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Environmental Studies

BBAAE102

CENTRE FOR DISTANCE AND ONLINE EDUCATION

ENVIRONMENTAL STUDIES
(BBAAE102)

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ENVIRONMENTAL STUDIES

Block -1

Environment and its Components

UNIT-1 CONCEPT OF ENVIRONMENTAL STUDIES

UNIT STRUCTURE

1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- define environmental study
- understand the nature and scope of environmental study
- know the significance and rules of conservation of environment
- Find out the steps for preservation of environment.

1.2 INTRODUCTION

In recent times, environmental studies have gained importance all over the world. It is essential that everybody should know about the basic issues and concepts included in environmental studies. Since all living beings e.g. Plants and animals, and the surrounding non-living objects, are parts of the environment, so environmental studies include all of them. It is therefore necessary for everyone to know about the environment, its significance for our survival and the need for preservation of the environment.

Constant increase in population and also increase in human activities along with the rapid industrialization and the use of machines and transport have their impact on nature, which has caused rapid changes in the environment leading to environmental pollutions. For all these reasons preservation of environment is essential. Creation of public consciousness/awareness has become the call of the hour.

1.3 NATURE AND SCOPE OF ENVIRONMENTAL STUDIES

Records show that people were conscious about environment in the past. We can find traces of conservation of environment in Indian culture during the Vedic age. According to different religious practices and customs, animals and plants were worshipped. The creation of different animals and plants in different environment was known to people long time ago. Scientific studies were carried out on the mutual impact of living beings and environment and a new study was started in the year 1869 for the first time, which came to be known as environmental studies.

Because of the pioneering efforts of some people the concept of conservation of environment was gradually gaining importance.

A healthy environment presuppose the existence of the following elements:

- Pure air
- Plenty of clean water
- Adequate/ Plenty of place for growth and development
- Abiotic salt and strength needed for the growth and development of the body.

In reality all human beings and animals are dependent on plants. Again plants are dependent on various microorganisms, insects, and birds frothier living. Therefore, environment is made up of

- All living beings and non-living objects that are components of environment
- All kinds of living beings are essential to sustain environment.
- All living beings are interdependent. Because of these reasons, the concern for conservation of environment is growing all over the world.

For the first time Charles Darwin in his book Origin of Species in1859 scientifically established the relationship between living beings and their habitats. In fact, Ralph Emerson, before Darwin, in 1840 warned that business-activity would destroy environment. Rachel Carson, an American lady wrote in an article about the use of insecticide/pesticide and also wrote a book Silent Spring which became a pioneering work in modern environmental revolution. India was also not lagging behind. In fact noted Ornithologist Salim Ali's Book of Indian Birds and his autobiography falloff a Sparrow are regarded as the path-breakers in the study of environment. Sundarlal Bahuguna who is associated with Chipko Agitation and Medha Patkar who stood for the Narmada Bachao agitation have championed the cause of the protection of environment. It can be mentioned here that M.C.Mehta fought for the protection and preservation of the Taj Mahal. Voices have been raised for cleaning the water of the Ganga and also for the inclusion of environmental studies in the curriculum of schools and colleges. Besides, cases are also lodged in the courts of justice for the protection of environment for the public interest.

The scope of environmental studies is very vast. Since several areas and numerous elements have been covered in this subject, its scope has-been gradually increasing.

The following are the contents of the course on environmental studies:

- Natural Resources: their preservation and conservation and their management.
- Eco-system and Bio-diversity.
- Environmental pollution and control
- Social problems connected with environment and development
- Population and environment

The treasures which are given by nature for our use are called the natural resources. Nature endows us with all the required materials which fulfil our essential needs and which are necessary for us to enjoy a happy life. But the supply of these natural treasures is very much limited. On the other hand, population explosion and our constant desire to live a luxurious life have led us to use these naturals resource indiscriminately. As a result, many natural resources gifted by nature have gradually become scarce. So, how to conserve and manage these resources in a balanced manner is the subject of discussion in environmental studies.

Plants and other living beings on this earth have undergone various changes and stages of evolution before reaching the present stage. Nature has created an intimate relationship between plants and living beings. In short, this is known as eco-system. Earthly elements play a significant role in creating living beings and plants.

From the combination of biotic and abiotic elements various species are created in the eco-system. Diversity of plants, living beings, organisms and all other diverse species present in the eco system taken together are called bio-diversity. Bio-diversity and Eco-system are another area of discussion in this unit. The presence in the air, soil or water of a substance with harmful effects is called pollution. Changes in environmental conditions affect natural life. Sometimes even the identity of living species is endangered. Pollution is due to some natural and manmade causes. Environmental studies study the problem of pollution, how it is caused, what are its effects and how it can be controlled.

Human beings through their intelligence have utilized natural resources. As opposed to other living beings, human beings have been trying to exploit natural resources through science and technology and due to this exploitation, nature has been affected. These man made problems are also discussed in Environmental studies. Population explosion is another grave problem. Rapid advancement of science and technology has significantly reduced the human mortality rates, while human birth rate has also in creasedin some countries, including India. The continuous rise in population has

resulted in large scale utilization of the natural resources leading to a pressure in the environment which is undergoing rapid changes. Population explosion and its effect on nature is another matter of discussion.

- **Definition of Environmental Studies:** Environmental study is the methodical and scientific study of the environment and how socio-economic and other factors affect it. The elements constituting the environment are divided into two – living beings and nonliving matter. This relationship between living beings and nonliving matter and the impact of the change of these two elements over other elements are abasic concern of Environmental studies.

- **Objective of Environmental Studies:** The main objective of environmental studies is to discuss what environment is and what is the relationship between the different elements of the environment.

Environmental studies discuss the relationship among various living and non-living things, as well as the relationship among the various species. Its influence on human beings, the interdependence between man and other species and how human activities influence them are some of the issues to be discussed within the scope of Environmental Studies.

1.4 MULTIDISCIPLINARY PERSPECTIVES OF ENVIRONMENTAL STUDIES

This is now clear from the definition of environmental studies that this is a unique brand of study. There is a need to understand the problems of environment and their solution and for this a general conception of science, commerce, arts, technology, law, medical science, computer etc. is essential.

Environmental study is called a multidisciplinary subject. In order to protect the world from destruction, the relationship among the different elements is necessary. Besides, it is also essential to know as to how to protect the environment. Environmental studies include all such subjects. That is why environmental studies can be called a multi-disciplinary subject.

1.5 RULES AND REGULATIONS OF ENVIRONMENTAL STUDIES AND PUBLIC AWARENESS

Problems arising out of the several conflicting processes among the environmental elements and human beings along with the instructions of environmental conservation are included in an environmental study. In fact, the environmental problems are caused by human activities. All the elements gifted by nature are considered essential

for human survival. But when natural resources are haphazardly used by man environmental problems are created. The human centric thoughts consider nature's gifts as man's exclusive domain. On the other hand, another school of thought, which is nature centric, considers nature as mother and lays emphasis on the conservation of nature. This kind of thought is beneficial to nature as well as to other living beings and this in a way helps to create a positive natural environment.

On the basis of these two contradictory schools of thoughts, –human centric and nature centric – some guidelines/principles are adopted to maintain sustainable environment, they are –

- Nature has given us all the necessary requirements for living. Therefore, it is our duty to love and care nature.
- We should consider each day a sacred day because on each day nature changes and this change of nature brings to us the advent of a new season.
- Considering man to be superior to other beings, man has no right to push other beings towards destruction.
- We should always be grateful to plants and other living beings because they provide us the necessary food for the sustainability of our life.
- Man should control the rapid rise in population because it causes an increasing burden for nature.
- We should not waste the rare resources for destructive purpose like creating deadly weapons.
- Instead of exploiting nature for use in our self-interest, we should try to protect the loss and damage caused to nature by excessive human interference.
- It is nothing but a futile attempt to escape from the complaint that we are not guilty for the deeds of destroying natural resources.
- Our future generation should not suffer because of our exploitation of nature and that we should be conscious of this fact.
- Limited resources of nature should be enjoyed equally by all and they should be used in a limited or economical way.
- **Public Awareness:** Conservation of environment is related to public co-operation and if public cooperation is missing then neither any government nor any public organization can be successful in environmental development. Public co-operation is dependent on public awareness. It is not possible to solve environmental problems without public co-operation and their knowledge relating to environment. For instance, in the present context, the use of polythene and lack of knowledge as to how these polythenes create pollution and what are its impacts on society are some of the issues which demand general public attention. Only legal actions cannot solve these problems.

Instead of doing things that harm nature, man should feel the necessity to protect and conserve nature and to spread knowledge through environmental studies to solve the environmental problems.

Therefore, awareness for the protection of environment should be the main motto here of Environmental Studies

1.6 LET US SUM UP

- People have been conscious about environment since time immemorial.
- Scientific studies have been carried out on the impact of the living beings on environment and this kind of study was started in the year 1869. Earnest Hackle for the first time scientifically explained environmental studies.
- The importance of environmental studies cannot be denied and this subject is essential for law, medicine, science, commerce etc.
- The influence of environment can be seen in all aspects of our life and work and therefore it is essential to have some knowledge about this subject. Our education is incomplete without this knowledge.
- More pollution will create more danger to the lives of the living beings. Therefore it is necessary for all living beings to conserve environment in order to sustain.
- It is not the sole duty of the government to protect environment. In order to protect nature, all human beings should come together and act towards it. Therefore, it is important to create awareness among the general public for a clean and healthy environment by protecting its resources.

1.7 FURTHER READING

2. Asthana, D. K. & Meera A. (2012). A Textbook of Environmental Studies.New Delhi: S. Chand and Company Ltd.
3. Bharucha, E. (2004). A Textbook of Environmental Studies. New Delhi:UGC.
4. Kaushik, A. & Kaushik, C. P.(2006). Perspectives in EnvironmentalStudies. India: New Age Publications (Academic).

1.8 POSSIBLE QUESTIONS

VERY SHORT ANSWER QUESTIONS

1. What do you mean by Environmental studies?
2. How can pollution be controlled through environmental studies?

SHORT ANSWER QUESTIONS

1. Explain the importance of rules and principles of Environmental studies.
2. Explain the importance of Environmental studies in the present context?

LONG ANSWER QUESTIONS

1. Environmental studies being a multidisciplinary subject, mention the other subjects which have relation with it. Explain.
2. What is the role of Environmental studies in the conservation of biodiversity?

UNIT-2 THE ENVIRONMENT

Structure

2.1 LEARNING OBJECTIVES

After studying this unit, you will be able to:

- define environment;
- describe the various components that make the environment;
- distinguish between natural and man-made environment;
- recognize the significance of the environment for life's proper functioning; and
- Understand the concept of biosphere and its functional unit − the ecosystems.

2.2 INTRODUCTION

The Earth is the only planet known to support life as we know it. It supplies us with all the resources, the materials we use and the food that we eat or drink. All living organisms have a specific surrounding or medium with which they continuously interact, from which they derive sustenance and to which they are fully adapted. This surrounding is their environment.

An understanding of the environment requires that we know what makes up the environment, and what its limits are and why is a scientific study of the environment important. In the natural world where we all live on the planet Earth, life is confined to a very thin sphere around the globe where conditions for sustenance are favorable. Anywhere below or above this layer conditions become limiting. In introducing the environment we familiarize you with the various components of the environment and their interaction that make the functional units. You will come to appreciate the interdependence of various components of the environment as you proceed along this course.

2.3 CONCEPT OF THE ENVIRONMENT

Prior to 1950s, for most people the term environment meant the set of conditions at home or in their work places. In the years that followed, with the publication of Rachel Carson's landmark book "Silent Springs" (1960) as well as the occurrence of major environmental events such as the spilling of oil along the picturesque northern coast of France, the death of fish and other organisms in thousands in Swedish lakes due to long range air pollution and the much publicized threats of extinction of many species, the concept of the environment gained widespread acceptance.

Today the environment is widely accepted as a major issue for the very survival of humans and other life forms the world over with serious social and political ramifications. It is realised that a concern for the environment is an integral part of the overall process of development and economic growth. This issue is particularly important for developing nations, which need to keep promoting economic activities in order to improve the living standards of their people.

At present there are three points on which there is general agreement with regards to the environment:

- The environment is a common concern for both industrial and developing countries although problems resulting from poverty and affluence are different.
- The solution of environmental problems can only be achieved through international cooperation.
- Integration of economic growth and environmental protection must be done according to the sustainable development approach.

Although the importance of certain environmental issues may change with time, the principles governing the underlying biological and physical systems do not change. Hence, the basic ecological concepts need to be understood too, for Ecology deals with the interactions between the organisms and their environment.

Let us now examine what we mean by the environment in scientific terms. You are aware that no organism can exist in isolation, without interacting with other organisms and its physical influences like light, moisture, temperature soil etc., in very broad terms we can say its environment or surroundings. **Thus we can define environment as the sum total of living and non-living components, influences and events surrounding an organism.** The living components are called the **biotic** components while the non-living are called **abiotic** or physical components (Table 2.1). However, it is important to understand that the living and physical components are intimately interwoven and interdependent, they cannot be looked upon in isolation and we classify them in separate categories only for convenience.

For example, the Earth as a planet has been profoundly altered by the life that inhabits it. The Earth's air, oceans, soils and sedimentary rocks are very different from what they were before the evolution of life. In many ways, life helps control the makeup of air, oceans and sediments.

