It is because such field work may be carried out following mainly the first of the following activities.

1. Observation, 2. Interview, 3. Participation, 4. Data processing, 5. Interpretation.

There is no hard rule for the field work to follow the activities above. In fact, all the field work relevant to the students in the school may be conducted with any one of above as the most basis activity, depending on the time available.

Field work exercises using interview as the basic method of data collection can help with the interpretation of collected materials. It is possible to collect information through interviews without having to follow participatory methods. The data collected through participatory methods may be textual or verbal data rather than statistical data. As textual or verbal data cannot be subjected to quantitative analysis, they are amenable to direct use in interpretations. There are professional who take the essence of such materials for analysis and interpretation. In all field work, interpretation/explanation is the final activity. Every students participating in a field work learns some general explanations to the phenomena observed.

Report Preparation : Research investigation and information has limited value unless it is collected and published in a usable form and presented to those who may apply it. It is also our responsibility as a researcher or as an investigator to show promptly that the results are worthwhile and the only way to convey these thoughts is by writing a good report. There are three major stages of report preparation. They outlining the report, writing the rough draft and revising the rough draft.

Outlining the Report :

Outlining is a necessary preliminary step to report writing. It involves the planning needed to prepare a clear report that is logically organized concise, and easy to read. Without an outline most inexperienced authors write reports that are confusing and difficult to follow. The outlining stage is a natural progression from the analysis and sorting stage. In the sorting stage concentration is on what results should be presented in a report. In the outlining stage attention is directed to *how* these results should be presented.

Several methods can be used to arrange the subject matter that will be represented in an outline. One of the best ways to start is to write down all the points that you want to include without regard to their order. You can then more easily arrange them in a logical order. Some authors use an index card system in which each separate item of the proposed report is tabulated together with a paragraph describing the material that must be treated under that item.

Other authors follow a similar method but use full sheets of paper for each subject and give a much fuller description of the material under the subject headings. The latter method puts you in a good position to complete the report in a short time : Each subject has been so fully expanded that the problem remaining is one of combining and rewriting the information contained on the separate sheets of paper. Others choose to do their outlining on a computer. Any of these methods permit you to note thoughts that occur during the course of writing one report section but that should be treated in other sections. Cultivate the habit of going to the original outline to record thoughts for later consideration.

Writing the Rough Draft :

With a logically organized outline and the necessary illustrations already prepared, writing the rough draft should be much easier than you thought. But do not expect to write the final version in the first attempt. Try to start writing the first version of the draft immediately after completing the outline while the ideas developed there are still fresh in your mind. Write this first version as rapidly as possible. Concentrate on *what you* want to say rather than how to say it. Keep writing down the thoughts as they flow into your mind, following your outline. Avoid going back over what you have written until you are through writing.

Revising the Draft :

Revising a draft is comparable to painting a house : the appearance is improved without influencing the structure. But a report's "appearance" (readability) may determine whether or not it is read. Before you can revise your rough draft, you must recognize that it is not perfect. Approach it with a critical attitude. This can best be done by setting the draft aside for a few days, or at least overnight. This time lag should give you a fresh viewpoint and allow you to change to the role of a reader. This change in roles is most important because you must try to see what is actually written rather than what you think you wrote.

Practical Exercises

1. Under take a field visit for a day and prepare a report.

The following themes can be considered for conducting a field work.

- | | |
|----------------------------|-------------------------|
| a. Tourist spot | b. Wild life Sancturies |
| c. Hilly area | d. Industrial visit |
| e. River banks | f. Market Place |
| g. Meteorological stations | h. Agricultural biome |
| i. Forest biome | |