Table 2.1 Components of the environment

Abiotic	Biotic
Light (Energy, Radiation)	Microbes
Atmospheric gases and wind	Plants
Temperature and heat flow	Animals
Water	(including human beings)
Gravity	
Topography	
Geological Substratum	
Soil	

The physical components set the condition for the survival of the biotic components which in turn take care of the maintenance of the environment. Thus linkages among components of the environment are pathways for the flow of energy and cycling of materials For example, green plants obtain essential resources from the physical realm − water and minerals from the soil, carbon dioxide from the atmosphere and light energy from the sun, and manufacture their food. Animals depend on plants and other animals for their source of food. We in turn harvest the land and the seas for our food; obtain minerals, fuel from the Earth's crust. We will learn more about these later in this course.

2.4 TYPES OF ENVIRONMENTS

Recall the definition of the environment, and consider a fish living in a natural pond. Its **external environment** will be the water in the pond which it primarily inhabits.

The water would contain nutrients, oxygen and other organisms that the fish requires to sustain its life. As opposed to the external environment, the body cavity within the fish provides an **internal environment** quite separate from the outside environment. The body surface acts as an exchange barrier between the internal and the external environment of the fish. The internal environment is relatively stable as compared to the external environment. However, illness and injury or even environmental stress can upset it. But when the cause of the upset is removed, the internal environment comes back to its original condition.

The pond which the fish inhabits is a **natural environment**. The abiotic factors of the pond, like light, temperature, depth, nutrients, and dissolved gases will provide the life supporting chemical and physical factors for the fish. The other living organisms inhabiting the pond, like bacteria, insects, worms, Mollusca, tadpoles, frogs, submerged vegetation etc. could be food for the fish. Examples of such natural environments on land include forests, grasslands, savannah, deserts, etc. In any of these natural environments the climate, physiological, edaphic (soil-related) and biotic factors interact with each other and influence the life forms. So far we have discussed only the natural environment but there are several components of environment which are created by humans, like crops fields, cities, industrial spaces etc. (Fig2.1andTable 2.1). These are places made artificially by humans through planned manipulation. For example, let us consider a city. The city environment is totally created by human beings. One of the most important components − water is not taken from streams directly but is first filtered, purified and used for drinking and other municipal purposes. The metabolic waste and garbage are not disposed off locally but are carried for treatment or dumping to a remote place, away from the city. Food for the people in cities often comes from rural areas.

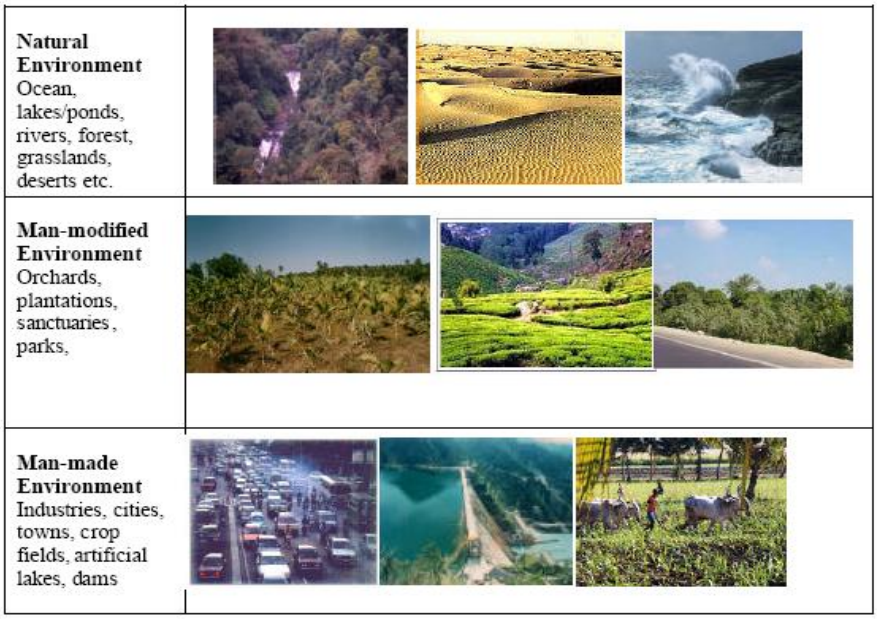


Fig.2.1: Examples of different types of environment

An environment made by humans results in the consumption of excessive amounts of materials and energy necessitating care, supervision and management, and often interferes with the natural environment.

Significance of the environment for life

Whatever type of environment organisms inhabit, they all need life supporting elements for their survival. These include air that they breathe, food and water they take in, and shelter either as natural enclosures (like caves and tree holes) or as artificial dwellings (like houses). Environment is the only source that provides these life supporting elements.

We make use of the land for cultivating crops. Soils provide nutrients needed for the growth of plants. The land form determines the soil types found in any one area and soil itself varies from place to place. Some soils are rich in nutrients and others are lacking in them. The soils lacking nutrients need the addition of fertilizers. Climate and short term weather changes are characterized mainly by wind, temperature, pressure and rainfall and are determined by the properties of the atmosphere. Air in the atmosphere provides living organisms with oxygen, without which survival of most of the living organisms will be threatened.

From the above description you have learnt about the concept of the environment, the different types of environments and about the significance of the environment for life. Next we will find out where these environments exist on planet Earth.

SAQ 1 Define the environment and explain the difference between external and internal environment.

2.5 CONCEPT OF BIOSPHERE AND ECOSYSTEM

The relatively thin zone of air, soil and water where life exists is known as the biosphere. It extends from the depths of the oceans to about 10 km high up in the atmosphere and includes all the rivers, lakes, ponds as well as the solid sediments that exchange material with living beings. Life in this zone depends on the Sun's energy and on the circulation of heat and essential nutrients. The only exceptions are the life forms found in the deep-sea hydrothermal vents that depend on the energy from the Earth. This energy is used and given off as materials are recycled. Since living organisms need essential elements for survival like air, water and land, the biosphere includes parts of the atmosphere, hydrosphere and lithosphere (Fig.2.2).

When the concept of the biosphere was first proposed it was considered to be the Earth's integrated living and non-living life supporting system. Although it was proposed as early as 1920, by the Russian scientist Vladimir Ivanovich Vernadsky

(1868-1945) it was only in the recent times that it has been widely adopted and used. The integration of living organisms and the non-living life supporting system mentioned in the concept of the biosphere has occurred in many ways. For instance, the biosphere

- contributes to the global energy system;
- affects rates and patterns of weathering within the lithosphere;
- plays an important role in the water cycle;
- links the lower atmosphere (troposphere) with the lithosphere;
- Provides a vehicle for the transfer of chemicals via the bio-geochemical cycles.

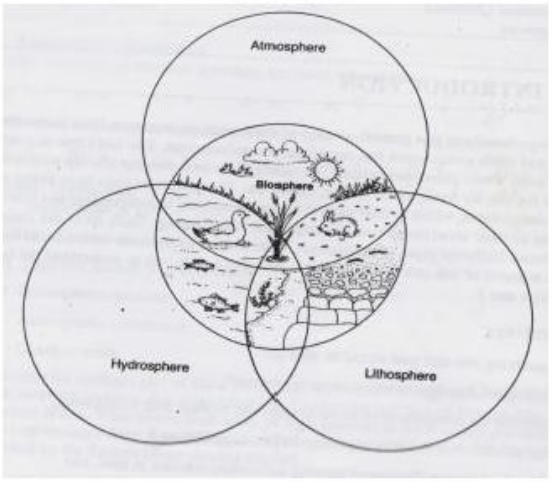


Fig.2.2: Idealized scheme of the biosphere in relation to atmosphere, hydrosphere and lithosphere. The area of contact and interaction between these components is important for life, for it is here that the basic processes of life like photosynthesis and respiration occur

You will come to know more about the above processes in later units.

Originally the concept of the biosphere was applied to the Earth's surface where plants and animals made their home. In recent times the biosphere has been extended by Gaia hypothesis to include parts of the atmosphere and subsurface geology that were previously thought of as non-living.

For centuries scientists have viewed the Earth and its environmental systems as a sort of mechanical machine, driven by physical forces like volcanoes, rock weathering and the water cycle. It was clear that organic activities played an important role in some environmental systems, such as the biogeochemical cycles. However, until quite recently biological factors were seen as secondary to physical and chemical ones.

A revolutionary new theory was put forward by James Lovelock in 1970s. He called it the Gaia hypothesis, after the Greek Earth goddess. The theory was revolutionary because it treated the Earth as a single living organism, in which the biological, chemical and physical factors played important roles. Lovelock argued that the Earth's living and nonliving systems form an inseparable whole, regulated and kept adapted for life by living organisms themselves. He sees Gaia as a complex entity involving the Earth's biosphere, atmosphere, oceans and soil and constituting a feedback system which seeks an optimal physical and chemical environment for life on this planet. However, Lovelock regarded the biosphere as a "single organism" (called a super organism by some scientists).

Looking closely at plants and animals in the biosphere, naturalists observed groups of plants and animals in the biosphere arranged in an orderly manner. Two concepts emerged from their observations which led to the use of the term **"ecosystem"** to describe the complex interactions between living organisms and their non-living surroundings.

The first concept was that plants and animals formed a natural association, each with distinctive members. Just like morphological data allowed systematics to assign species to a hierarchy of taxonomic groups, detailed studies of the ecological distributions of plants led to the classification of biological communities.

The second concept was the realization that organisms are linked, both directly and indirectly by means of their feeding relationships. Arising from these, the concept of the ecosystem was formulated. A system is a collection of interdependent parts that function as a unit and involve inputs and outputs. An ecosystem represents the sum of all natural organisms and the non-living life supporting substances within an area. It was considered as an open system with a series of major inputs and outputs and these effectively "drive" the internal dynamics of the system.

The ability to recognize distinctive ecosystems in the biosphere gave ecologists a convenient scale with which to consider plants and animals and their interaction. This is because it is more localized and thus more specific than the whole biosphere. A variety of natural ecosystems are found in the biosphere and you will come to know about them, their components and their functioning in later units.

SAQ 2

What is the Gaia Hypothesis?

2.6 ENVIRONMENT

Normally environment means geographical and related conditions surrounding a given cluster of people. Thus, it includes land and land farms of the region, water, plants, animals and other living organisms, and the interfaces and situations arising due to their natural interactions.
Components of Environment

The environment, as mentioned already, has the following four components:

1. Atmosphere
2. Hydrosphere
3. Lithosphere
4. Biosphere

Each component has its special role to play on this globe, especially with reference to sustaining all life forms in harmony with the rhythm of nature. This rhythm is fundamental to all sustainable development.

2.6.1 Atmosphere

- Oxygen for human respiration (metabolic requirements).
- Oxygen for wild fauna in natural ecosystems and domestic animals used by man as food.
- Oxygen as a part of carbon dioxide, used for the growth of plants (in turn are used by man).

The atmosphere forms a protective shell over the earth. The lowest layer, the troposphere, the only part warm enough for us to survive in, is only 12 kilometers thick. The stratosphere is 50 kilometers thick and contains a layer of sulphates which is important for the formation of rain. It also contains a layer of ozone, which absorbs ultra-violet light known to cause cancer and without which, no life could exist on earth. The atmosphere is not uniformly warmed by the sun. This leads to air flows and variations in climate, temperature and rainfall in different parts of the earth. It is a complex dynamic system. If its nature is disrupted it affects all mankind. Most air pollutants have both global and regional effects.

Living creatures cannot survive without air even for a span of a few minutes. To continue to support life, air must be kept clean. Major pollutants of air are created by industrial units that release various gases such as carbon dioxide, carbon monoxide and toxic fumes into the air. Air is also polluted by burning fossil fuels. The buildup of carbon dioxide which is known as ‘greenhouse effect’ in the atmosphere is leading

to current global warming. The growing number of scooters, motorcycles, cars, buses and trucks which run on fossil fuel (petrol and diesel) is a major cause of air pollution in cities and along highways.

Air pollution leads to acute and chronic respiratory diseases such as various lung infections, asthma and even cancer.

2.6.2 Hydrosphere

- Clean water for drinking (a metabolic requirement for living processes).
- Water for washing and cooking.
- Water used in agriculture and industry.
- Food resources from the sea, including fish, crustacea, sea weed, etc.
- Food from fresh water sources, including fish, crustacea and aquatic plants.
- Water flowing down from mountain ranges harnessed to generate electricity in hydroelectric projects.

The hydrosphere covers three quarters of the earth's surface. A major part of the hydrosphere is the marine ecosystem in the ocean, while only a small part occurs in fresh water. Fresh water in rivers, lakes and glaciers, is perpetually being renewed by a process of evaporation and rainfall. Some of this fresh water lies in underground aquifers. Human activities such as deforestation create serious changes in the hydrosphere. Once land is denuded of vegetation, the rain erodes the soil which is washed into the sea.

Fig.2.3

Chemicals from industry and sewage find their way into rivers and into the sea. Water pollution thus threatens the health of communities as all our lives depend on the availability of clean water. This once plentiful resource is now becoming rare and expensive due to pollution.

2.6.3 Lithosphere

- Soil, the basis for agriculture to provide us with food.
- Stone, sand and gravel, used for construction.

- Micronutrients in soil, essential for plant growth.
- Microscopic flora, small soil fauna and fungi in soil, important living organisms of the lithosphere, which break down plant litter as well as animal wastes to provide nutrients for plants.
- A large number of minerals on which our industries are based.
- Oil, coal and gas, extracted from underground sources. It provides power for vehicles, agricultural machinery, industry, and for our homes.

The lithosphere began as a hot ball of matter which formed the earth about 4.6 billion years ago. About 3.2 billion years ago, the earth cooled down considerably and a very special event took place - life began on our planet. The crust of the earth is 6 or 7 kilometers thick and lies under the continents. Of the 92 elements in the lithosphere only eight are common constituents of crustal rocks. Of these constituents, 47% is oxygen, 28% is silicon, 8% is aluminum, 5% is iron, while sodium, magnesium, potassium and calcium constitute 4% each. Together, these elements form about 200 common mineral compounds. Rocks, when broken down, form soil on which man is dependent for his agriculture. Their minerals are also the raw material used in various industries.

2.6.4 Biosphere

- Food, from crops and domestic animals, providing human metabolic requirements.
- Food, for all forms of life which live as interdependent species in a community and form food chains in nature on which man is dependent.
- Energy needs: Biomass fuel wood collected from forests and plantations, along with other forms of organic matter, used as a source of energy.
- Timber and other construction materials.

This is the relatively thin layer on the earth in which life can exist. Within it the air, water, rocks and soil and the living creatures, form structural and functional ecological units, which together can be considered as one giant global living system, that of our Earth itself. Within this framework, those characterised by broadly similar geography and climate, as well as communities of plant and animal life can be divided for convenience into different bio-geographical realms. These occur on different continents. Within these, smaller bio-geographical units can be identified on the basis of structural differences and functional aspects into distinctive recognizable ecosystems, which give a distinctive character to a landscape or waterscape. Their easily visible and identifiable characteristics can be described at different scales such as those of a country, a state, a district or even an individual valley, hill range, river or lake.

The simplest of these ecosystems to understand is a pond. It can be used as a model to understand the nature of any other ecosystem and to appreciate the changes over time that are seen in any ecosystem. The structural features of a pond include its size, depth and the quality of its water. The periphery, the shallow part and the deep part of the pond, each provide specific conditions for different plant and animal communities. Functionally, a variety of cycles such as the amount of water within the pond at different times of the year, the quantity of nutrients flowing into the pond from the surrounding terrestrial ecosystem, all affect the 'nature' of the pond.

2.7 WHY SHOULD WE BE CONCERNED ABOUT THE ENVIRONMENT

Why is there so much concern about the environment today? The answer is simple; our very existence depends on the conservation or well being of the environment. The unprecedented population growth and economic progress of the 19th and 20th centuries have expanded our demands on the environment. However, today the whole world particularly the developing countries are facing a near-crises situation regarding the environment.

Perception of environmental concerns differs with different societies. What some people may consider to be a serious problem may be the solution for a different problem. For example, if a factory is set up in a village, the villagers might be happy because as it provides more jobs for the local population's economic growth. While some others may feel that the setting up of the factory would pollute the environment, generate more waste and decrease the standard of living.

However, broadly there are three prevailing viewpoints regarding the environmental concerns:

1. The environmental concern is a conspiracy of the developed First World against progress in the Third World and that environment will become an issue of importance only when the underdeveloped countries reach the levels of production and consumption of the industrialised nations.
2. The second viewpoint argues strongly that the emphasis on preserving for instance, the tiger and the aesthetic beauty of green belts is diverting the attention from the problems of the poor and that environment has nothing to do with providing a better deal to the large and ever-growing population.
3. The third, in a paradoxical turn, holds this very same, large and ever-growing population responsible for the environmental crisis, maintaining that there is too little of everything except people.

The three different views illustrate how little we know of ecosystems and Eco balance. Let us examine each of these views briefly.

The first view is that environmental concerns are the business of rich countries which cause most of the pollution. But environment and development are not necessarily incompatible. The mistake made by developed countries can be avoided if proper developmental strategies are worked out. Further, there is no division such as the environment of developed countries and that of developing countries. Degradation of the environment is going to affect each of us irrespective of the country, region or area. An example is the Chernobyl disaster which has the potential to affect a total of Thousands of human and animal lives and devastate large areas of land within and outside the former Soviet Union.

Fig.2.4: Chernobyl and its effect on human beings (Source:ohamill.netfirms.com/chernobyl.htm and http://www.cems.alfred.edu/students/wirkuscp)

Proponents of the second viewpoint would prefer development to improve the lot of the poor at the cost of environmental conservation. But in this model the poor will get the worst of everything, including the effects of pollution resulting from industrialization and urbanization. We had a burning example of this in Bhopal tragedy in which thousands of the poorest of poor people died. The poor are worst affected by impure drinking water, unsanitary living conditions, disease and so on.

The point raised in the third viewpoint that population pressure leads to environmental degradation is an old one. The problem is not so much of the poor destroying the environment by their sheer numbers as that they are deprived of their share in the distribution of resources. It should, therefore, be clear that there are factors other than poverty and population which are responsible for the pollution on the Earth.

You must understand that environment is not just pretty trees, threatened plants, animals and ecosystem. It is literally the entity on which we all subsist, and on which the entire agricultural and industrial development depends. Development without

concern for the environment can only be short term development often causing enormous environmental degradation apart from human suffering, increased poverty and oppression. With these few words of caution, we summarise the contents of this unit.

2.8 LET US SUM UP

- The concept of environment is the surrounding of an organism, including its life supporting physical and biological factors.
- The different types of environments include external environment, internal environment of an organism and the natural and manmade environment in which the species survive.
- Biosphere is the region on the Earth where all living organisms survive. An ecosystem is the basic functional unit in nature, defined by ecologists. Ecologists help to understand the complex relationships between living organisms and their surroundings.
- Human beings in search of food shelter and material comfort affect the environment either advertently or inadvertently. The impact of the human society has multiplied over last several hundred years.

2.9 FURTHER READING

1. The Environment − Principles and Applications by Chris Park.
2. Human Environment Block 1 IGNOU publication.

2.10 POSSIBLE QUESTIONS

1. Define the terms environment, biosphere and ecosystems.
2. Describe the concept of biosphere.
3. Discuss the significance of the environment to living organisms.

UNIT-3 ECOLOGY AND ECOSYSTEM

Structure

3.1 LEARNING OBJECTIVES

After you have studied this unit you would be able to:

- define and use in the proper context terms such as ecology, environment and ecosystem
- outline the development of the discipline of ecology, ,
- describe the three main subdivisions of ecology, namely autecology, synecology and habitat ecology,
- show with the help of a diagram the interrelationship between ecology and other biological disciplines,
- describe an ecosystem, its types and structure,
- get an idea about the productivity of the ecosystem, its elements
- and its trophic structure,
- acquire knowledge about food chain and food web, and how it is helpful to us

- discuss energy flow in an ecosystem
- get a comprehensive idea about the ecological pyramid and its
- different types,
- Discuss the important ecosystems.
- Define and use in proper context the term biogeochemical cycle and explain the Importance of the concept.
- distinguish between gaseous and sedimentary cycles,
- Outline the course of carbon, nitrogen.

3.2 INTRODUCTION

You have already been introduced to the concepts of environment, ecology, ecosystem, energy flow and nutrient cycling in the foundation course on Science and Technology. As you are aware ecology is the scientific study of the reciprocal relationship between organisms, including microbes, plants, animals as well as man, with their environment. It deals with the ways in which organisms are moulded by their environment, how they make use of environmental resources including energy flow and mineral cycling. Everything that surrounds or affects an organism during its life time is collectively known as its environment ' which comprises both living (biotic) and nonliving (abiotic) components. The extinction of, many plant and animal species, pollution of the environment and population explosion are some of the major ecological problems affecting the balance of nature on a global scale. In order to manage the earth and its life support systems, it is thus imperative to understand its ecological processes.

In this unit, which is the first unit of the ecology course, we will begin by briefly explaining some of the basic terms and concepts of ecology. We shall then discuss the comprehensive definition, history, scope and the various branches of ecology. Besides, we will also describe the basic features of ecosystem structure and function.

3.3 ECOLOGY

3.3.1 Definition

Very often a word has a precise well-defined meaning in scientific literature but is loosely used in everyday language. It is, therefore, necessary for you to be clear about a few concepts and definitions before we begin the study of ecology.

Ecology is a familiar term today. Although ecological studies have been going on for many years, however, it is only recently that people have become aware of ecology as a part of their daily life. These days' newspapers and magazines provide ample space to highlight the nature and the consequences of man's impact on nature -

deforestation, soil erosion. The Bhopal gas tragedy, the Chernobyl disaster, ozone hole, global warming and many other problems. Public outcry about such problems clearly emphasises the relevance of ecology for our society. Ecology is now a well-developed branch of science having increasing importance to human welfare and survival.

The term ecology was coined only as late as 1868. It has been derived from two Greek words namely, '**Oikos**' meaning home or estate and '**logos**' meaning study. Literally it means the study of the home or household of nature. Ecology is defined 'as the scientific study of the relationship of the living organisms with each other and with their environment.'

Ecological studies are aimed to understand the relationships of organisms with their environment. This could be best achieved by extensive field observations and experimental studies to verify the field observations.

3.3.2 History of Ecology

The roots of ecology lie in Natural History, which is as old as human civilization itself. As a matter of fact man indulged in ecology in a practical sort of way, though unknowingly, since early history. In primitive societies every individual was required to have intimate knowledge of his environment for survival, i.e., of the forces of nature and of plants and animals around him. Primitive tribes, which were dependent on hunting, fishing and food gathering needed detailed knowledge of their environment to obtain their sustenance. Later, the adoption of settled agricultural life further stressed the need to learn practical ecology for the successful domestication of plants and animals.

Our ancient Indian texts are full of references to ecological principles. The classical texts of the Vedic period (1500 BC-600 BC) such as the **Vedas**, the **Samhitas**, the **Brahmans** and the **Aranyakas-Upanishads** contain many references to ecological concepts.

The Indian treatise on medicine, the **Caraka-Samhita** (1st Century AD4th Century AD) and the surgical text **Susruta-Samhita** (1st Century AD-4th Century AD), show that people during this period had a good understanding of plant and animal ecology. These texts contain classification of animals on the basis of habit and habitat, land in terms of nature of soil, climate and vegetation; and description of plants typical to various localities**. Caraka- Samhita** contains information that air, land, water and seasons were indispensable for life and that polluted air and water were injurious for health.

Similar awareness of ecological issues was prevalent in Europe in the 4th Century BC. The early Greek philosophers were well aware of the importance of environmental studies. Hippocrates in his work **'On Airs, Waters and Places'** stressed the need for ecological background for medical students, as he emphasized the effect of water, air and locality on health and diseases in man. Aristotle classified animals on the basis of habit and habitat.

Theophrastus (370-250 BC) was the first person to introduce ecological approach long before the term ecology was coined. He studied plant types and forms in relation to altitude, moisture and light exposure.

After a gap of several centuries European naturalists made significant contribution to ecological thinking. The French Naturalist Georges Buffon (1707-1788) in his book Natural History (1756) made a serious attempt to systematise the knowledge concerning the relation of animals to environment.

In the early eighteenth century Anton-van Leeuwenhoek (1632-1723), the micro scopist, pioneered the study of food chain and population regulation which have grown into the major areas of modern ecology.

It was Hanns Reiter who in 1868 appears to have coined the term 'ecology' by combining the two Greek words Oikos (home) and Logos (study). However it was the German biologist Ernst Haeckel (1866- 1870) who for the first time elaborated the definition of ecology as follows:

> "By ecology we mean the body of knowledge concerning the economy of nature - the investigations of the total relations of animal both to its inorganic and to its organic environment; including above all, its friendly and inimical relation with those animals and plants with which it comes directly or indirectly into contact - m a word, ecology is the study of all the complex interrelations referred to by Darwin as the conditions of the struggle for existence."

A few years earlier to Haeckel, the French zoologist Isodore Geoffroy St. Hilaire and the English naturalist St. George Jacksom Mivart had proposed the terns "ethology" and "hexicology" respectively, which are almost similar to 'ecology'. A British zoologist Charles Eton (1 927) in his pioneering book "**Animal Ecology'** defined ecology as scientific natural history.

The concept of community in ecology was applied by Karl Mobius (1877) to animals. Whereas Forbes (1887). Warming (1909). Cowles (1899), Clements (1916) and many others made notable contributions to the study of plant and animal communities.

The concept of 'population' and its several related aspects developed in the early part of the twentieth century. Mathematical techniques were used for understanding community ecology. These mathematical and statistical methods have since been applied for an understanding of population dynamics.

In 1935 a distinguished British botanist, Sir Arthur Tansley introduced the concept of the ecosystem or ecological system. This was a major development in the history of ecology.

The concept of ecosystem along with the ideas on the trophic-dynamic aspect 6f community developed by Lindeman (1942), and biogeocoenoses by Sukachev (1944) stimulated investigations on the organism - environment complex from a holocoenotic standpoint and led to a major breakthrough in the progress of ecology. Recently, an American ecologist Eugene P Odum (197 1) has defined 'ecology as the study of the structure and function of nature'.

In India, ecological studies began as elsewhere with the descriptive phase at the end of the nineteenth century. Descriptive accounts of the forests were prepared by the forest officers (1875-1929). However, the first comprehensive ecological contribution was made in 1921 by Prof P. Dudgeon of Allahabad University who described the role of environment in the succession of communities.

By the 1940s there was sufficient ecological information of the descriptive and observational kind. There was now a need for precise determination of the behavior and distribution of plants (individually or in groups) in relation to specific environmental factors. This led to the experimental approach (1940- 1965). Extensive synecological studies were carried out on forest and grassland communities and autecological studies on trees, herbs and grasses under the guidance of Prof. R. Misra, who established a flourishing school of ecology at the Banaras Hindu University, by the 1960s.

In the early sixties the need for developing a better understanding of the structure and function of different ecosystems was considered necessary for the effective management of natural resources. Especially in view of the growing human population.

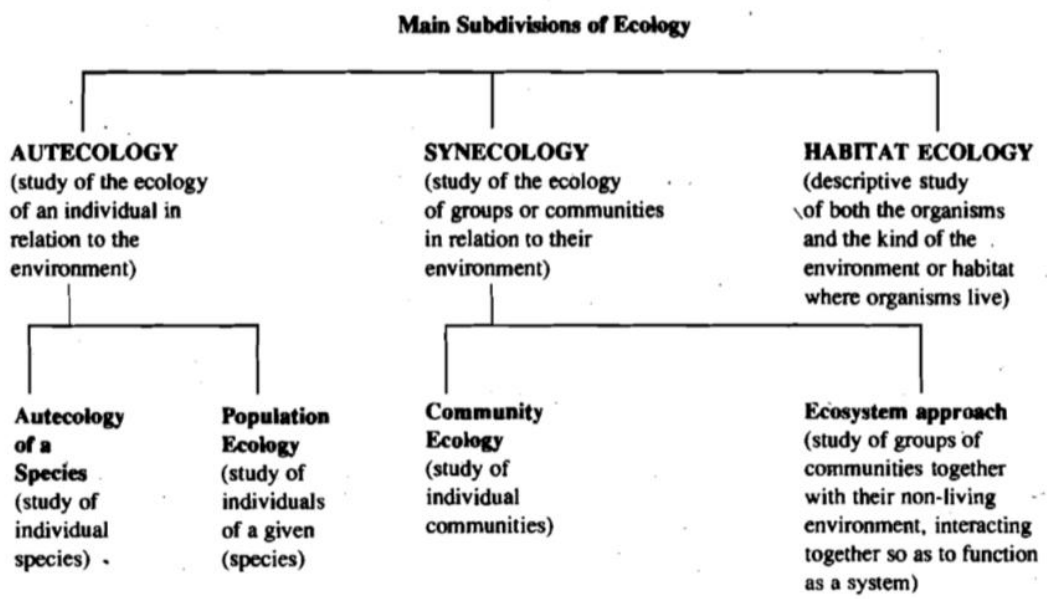
With this view, the International Biological Programme (IBP) was launched (1964-1974) with a focus on the biological basis of productivity and human welfare. Under the aegis of this programme, productivity of different terrestrial and aquatic ecosystems was evaluated apart from studies on human adaptability, conservation of ecosystem and the use of biological resources.

Much of the recent interest in ecology stems from the problems caused by rapid population growth and widespread deterioration of environment due to pollution of air, soil and water. Ecological studies are now increasingly geared to promote conservation and rational utilization of natural resources through international efforts such as Man and Biosphere Programme of UNESCO (MAB), United Nations Conference on Human Environment held at Stockholm in 1972, United Nations Environment Programme (UNEP), International Union for Conservation of Nature and Natural Resources, (IUCN) and World Wide Fund for Nature (WWF). The science of ecology has much to contribute in solving the problems of environment.

3.3.3 Subdivisions of Ecology

Ecology was earlier divided into plant and animal ecology. However, modem ecology does not make any such distinction since plants and animals are intimately interconnected and interdependent amongst themselves and on their environment.

The three main subdivisions of ecology today are given below: i) Autecology, ii) Synecology, iii) Habitat ecology.



i) **Autecology**: It is the study of individual species or individuals in relation to the environment. There are two approaches to autecological studies (a) **autecology of species** where individual species are studied (b**) population ecology** where individuals of the same species are studied.

ii) **Synecology**: It is the study of the community of living organisms as a unit. The difference between autecology and synecology could be explained by the following example. If a neem tree (or several neem trees) or a crow (or several crows) are studied in relation to the environment then this would be an autecological study. However, if the study deals with a forest

community as a whole in which many different buds, trees and animals share the same area, then it would be called a synecological approach.

Synecological studies can be of two types. a) **Community ecology** is concerned with the study of biotic (living) community comprising of interdependent plants and animals in a particular area, b) ecosystem ecology which is a recent development in ecology. It deals with the community of living organisms and their environment as an integrated unit of nature.

iii) **Habitat ecology**: It is the study of the habitat or environment of organisms and its effect on the organisms. In this approach different types of habitats such as terrestrial, fresh water, marine, and estuarine are the focus of study.

3.3.4 Relationship of Ecology with Other Disciplines of Biology

In order to understand the scope and relevance of ecology let us consider its position in relation to other biological disciplines, with the help of a diagram in the shape of a cake see Fig 1.1.

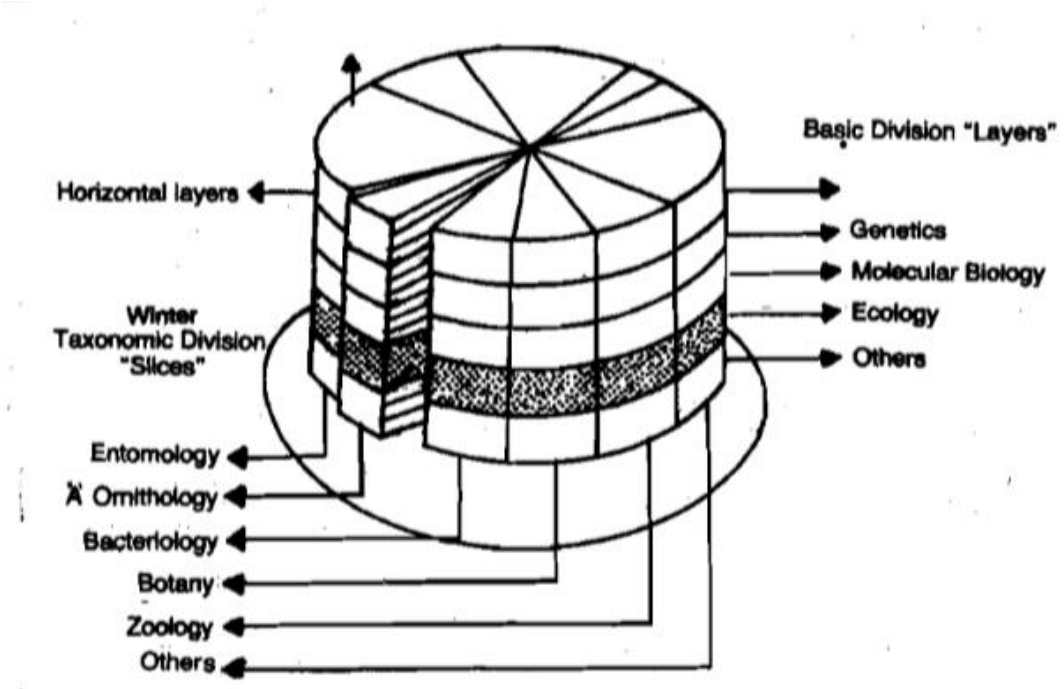


Fig 3.1: The layered biological cake showing the relationship d ecology with other biological disciplines.

This hypothetical biological cake has several horizontal layers representing the 'basic' divisions of biology, common to all organisms - morphology, physiology, genetics, ecology, evolution, molecular biology, developmental biology etc. These horizontal layers are divided vertically into unequal 'taxonomic slices' of biology as well. Each such slice is labelled by the specific kinds of organism. The thicker slices represent large divisions of biology and are labelled Zoology, Botany, and Bacteriology etc. The thinner slices are labelled a Phycology, Ornithology, and Protozoology as they deal with specific type of organisms.

Let us consider slice 'A', i.e. ornithology - the study of birds. This slice with its horizontal layers of molecular biology, developmental biology, genetics, ecology etc. indicates that there are different approaches to the study of birds. The approach may be molecular or ecological, or of any other type, or a combination of two or more approaches. The 'biological cake' analogy helps us appreciate that ecology is a basic division of biology.

It is often important to restrict work to certain taxonomic species or groups because different kinds of organisms require different methods of study. For example, one cannot study pigeons and bacteria using the same methods. However, the modem ecological principles have provided many unifying concepts such as energy flow, nutrient cycling and population dynamics for comparing diverse ecosystems.

3.4 ECOSYSTEM

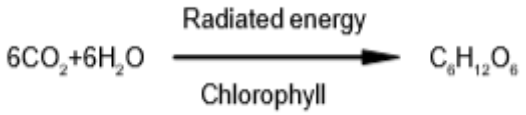
The term ‘ecosystem’ (Greek: Eco-environment, system: action: reaction or interaction and inter dependence) was first used by A.G. Tansley in 1935. Russian ecologist Sukachev defined it as Biogeocoerosis in 1944. The intermingling of the organic and inorganic elements in the environment is called the ecosystem. The chemical cycle through which energy flows to the bio-diversity, food chain and material cycle etc. help create action and reaction within the intermixture. This is called ecological system. According to Odum (1963), ecosystem is the main active unit of ecology.

- **Types of Ecosystem:** There are different types of ecosystems in our environment. These are:
    - Natural and Permanent Ecosystem: This ecosystem becomes effective in a natural environment without human interference. This system is of two types –
        - Terrestrial Ecosystem: This system is effective on land, e.g. grassland ecosystem, desert ecosystem and forest ecosystem.
        - Aquatic Ecosystem: This system is effective in water. It is of two types:

i. Freshwater Ecosystem: This works in streams, ponds and lakes.
ii. Marine Ecosystem: This works in seas, oceans and bays.

- Temporary and Natural Ecosystem: This system is effective in a natural environment, but it is temporary and dependant on rainfall.
- Artificial or Manmade Ecosystem: These are created by man, e.g. croplands, space ecosystem, fisheries etc. The aquarium in the drawing room is also one type of artificial ecosystem.

- **Structure of Ecosystem:** The main factors of the ecosystem are the biotic and abiotic elements.
  - Biotic Factors: All living beings within an ecosystem are included in the biotic factors. These biotic factors are of two types depending on the mode of nutrition.
    - Autotrophic Factors
    - Heterotrophic Factors
    - Autotrophic Factors: These include green plants, photosynthetic bacteria and cyanobacteria. These organisms can produce their own food through the use of abiotic elements like CO_2 and H_2O during photosynthesis. So, these factors can be called producers. The autotrophic factors include grass, shrubs, trees and microscopic phytoplankton.



    - Heterotrophic Factors: The living beings included in these factors cannot produce their own food, and consume only pre-produced biotic food or else break down complex biotic compounds. Therefore, these factors are called consumers. Depending on their shape, the heterotrophic beings are divided into two types.

They are –

a) Macro Consumers: Those animals which consume the producers either directly and indirectly are called macro consumers. These animals can be divided into four types—

i) Primary Consumers: Animals like cows, buffaloes, goats, deer, rabbits, and horses etc. which directly consume plants are called primary consumers. These animals are also called herbivores.

ii) Secondary Consumers: Animals like fox, wild cats, snakes, carnivorous fish, frogs, toads, centipedes etc.live by feeding on herbivorous animals.

iii) Tertiary Consumers: Those animals which feed on secondary consumers for survival are called tertiary consumers. E.g. wolves.

iv) Quaternary Consumers: Lions, tigers etc. live by feeding on tertiary consumers. These are called quaternary consumers.

b) Micro Consumers: There are certain living organisms in the environment which decompose dead plants and biotic compounds. They feed upon some of these matters and return the abiotic compounds to the environment. These organisms are called decomposers or detritivores e.g. bacteria, fungus. These organisms help in recycling matter.

- Abiotic Factors: Physico-Chemical factors are included in this category. These can be divided into three types –
  - Abiotic Matter: This includes carbon, nitrogen, carbon-dioxide, water etc. These are intimately related with the material cycle.
  - Biotic Compounds: Include carbohydrates, protein, lipids, nucleiacids etc. These are found in dead biotic matter.
  - Edaphic Factors: Climate, light, air, temperature etc. which are related to land are called edaphic factors.

- **Examples of Ecosystem (Fresh Water Ponds):** Fresh water ponds are a good example of ecosystem. Pond represents a fresh water ecosystem. The study of a pond gives a comprehensive idea of the structures and function of an ecosystem.
  - Abiotic Elements: Water, carbon dioxide, oxygen and its compounds, amino acids, humus etc. are the abiotic matters of the pond ecosystem. Adequate light, temperature and climatic conditions control the efficiency of the pond ecosystem.
  - Biotic Elements: Producers and different consumers are the biotic factors. The biotic matters found in ponds are—
    - Autotrophic Consumers: Spirogyra, oscillator arabina, flagmitos, potamgatonvelisner and ecocrinia are examples of autotrophic consumers.
    - Macro Consumers: Paramecium, daphnia Cyclops etc. are zooplanktons, worms etc. are primary consumers. Small fishes living in water and insects like dung beetles live by feeding on primary consumers. These together are called secondary

consumers. Comparatively, big fishes consume these small organisms. These living things which live by consuming secondary consumers are called tertiary consumers.

- Decomposers or Micro Consumers: The numerous bacteria and fungi which are found in muddy water are called micro consumers. The main function of the micro consumers is to decompose dead animals, plants and animal refuse and then to return the abiotic compound to the pond ecosystem. Therefore, they are called decomposers.

- Trophic Structure: The living organisms which derive energy from the same source are said to belong to the same trophic structure. The green plants which use the sun's energy to produce food – e.g..planktons, herbs, shrubs or trees etc.- are said to belong to the first trophic structure (T1). Herbivorous plants or primary consumers which depend upon the autotrophic producers for survival belong to the second (T2) trophic structure. Secondary consumers belong to the third (T3) trophic structure and the tertiary consumers belong to the fourth (T4) trophic structure. Quaternary consumers live in theT5 level, and the decomposers belong to the final or residual level in the structure. There can only be a few trophic structures in an ecosystem. This is because –
  - In moving from one place to another, there is a deficiency in the food energy.
  - The food is not used wholly
  - A huge amount of energy is used in breathing

3.5 FOOD CHAIN

In a trophic structure, the process of eating and being eaten among the living beings helps the food energy to flow in an orderly manner. This is called the food chain. The characteristics of food chain are as follows:

- Food is consumed frequently. The big animals consume the small animals for food.
- The solar energy flows from the sun to the producers and from the producers to the consumers in one direction.
- Each time energy is transformed, 80-90% of the static energy is radiated as heat energy.
- There can be four to five trophic levels in one food chain. It may be mentioned that 6 food chains can supply enormous energy.

- Food chain is always unidirectional
- The omnivores dominate more than one trophic structure in one food chain.

Food chains are of two types– Grazing Food Chain and Detritus Food Chain.

- **Grazing Food Chain:** As a primary source of energy the grazing food chain produces food through photosynthesis using the sun's rays, and thereby it creates the first trophic structure of the food chain. The primary consumers (herbivores) depend upon producer for survival and form the second level. On the other hand, the carnivores prey upon the herbivores.
  They are of many types. These food chains are long and they end in the decomposition level.

Figure 3.1 : Ideal Structure of Ecosystem

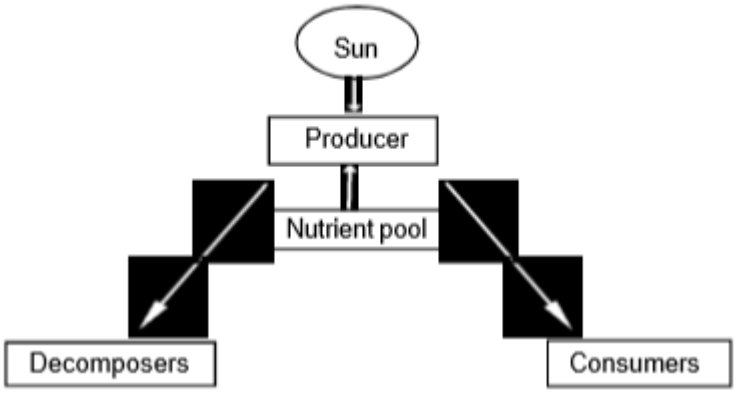


Table 3.1 : Food Chain

Types of Ecosystem	Producer	Herbivorous/ Carnivorous	Primary Carnivorous	Secondary Carnivorous	Tertiary Carnivorous
Grassland Ecosystem	Grass	Insect	Forg	Snake	Predatory Birds
	Grass	Rat/Mice	Sanke	Predatory Birds	
	Grass	Rabbit	Fox	Hyena	Lion
Pond Ecosystem	Phyto Plankton	Animal Plankton	Small Fish	Big Fish	Predatory Birds

- **Detritus Food Chain:** The dead mater is the primary source of energy of the detritus food chain. The fallen leaves and dead animals are the main sources of the dead biotic matter. Protozoa or unicellular organisms, bacteria, fungi etc are the primary consumers of decomposed matter. The insects and their larvae survive on decomposed matter. The detritus food chain is shorter than the grazing food chain

Table 3. 2 : Grassland Food Chain

Types of Detritus	Detrivores	Detrivore Consumers	Small Carnivorous	Big Carnivorous
Mangrove Fallen Leaf Dead Bodies	Fungi Bacteria Protozoa	Insect Larva Certain Crustacean Mollascs & Fishes	Fish Fry and Small Fish	Big size Fish and Fish Eating Birds

3.6 FOOD WEB

The food relationship among the different living beings in the biotic community is called the food web. There is a web-like connection among the different trophic levels in different food chains. This is called the food web or food cycle.

No plant or animal in an ecosystem can be free of the food chain. The inter-relationship among the three types of food chain, e.g. predatory food chain, parasitic food chain and necrophagous food chain, - forms the food web. Some of the characteristics of food web are –

- Food web gives direction to an alternative means. Even though a crop may be destroyed due to disease related causes, the animals which survive on them are not affected, because of the availability of alternative sources of food. An ecosystem remains stable if alternative sources of food are available.
- The probability of alternative sources in the food web obstructs the increase in the population of the highly productive species.
- The food web especially contributes to the development of the ecosystem. E.g. Terrestrial food web.

In a grassland ecosystem, the five probable food chains mutually connect, and create a food web.

1) Grass – grasshopper – predatory bird.
2) Grass – grasshopper, lizard – predatory bird
3) Grass – rabbit – predatory bird
4) Grass – mouse/rat – predatory bird
5) Grass – mouse/rat/snake – predatory bird

3.7 ENERGY FLOW

The main function of the ecosystem is energy flow. The energy flow is governed by two main laws of thermo-dynamics. The first law is that –energy can neither be produced nor be destroyed; it can only be transformed from one state to another. The second law affirms that some amount of energy is lost in transformation.

Leaves contain chlorophyll and therefore they are green in colour. Because of the presence of chlorophyll, the plants can produce their own food using the sun's rays during photosynthesis. The biotic community that sustains itself through photosynthesis is called the primary producers of the ecosystem. The average percentage of radiated energy is 1-5%. The plants utilize a part of this energy during breathing.

The main features of energy flow are –

- The energy from the sun to the producers, and from the producers to the different consumers in the food chain always flows in one direction. During energy transformation, 80-90% energy utilized in metabolic activities like respiration, excretion etc is lost as heat energy. This means that in the next trophic level, only 10-20% energy is realized.
- In thermodynamics, energy flow follows both the laws mentioned above.

For example–

- Lindaman (1942) through a fresh water ecosystem (a lake) has explained the model of unidirectional energy flow through a diagram, and has shown that autotrophic organisms utilize only 0.1% of the solar radiation during photosynthesis. Of the total production, 21%is used in metabolic activities, 63% in an unused state, 3% in decomposition and 13% is kept for herbivores. In case of herbivores, 30% is used in metabolic activities, 57% is left unused and 3% issued in decomposition. This means that 20% of autotrophic energy is used in secondary production. The process of energy transformation from herbivores to primary carnivores happens again and again.
- E.P. Odum (1963) has shown through a model of the energy flow in the three trophic levels that – 50% of the light energy which falls on green plants is extracted by autotrophic organisms, and only 1% is transformed to the biotic community.

On the basis of this discussion, depending upon the energy flow, the characteristics of an ecosystem can be defined as follows:

- Energy flows in a unidirectional manner
- The usable energy is reduced gradually

- The radiated energy from the sun is changed into the non-living state as heat energy.

3.8 ECOLOGICAL PYRAMID

The graphical representation of the population or biotic community in an ecosystem, the reserved energy in the different trophic levels in a food chain is called the ecological pyramid. The concept of ecological pyramid was first suggested by the English scientist Charles Elton in 1927.

Therefore, it is also known as Eltonian Pyramid. The lower, middle and upper levels of the pyramid denote the population of the producers, herbivores and carnivores respectively. The ecological pyramid can be vertical towards the top or the opposite, or it can be in the shape of a weaver's reel.

Depending upon the ecological parameter, ecological pyramid is divided into three types.

- **Pyramid of Numbers:** In this pyramid, a graphical representation of the size of the biotic population in different trophic levels is given. Grassland ecosystem and pond ecosystem are very good examples of pyramid of numbers. In the predatory food chain, even though the organisms in the trophic structure increase in size gradually, they, however, decrease in numbers. In the pond ecosystem, the phytoplankton leads to big fishes, and in the grassland ecosystem, grasslands to predatory birds. The producers are small in size, but large in numbers. On the other hand, the higher level carnivores are bigger in size but smaller in numbers.
- **Pyramid of Biomass:** The dry weight of biotic matter in an ecosystem's called biomass. The graphical representation of the biomass in per unit structure of the trophic level is called pyramid of biomass. The pyramid of biomass of the terrestrial ecosystem is always vertical. The biotic population is the largest at the producer level, and it decreases gradually towards the upper reaches of the trophic structure. In an aquatic ecosystem (pond ecosystem), the pyramid of biomass is upside down, or the apex is at the bottom. The organisms in this trophic structure depend upon the reproductive capacity and age of the community because the number of zooplanktons is more than thet of the phytoplankton, but less than the secondary consumers.

Figure 3.2 : Pyramid of Biomass (Pond Ecosystem)

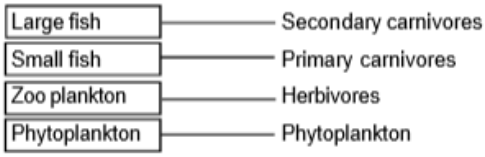


Figure 3.3: Pyramid of Biomass (Terrestrial Ecosystem)

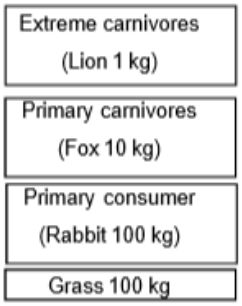
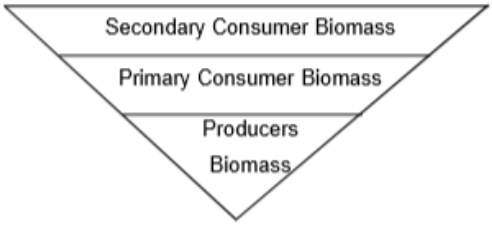
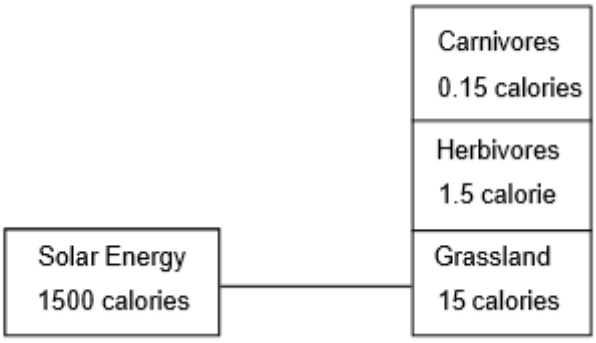


Figure 3.4: Inverted Pyramid of Biomass (Pond Ecosystem)



- **Pyramid of Energy:** The graphical representation of the amount of energy per unit area and per unit time in a trophic structure is called pyramid of energy. According to the second law of thermodynamics, each time energy moves from the lower trophic levels to the higher levels, 80-90% of the energy is made available for the autotrophic. The herbivores and carnivores get 10% and 20% energy respectively for metabolic activities. In each trophic structure, 10% chemical energy is saved. Lindaman first proposed this chemical reaction in 1942, Pyramid of energy is always straight and vertical.

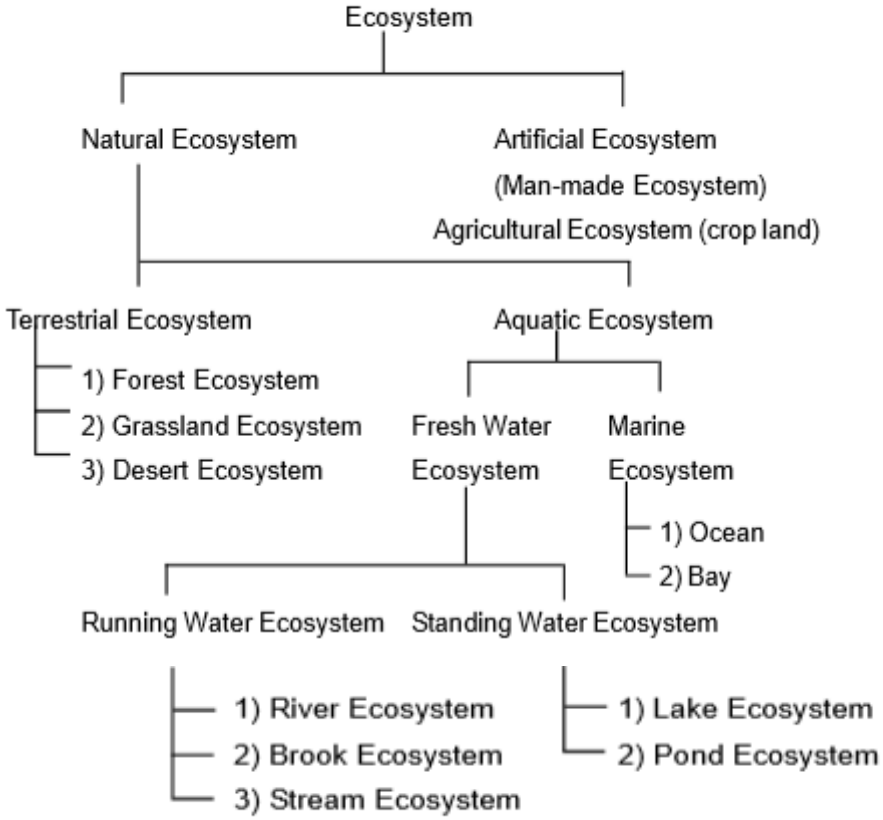
Figure 3.5: Pyramid of Energy



3.9 MAIN ECOSYSTEMS

There are three types of ecosystems in the environment (i) Terrestrial ecosystem, (ii) Fresh water ecosystem, (iii) Marine Ecosystem. The plants and animals residing in a specific geographical region is called biomass. The condition of plants is dependent upon various physical factors like the type of soil, rainfall, amount of light, time etc.

Table 3.2 :Different Ecosystems in the World



- **Terrestrial Ecosystem**

➢ Forest Ecosystem

The forest ecosystems are of different types, namely –

- Evergreen Forest Ecosystem
- Coniferous Forest
- Deciduous Forest

Evergreen forest ecosystems are also known as tropical rainforests. It covers an area of 20X106 square kilometers. This constitutes 1/12 of the earth. Evergreen forests are found in different parts of the world, e.g. Mexico, South America (Amazon and Orinock river basin), African Congo river basin, South-east Asia etc. In India, rainforests are found in the Western Ghats, Andaman's, North-East

Himalayas (Assam) etc. Almost half the population of plants and animals in the world are found in these regions. Therefore, the rainforests are rich in biodiversity. It is also very productive. In the rainforests, 1200 kilo calories of energy are produced per square meter per year. The main characteristics of rainforests as

- Its temperature is high (230 to 270C)
- Every year, 200-1000cm of rainfall occurs
- Warm and moist climate
- Contains sufficient quantities of minerals and humus
- The height of plants depends upon the species. Some trees grow up to 30-40 meters.
- Plants which can grow in the shadow of big trees, like, bamboo, ferns and other shrubs also exist.
- 70-80% insects and 80-85% birds reside in the rainforests. Other animals which live in these forests are monkeys, languor, snakes, ant- eaters, bats, cheetah etc.
- The main trees of the rainforests are rosewood, mahogany, dimro, nutmeg etc.

- **Grassland Ecosystem:** The main grasslands of the world are the plains of Europe and Asia, the Prairies of North America and Canada, the Pampas of South America, the Tuscus of New Zealand and Veldts of Africa etc. The largest grasslands are the Plains of Russia and Siberia. It covers almost 9X106 square km area. It has been ascertained that every year, 2500 kilo calories of energy is produced per sq. meter in these grasslands. The main characteristics of the grassland region are:
  - The amount of rainfall every year is 25-95 cm
  - Amount of humus in the soil is more
  - The plants are different varieties of short and long grass. e.g. Andropagan Panicam, Desmodium, Cyanodon.
  - The animals are primary consumers, grazing mammals (eg.bison, antelope, zebra, big-horned sheep and deer), and animals living in burrows (e.g. Rat, rabbit, prairie dog and land squirrels).These herbivorous animals are food for wolves and predatory birds.
  - These grasslands are very useful for crop production and cow rearing.

- **Desert Ecosystem:** 20% (1/5th) of the world's land area is desert. Some famous deserts are mainly in south-west America (the famous west desert Death Valley) Mexico, Peru, North Africa (Sahara and Kalahari), China (Tibet, Gobi), India (Thar), South America (Atacama)and Mid-Australian region (Tanami Gibson, Victorian) etc. The main characteristics of the desert ecosystem are :
  - Amount of rainfall is 5-25 cm only.
  - Climate is extremely dry.
  - Too hot in daytime and too cold at night
  - Population of plants and animals is much less.

- Among the plants, shrubs and small trees can be found sparingly.

  Some plants are seen growing only in the rains. They have a very short shelf life (10-14days) e.g. Boerhaavia. Some plant scan retain water, e.g. Hardy Grass. Some other plants can live for long, e.g. Dates. Some plants are fleshy and juicy, e.g. Cacti, Euphabia.

- The chief animal of the desert is the camel. In addition, there are also kangaroos, rats, rabbits, foxes, cats and some other mammals. Among reptiles, there are horned lizards; among birds, there are insectivorous birds, owls; and among the insects, there are ants, wasps, centipedes, spiders etc.

- **Aquatic Ecosystem:** Water constitutes 71% of the total volume of the earth. Only 29% is land. Therefore, the number of aquatic ecosystems is more. Aquatic ecosystem is mainly of two types –Freshwater ecosystem and marine ecosystem.

➢ Freshwater Ecosystem : It is of two types –
- Standing Water (lake and pond)
- Running Water (stream, river)
- Standing Water (lake and pond):
  Lake Ecosystem: Lakes and ponds are standing water bodies. Lakes are large in size and also deep. Lakes are classified on the basis of productivity and physical factors. Deep lakes are divided on the basis of the capacity of light to penetrate its depth.

  a) Spilimnion – the surface temperature becomes 11-120Cbecause of the sun's heat in the summer; it become scold in winter.
  b) Hypolimnion – Deep surfaces are always cool (50C)
  c) Thermocline – There is variation in heat.

Depending upon productivity, lakes are divided into two types –

First: Eutrophic Lake: Its depth is less. There are large number of bio producers, but the amount of oxygen is less. The circulation of nutrition is frequent. e.g. Kashmir's Dal Lake.

Second: Oligotrophic Lake. These lakes are generally quite deep. The mountain inside the lakes are called vidges. They are Circulation of nutrition is also less.

Pond Ecosystem: The plants found in ponds are:

a) Those which can be seen with the help of microscopes like chlamydomones, chlorella, spirogyra, eugonium, zygnema,

b) Those which floated on water such as – floating plants like cerataphylum, articularia, hydrila,
c) Floating plants like ozola, wolphia, salvinia, pigtialemona, echornia etc.
d) Plants with roots like vallisnaria, nelumb, typha etc. The roots of saggitaria, frogomytes can however be seen.

Among animals, there are zoo planktons like ciliates and flagellata protozoa, rotifera, daphnia, cyclops, haylly, dragonfly,damal fly; nekton like- water boatman, beetles, water insects, fish, frog, turtles, snakes etc. and those that live in the depths like hydra, prawns, crabs and the different varieties of snails etc.

- Running Water Ecosystem (Stream, river): Running water ecosystem is also known as flotic ecosystem. In this ecosystem, water always flows and it is always changing.

- Marine Ecosystem: Marine ecosystem is of three types: open seas, coastal regions, and bay regions. The main feature of the marine ecosystem is that its water is salty (average salinity 3.5%).The salt content varies according to the depth. The factors responsible for the limitation of the biotic community are the temperature of the sea, salinity, water pressure, and light. As the depth of the sea increases, the water pressure also increases

3.10 BIOGEOCHEMICAL CYCLING

You have studied that energy flows through ecosystems ‘enabling the organisms to perform various kinds of work, and is ultimately lost as heat. It is gone forever in terms of usefulness to the system. On the other hand, nutrient materials never get 'used up'. They can be recycled again and again indefinitely. For example. When we breathe, we inhale several million atoms that may have been inhaled by say, Akbar or any other person you may care to choose from history. First let us explain .what we mean by mineral nutrients. As you have learnt of more than 100 chemical elements, about 40 are present in living organisms. Some are needed in relatively large amounts and n, arc called **macronutrients** while some are needed in only trace amounts and so named **micronutrients** (see Table 3.3).

Table 3.3

Relative amounts of some chemical elements that make up living things

	Element	Main Reservoir
Major Macronutrients (> 1% dry organic weight)	Carbon	Atmosphere
	Hydrogen	Hydrosphere
	Oxygen	Atmosphere
	Nitrogen	Atmosphere and Soil
	Phosphorus	Lithosphere
Relatively Minor Macronutrients (0.2 – 1% dry organic weight)	Calcium	Lithosphere
	Chlorine	Lithosphere
	Copper	Lithosphere
	Iron	Lithosphere
	Magnesium	Lithosphere
	Sulphur	Lithosphere and Atmosphere
	Sodium	Lithosphere
	Potassium	Lithosphere
Some Micronutrients (<0.2% dry organic weight)	Aluminium	Lithosphere
	Boron	Lithosphere
	Bromine	Lithosphere
	Zinc	Lithosphere
	Cobalt	Lithosphere
	Iodine	Lithosphere
	Chromium	Lithosphere

Individual nutrients can exist in combination with other elements forming different compounds. But living organisms may not be able to obtain the essential nutrients from all, those compounds. For example, plants can use carbon only in the form of carbon dioxide (CO_2). Similarly all organisms' need nitrogen but most of them are incapable of utilizing the gaseous N_2 present in the atmosphere unless it is available in form of soluble nitrates (NO_3) or ammonia (NH_3).

The mineral nutrients move from the non-living to the living and then back to the non-living components of the ecosystem in a more or less circular manner. This is known as **biogeochemical cycling** (bio for the living, geo for atmosphere. water, rocks and soil and chemical for the elements and processes involved). We generally call them **nutrient or mineral cycles**. You should, however, remember the important role of

a) green plants which organise the nutrients into biologically useful compounds,
b) Decomposers which ultimately return them to their simple elemental state.
c) Air and water which transport the nutrients to long, distances between the abiotic and biotic components of the ecosystem.

You should also get familiar with the two important terms associated with biogeochemical cycles:

a) The different **reservoirs or pools** of nutrients like the atmosphere and rocks. These are large and the relative size of these pools is important when one assesses the effect of human activities on nutrient cycles.
b) The **compartments** of the cycles through which the nutrients move. They are relatively short-term stores of nutrients in comparison with reservoirs; for example, the plants and animals through which the nutrients move and in which they are stored for short periods in a cycle.

Fig. 3.4 shows a model. The reservoirs are the atmosphere and rocks; the major compartments are sea and sediment, freshwater and soil. The5e include the primary producers and consumers and dead organic matter in the decomposer system

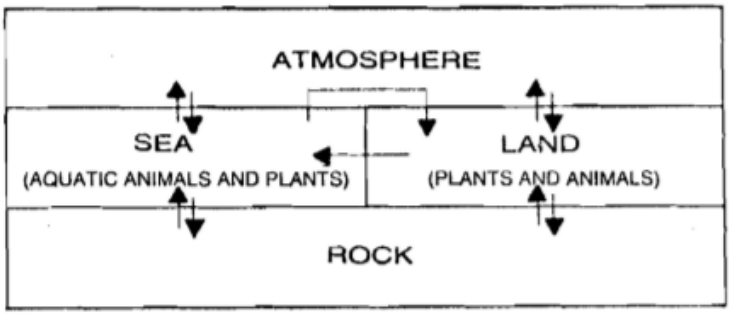


Fig.3.4: A model of the biogeochemical cycle. The arrows indicate the outgoing minerals.

Now let us study two types of biogeochemical cycles.

Types of Biogeochemical Cycles: There are two basic types of biogeochemical cycles, **gaseous** and **sedimentary**. In the gaseous type of biogeochemical cycle there is a prominent gaseous phase. Cycling of carbon and nitrogen represents gaseous biogeochemical cycles. In sedimentary cycles the main reservoir is the lithosphere from which the nutrients are released largely by weathering of rocks. The sedimentary cycle is exemplified by phosphorus and sulphur.

When we describe biogeochemical cycle; we often say that a cycle is **perfect** or **imperfect**. A perfect nutrient cycle is one in which the nutrients are replaced as fast as they, are used up. Most gaseous cycle's arc generally considered perfect. In contrast, sedimentary cycles are considered relatively imperfect, as some nutrients are lost' from the cycle into the soil and sediments and become unavailable for immediate cycling i.e., there are more stages in which short-term or long-term stagnation occurs. Most significant of the stagnation stages is sedimentation in oceans and deep continental lakes. So if portions of nutrients. Such as phosphorus or sulphur are lost. They are unavailable to organisms for comparatively, longer periods. Human beings have so speeded up the movement of many nutrients that the cycles tend to become

imperfect or rather acyclic resulting in too much of nutrients at one stage or too little at another. We will discuss this in detail when we come to the phosphorus cycle.

Factors or processes which promote nutrient loss from the compartments of biogeochemical cycles to the reservoir can impoverish ecosystems over long run. For example, continuous cultivation and cropping without the use of fertilizers is bad for the soil. Small particles and nutrients wash with runoff waters or leach down to groundwater and rivers through subsoil to the sea, where they may get buried with sediments which may eventually be incorporated into rocks.

Agriculture, forestry operation (e.g. deforestation). And other activities can profoundly affect the rates of nutrient cycling. For instance, burning of fossil fuels contributes towards the buildup of carbon dioxide in the atmosphere. We will learn more of this as we discuss each cycle individually

3.11 CARBON CYCLE

Carbon is the basic constituent of all organic compounds. Next to water, carbon is the most significant element constituting 49 per cent of the dry weight of organisms. The carbon cycle is essentially a perfect one, that is, carbon is returned to the environment about as fast as it is removed. The source of all carbon in living organisms, dead. Organic material and fossil deposits is carbon dioxide found in the atmosphere.

Table 3.5: Carbon in major biospheric compartments

Major Compartments in the Biosphere	Carbon in 10^9 tons
Atmosphere	711
Terrestrial	3,100
Oceans (mostly as carbonates)	39,000
Fossil fuels	12,000

Source : Data from 1981 report of the Council on Environment Quality.

The atmosphere has an average concentration of about 0.032 per cent or 320 ppm of CO_2. Apart from the atmospheric pool, a considerably large amount of CO, is found dissolved in the ocean$. It is estimated that the oceans contain more than 50 times as much carbon as there is in the atmosphere. The oceanic reservoir tends to regulate the amount in the atmosphere. Table 3.5 shows the major biosphere compartments involving carbon. The cycling of carbon involves the atmospheric reservoir, from where it is taken. Up by the producer to consumer and from both these groups to the decomposer and then back to the reservoir (Fig. 3.5). Let us now consider each stage of the cycle.

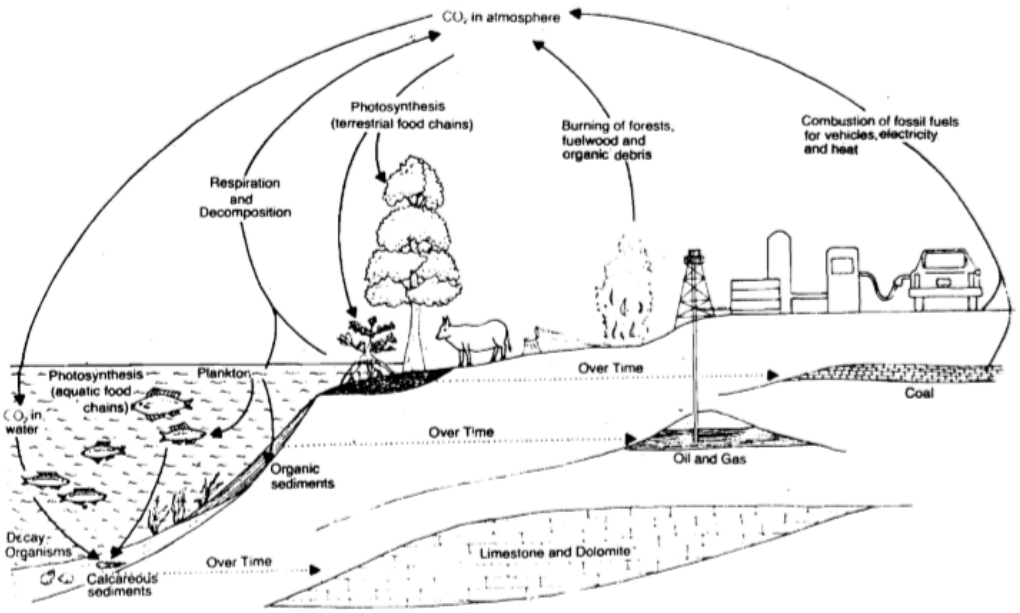


Fig. 3.5 Simplified carbon cycle.

Through photosynthesis, green plants pick up carbon from carbon dioxide they take m from the atmosphere. AS much as 4 to 9 Y 1013kg of carbon is fixed in the biosphere through photosynthesis annually.

Respiratory activity in the producers and consumers accounts for-the return of a considerable amount of carbon as CO_2 to the atmosphere. The most substantial return, however, is through the activity of decomposers in their processing of the waste materials and dead remains of other trophic levels.

Burning of wood, forest fires and combustion of organic matter also are additional man-made sources for releasing CO_2 into the atmosphere.

The rate of release of carbon depends on environmental conditions such as soil, moisture, temperature and precipitation. In tropical forests most of the carbon in plant remains is quickly recycled, for there is little accumulation in the soil. The **turnover rate** of atmospheric carbon over a tropical forest is about 0.8 year. In drier regions such is grasslands, carbon is stored as humus. In swamps and marshes where dead material falls in water and is not completely decomposed, carbon is stored as humus or peat and circulated very slowly. The turnover rate here is of the order of 3-5 years.

More than 99 per cent of the **total carbon** is present in the earth's crust's deposits of coal, petroleum, peat and limestone. These as you know are deposits of plant and animal remains. On weathering of carbonate rocks, burning of fossil fuels and volcanic activity, the bound carbon is returned to the atmospheric-aquatic reservoir.

In aquatic environments, the phytoplankton utilises the CO_2 that is dissolved in the in the water, or is present as bicarbonates and carbonates and convert this CO_2 into phytoplankton biomass. The phytoplankton is used as food by the aquatic food chain. The CO_2 produced in respiration is reutilized by the phytoplankton to produce more biomass. The carbon bound in the shells of snails and foraminifera as carbonates is deposited in the sediments when these animals die. In this manner a significant portion of the carbon gets buried in the sediment and is removed from circulation this may later surface as limestone rock or coral reef.

The atmospheric gaseous CO_2 remains in dynamic equilibrium with the CO_2 dissolved in oceans. The interchange between the two phases occurs due to diffusion, the direction of which depends on the relative concentrations of carbon dioxide. Carbon dioxide dissolves in water easily and some of it enters the aquatic phase through precipitation. A litre of rain water contains about 0.3 ml of gaseous CO_2. The CO_2 dissolved in the water, in soil or in oceans forms carbonic acid (H_2CO_3). The carbonic acid dissociates into hydrogen and bicarbonate ions (H^+ and HCO^-_3). The bicarbonate ions can further dissociate into hydrogen and carbonate ions. All these steps are fully reversible as shown in the following equation.

$$\begin{array}{l}\text{Dissolved } CO_2 + H_2O = H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons H^+ + CO_3^{-2} \\ \quad\quad \updownarrow \\ \text{Atmospheric } CO_2\end{array}$$

The direction of the reaction depends on the concentration of the critical component. For example, a local depletion of CO_2 would result in the movement of CO_2 from the dissolved phase into the atmosphere. Similarly the assimilation of bicarbonate ions (HCO^-_3) through photosynthesis by aquatic plants would tend to shift the equilibrium in the other direction. The equilibrium system actually is not as simple as it seems. It depends on several factors, pH of the water being one. At higher pH values i.e., alkaline conditions more carbon is present as carbonates; in acidic conditions more carbon is in the dissolved phase. '

It may now be apparent to you that what seemed like a simple cycle is actually quite complicated. However, it is important to recognise that there are limited avenues by which carbon is utilised and a much larger number by which it is restored to the atmosphere.

Human Impact on Carbon Cycle

Human activities have greatly influenced the carbon cycle. The discharge of CO_2 into the atmosphere is steadily increasing owing to burning of fossil fuels and destruction of forests. At the beginning of the Industrial Revolution about 1800, it is believed that CO_2 concentration in the atmosphere was 290 ppm (parts per ‘million) which is equal to 0.29 per cent. In 1958 when accurate measurements were first taken, the concentration of CO_2 was already 315 ppm, while in 1988 it had risen, to 350 ppm. A

major concern over the increasing concentration of CO_2 in the atmosphere is its possible effect on the average ambient global temperature. Carbon dioxide is one of the gases that helps to produce the 'greenhouse effect.' Rise in the ambient global temperature would have pronounced ecological effects. The warming would cause ice caps to ocean levels to rise, as a result the continental coastal regions would be flooded. The rise in temperature would also change the rainfall and vegetation patterns which would disrupt agricultural 'production. This has been verified by comparing with predictions of climatic patterns of the past through computer modelling studies.

3.12 NITROGEN CYCLE

You have already learnt that nitrogen is an essential constituent of protein - the building block of all living cells. It is also a major constituent of the atmosphere (79 per cent). Although organisms live in an atmosphere rich in gaseous nitrogen yet the organisms cannot use this nitrogen. It can be utilised only after gaseous nitrogen has been 'fixed' into some chemically usable form. The transformation whereby molecular nitrogen is converted into a variety of nitrogenous compound and its release again into the atmosphere, is what constitutes the nitrogen cycle (Fig. 3.6).

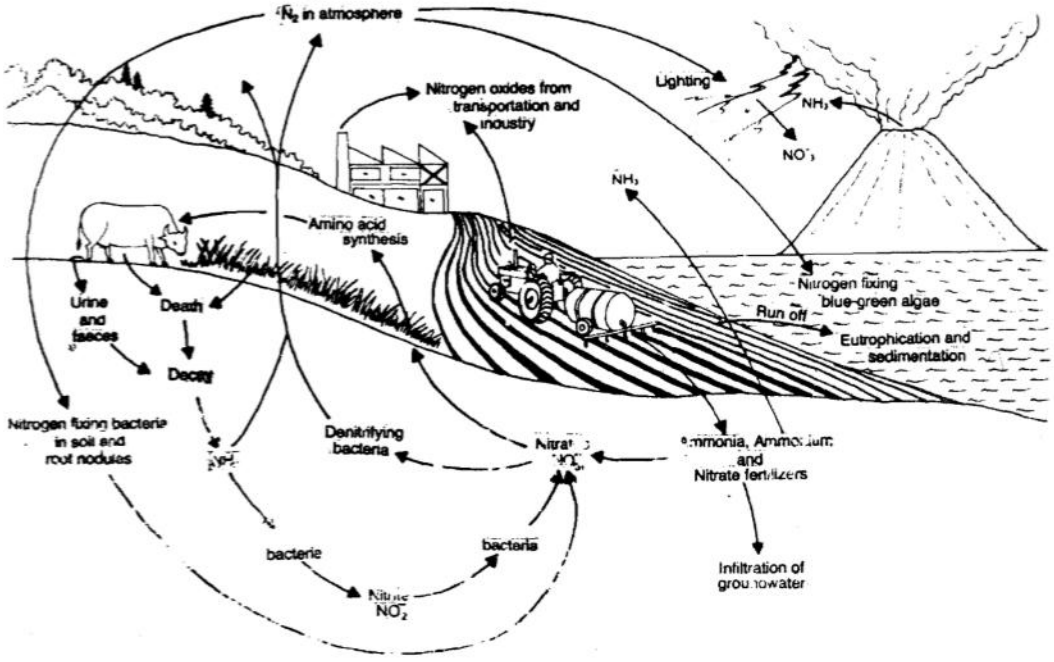


Fig.3.6: Nitrogen cycle. A simplified diagram representing major steps in the circulation of nitrogen involving various organisms and different forms of inorganic and organic nitrogen.

The largest reservoir of nitrogen is the atmosphere but the critical pools are represented by its organic and inorganic forms that can be used by plants and animals.

Nitrogen Fixation

As we have said before, atmospheric nitrogen cannot be used by plants or animals. It has to be first **fixed**. The term **nitrogen fixation** refers to the oxidation or reduction of atmospheric nitrogen to nitrates (NO^-_3) and ammonia (NH_3) which can be used by living organisms. In nature nitrogen fixation into these compounds occurs primarily in two ways:

i) **High energy fixation:** Through cosmic radiations, lightning, volcanic activity and meteorite trails which provide the high energy needed to combine atmospheric N_2 with oxygen and hydrogen of water. The resulting ammonia and nitrates are brought to the earth by rainwater.

ii) **Biological fixation:** Approximately 63% of all nitrogen fixed is through biological fixation. Nitrogen fixing organisms are primarily **prokaryotes; bacteria and blue green algae.** Nitrogen fixation requires activation of molecular nitrogen by splitting nitrogen into two atoms of free nitrogen N_2 + 2N. This is an energy requiring step, which in biological fixation requires 160 kcal mole. The actual fixation step, in which two atoms of nitrogen combine with three molecules of H_2 to form two molecules of ammonia (NH_3) releases 13 kcal mole. Therefore, the net energy requirement for nitrogen fixation is 147 kcal/ mole.

Except for the photosynthetic ones, all nitrogen fixing organisms need an external source of carbon compounds to provide the energy for this endothermic reaction. **It is an interesting fact that nitrogen fixation regulated by two enzymes nitrogenase and hydrogenase in nature requires low energy. In contrast, industrial nitrogen fixation requires very high temperature (400' C) and pressure (2 x 10' Pascal).** Table 3.6 illustrates the kind of organisms known to fix nitrogen. Symbiotic nitrogen fixation occurs largely in terrestrial situations whereas, fixation by free living organisms occurs in both terrestrial and aquatic situations.

Table 6.3 : Examples of symbiotic and free living nitrogen fixing organisms

Symbiotic	
HOST PLANT	N_2 FIXING ORGANISMS
Legumes (pea, alfalfa, pulses like arhar, beans, clover, etc.)	*Rhizobium*
Non-legumes (*Alnus, Myrica, Gasuarina, Hippophae, Elaeagnus, Coriaria, etc.*)	Actinomycetes
Tropical grasses (*Paspalum, Digitaria,* maize, sorghum)	*Azotobacter, Spirillum Klebsiella*
Cycads	Blue green algae
Ferns, (*Azolla*)	Blue green algae (*Anabaena*)
Lichens	Blue green algae
Free-living	
Aerobic bacteria — (*Azotobacter*)	
Anaerobic bacteria — (*Clostridium*)	
Anaerobic — photosynthetic bacteria — (*Chromatium, Rhodospirillum, Chlorobium*)	
Blue green algae — (*Nostoc*)	

i) Symbiotic Nitrogen Fixers

Of the symbiotic nitrogen fixing bacteria, species of Rhizobium form root nodules in legumes and are the most studied nitrogen fixers and the best understood. Species of Rhizobium are host specific to particular species of legumes. The rhizobia penetrate the root hair and once inside the root, the bacteria rapidly multiply and form swollen, irregular - shaped bodies in roots of legumes.

Some non-legume woody plants also have root nodules and fix nitrogen symbiotically. The organisms that cause the formation of nodule and fixation of nitrogen are actinomycetes (a kind of primitive fungus). Some examples of non-legumes are species of Alnw, Elaeagnus Myrica, Araucaria, Ginkgo, and Casuarina. Unlike legumes, which are largely tropical in origin, these nitrogen fixers originate in the temperate zone.

Nitrogen fixation by blue green algae or cyano bacteria may take place in free living forms or in symbiosis with fungi as in certain lichens, mosses. Ferns and at least one seed plant. The fronds of the small free floating aquatic fern Azolla contain small pores filled with symbiotic blue green algae Anubaena that actively fix nitrogen. For centuries this fern has played an important role in the rice fields of China. Before the rice fields are planted. The water filled paddy fields are covered with the aquatic fern which fixes enough nitrogen for the crop as it matures. This practice permits rice to be grown without further addition of nitrogen fertilizers'.

Symbiotic nitrogen fixers are more efficient than free living ones.

ii) Non Symbiotic Nitrogen Fixers

There are certain groups of free living bacteria both aerobic and anaerobic and blue green algae that fix nitrogen. Aerobic nitrogen fixing bacteria such as Azotobacter and anaerobic form Clostridium are widely distributed in soils as well as in fresh and marine waters. In fact accumulating evidence indicates that many soil and water bacteria are capable of nitrogen fixation and because they occur in abundance the total amount of nitrogen fixed is considerable.

The N_2 fixed in the soil and root nodules is used by the plants to form numerous nitrogenous compounds mainly proteins which then enter the food chain. Nitrogen is returned to the soil in the form of organic compounds through manure, dead plants, and animals and micro-organism. But most of this nitrogen is insoluble and not immediately available for plant use. The organic nitrogenous compounds have to be changed to inorganic compounds to be used by plants. This is done by two processes - ammonification and nitrification.

Ammonification

Many heterotrophic bacteria. Action mycetes and fungi in soil and water, metabolise the organic nitrogen and release it in an inorganic form as ammonia. This process is known as **ammonification** or **mineralisation.** This is an energy releasing reaction. For example, glycine-based protein releases 176 kcal mole. This energy is used to maintain the life 'process of the organisms that accomplish the transformation.

Nitrification

Ammonia or ammonium salts, are converted into nitrate in a process termed **nitrification**. To be useful to most autotrophic and heterotrophic organisms. This process occurs in warm moist soil with near neutral pH and takes place in two steps:

i) ammonia salt or ammonia is oxidised and converted into nitrite by *Nitrosomonas*

$$2NH_3 + 3O_2 \longrightarrow 2NO_2^- + 2H^+ + 2H_2O \quad 65 \text{ kcal/mole}$$

ii) Nitrite is further oxidised and converted into nitrate by *Nitrobactor*

$$2NO_2^- + O_2 \longrightarrow 2NO_3^- \quad 17 \text{ kcal/mole}$$

These nitrifying bacteria obtain their energy from this oxidation process. Now let us see how nitrogen is converted back into its gaseous form.

Denitrification

Nitrates are readily leached from the soil and also lost through denitrification the process by which molecular or gaseous nitrogen (N_2) as well as nitrous oxide (NO) 'and nitric oxide (N_2O) and nitrogen dioxide (NO_2) are formed from NO^-_3 by bacteria (such as pseudomonas) and fungi. They use the nitrate as a source of oxygen in the presence of glucose and phosphate. Denitrifying bacteria prefer anaerobic or partially aerobic habitats such as estuaries, bogs, lake bottoms and water-logged soils. The bacteria reduce the nitrates to nitrites which are finally converted to free nitrogen.

Figure3.7shows the processes involved in N_2 cycle namely fixation, assimilation, denitrification, decomposition, leaching, runoff in rainwater, etc., along with some estimates of annual global movements. The magnitude of the two flows is directly related to human activities - emissions into the atmosphere and industrial fixation that is largely added to farms in the form of nitrogen fertilisers are also shown.

The total annual nitrogen fixation is estimated to be 92 x 106 metric tonnes, whereas total amount denitrified and returned to the atmosphere is only 83 x 106 metric tonnes. The extra nitrogen added each year in the biosphere causes disbalance of nearly 9 x lo6 metric tonnes and is being largely built up in groundwater, reservoirs, rivers, lakes and the ocean.

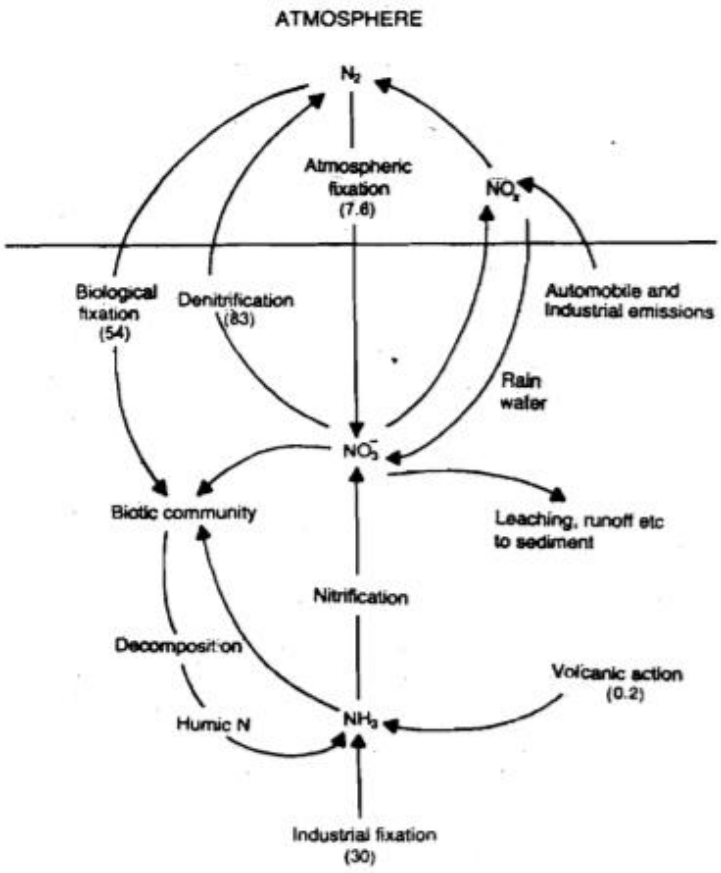


Fig.3.7**: Estimates of the magnitude of key flows in the nitrogen cycle. Numbers in parentheses are in lo6 metric tomes per year (Data from Delwich 1970 Scientific American)**

The self-regulating feedback shown in Fig3.7makes the nitrogen cycle a relatively perfect one when a large area or the biosphere as a whole is considered. Some nitrogen is lost to the ocean sediments and gets out of circulation but this is compensated by nitrogen entering the air by volcanic gases. Let us now assess the impact of human activities on this cycle.

Human Impact on Nitrogen Cycle

Human activities are profoundly affecting the cycling of nitrogen in nature. Over 30 x $l0^6$ metric tons/yr. of N_2 is fixed in the commercial production of fertilisers, an amount almost equal to that fixed biologically. The use of N_2 fertilisers affect the distribution of N_2 on earth. Much of the nitrogen in the harvested crops becomes animal and human waste in sewage waters and eventually enters the aquatic ecosystem through runoff and leaching. Nitrogenous compounds leached into the groundwater may be abundant in irrigation and drinking water where they can cause

serious health hazards. Nitrogenous compounds entering the lakes have fertilising effect resulting in algal blooms and promote **cultural eutrophication**. Excessive growth of phytoplankton in eutrophic lakes produces huge quantities of biomass and finally collapse due to nutrient exhaustion. The dead organisms are consumed by, detrivores which use up the oxygen supply. This problem of cultural eutrophication is, however, more severe in the case of phosphorus additions rather than nitrogen. When fossil fuels are burned we add nitrogenous compounds to the air. Large quantities of nitrogen oxide (NO) are released from vehicles and most of the NU is converted to NO_2 by combining with ozone (O_3) in the atmosphere. NO_2 is a toxic gas for humans and a cause of smog. It combines with water to form nitric acid, HNO_3, which forms 30% of the strong acids in the acid rain.

Now that you have learnt about the biogeochemical cycles where the main reservoir are in gaseous phase, we will discuss two sedimentary cycles namely phosphorus at sulphur. These are different from the earlier two gaseous cycles because the main reservoirs and major reactions involving their transformation are largely confined to the sediment.

3.13 LET US SUM UP

In this unit you have studied the following:

- **Ecology:** the study of relationship of living organisms to one another and to their environment.
- History of ecology from primitive man to the present time with special reference to the development of ecology in India.
- The subdivision of ecology into (i) autecology - study of individuals or populations of a single species with respect to their environment, (ii) synecology - study of interacting population of different species, (iii) habitat ecology - which deals with the study of habitat and the organisms within it.
- The relation of ecology with other biological fields such as botany, zoology, protozoology etc.

- After going through this unit, we have come to learn about ecosystem. There are different ecosystems in the world, namely forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystem.
- All these different types of ecosystem are discussed in detail. Besides, the unit also deals with food-chain, food web, ecological pyramids etc. We also got a comprehensive idea about food chain, food web, ecological pyramid etc. We have learnt that the pond we see everyday contains different plants and animals, which develop a relationship amongst them.
- Nutrients circulate from the environment to organisms and back to the environment in perpetual cycles referred to as biogeochemical cycles or

nutrient cycles. There are two types of cycles: gaseous, where the major reservoir is the atmosphere, these are represented by carbon and nitrogen and sedimentary cycles represented by sulphur and phosphorus with major reservoirs in the earth's crust.

- The carbon cycle involves the assimilation and respiration of carbon dioxide by plants, its consumption as carbohydrates in plants and animal tissue and its release through respiration and decomposition and combustion. Carbon is also withdrawn from the cycle into long-term reserves. The equilibrium of carbon dioxide between the sea, atmosphere and land is being disturbed by rapid release of carbon dioxide into the atmosphere by burning wood and fossil fuels. Increased carbon dioxide in the atmosphere has the potential to raise the ambient global temperature of the earth with serious ecological implications.
- Nitrogen cycle is characterized by fixation of atmospheric nitrogen by nitrogen fixing organism and industrial processes, its assimilation by planks in the form of nitrate and ammonium ion. Involved in the nitrogen cycle are the processes of ammonification, nitrification and denitrification. Human intrusion into the nitrogen cycle involves release of oxides of nitrogen into the atmosphere which cause air pollution and smog. Excessive nitrates released into the aquatic ecosystems cause cultural eutrophication.

3.14 FURTHER READING

1) Asthana, D. K. &Meera A. (2012). *A Textbook of Environmental Studies*. New Delhi: S. Chand and Company Ltd.
2) Bharucha, E. (2004). *A Textbook of Environmental Studies.* New Delhi:UGC.
3) Kaushik, A. &Kaushik, C. P.(2006). *Perspectives in Environmental Studies.* India: New Age Publications (Academic).

3.15 POSSIBLE QUESTIONS

VERY SHORT ANSWER QUESTIONS

1. What are the different types of ecosystems?
2. Write the names of the elements of an ecosystem.
3. Define trophic structure.
4. What is food chain?
5. What is the significance of food web?
6. Write the names of primary producers and secondary producers.
7. Write the names of the forest biomass?
8. Where in India can we find tropical rainforests?
9. What are the different types of ecological pyramid?

SHORT ANSWER QUESTIONS

1. What are the different characteristics of aquatic biome?
2. What is the role of the biotic and abiotic factors in the ecosystem?
3. What is the difference between food chain and food web?
4. Why does energy always flow in one direction?
5. Explain one pyramid of biomass.

LONG ANSWER QUESTIONS

1. Describe a pond ecosystem as an ideal ecosystem.
2. What is biome? Describe tropical rainforests and grassland biome.
3. What is ecological pyramid? Describe the various ecological pyramids found in an ecosystem.
4. Write the characteristics of food chain. Describe two kinds of food chain with examples.

ENVIRONMENTAL STUDIES

Block -2

Role of Individuals and their Associations in Environment

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UNIT-4 POPULATION ECOLOGY

Structure

4.1 LEARNING OBJECTIVES

After going through this unit, you will be able to,

- Understand how to measure population size and density
- Categorize methods for studying population changes
- Explain the differences between exponential and logistic growth patterns
- Understand the difference between density-dependent and density-independent growth regulation
- Explain what are the population attributes
- Outline how growth status of the population affects the stability of a population
- Discuss how the population structure of a given habitat during a given period, fluctuates and finally what happens to that population

4.2 INTRODUCTION

Population ecology is the study of the biological activities performed by the animal and plant groups which ultimately affects the size and number of individuals in that group. A population is a group of individuals of a species residing in a particular area. The geographic boundaries of a population may or may not be fixed for a particular species. At times the individuals of that population may migrate to a suitable environment for so many purposes.In island populations the boundaries are fixed to the periphery of the island, whereas the boundary of the terrestrial population of any

other animal or plant may not be fixed. The survival and the tenure of existence of that population depend on so many factors such as birth rate, death rate etc.

4.3 DEFINITION OF POPULATION

Population is a group of individuals of a particular species, which are found in aparticular geographical area, which can interbreed among them. Basing on the size of area and the number of individuals in that group, they are named as

a. Local population: that occupies very small habitat.
b. Meta-population: a group of closely related local populations.

Population ecology is an important area of ecology because it links ecology to the population and evolution. Natural selection operates at different levels of population.

4.4 SUBJECT MATTER OF POPULATION ECOLOGY

4.4.1 Population Demography

Population consist of all the species living within a specific area, and whose attributes depends on a number of factors: seasonal changes in the environment, forest fires, volcanic eruptions, inter and intra population competitions. The study of population dynamics and demography uses a series of tools to examine how population respond the biotic and abiotic environmental changes.

4.4.2 Methods of measurement of population characters

The most accurate way to determine population size is to simply count all of the individuals within the habitat. However, this method is often not logistically or economically feasible, especially when studying larger habitats. Thus, scientists usually study population by sampling a representative portion of each habitat and using this data to make inferences about the habitat as a whole. A variety of methods can be used to sample populations to determine their size and density. For immobile organisms such as plants, or for very small and slow-moving organisms, a quadrat may be used. A quadrat is a way of marking off square areas within a habitat, either by staking out an area with sticks and string, or by the use of a wood, plastic, or metal square placed on the ground. After setting the quadrats, researchers then count the number of individuals which lie within their boundaries. Multiple quadrat samples are performed throughout the habitat at several random locations. All of this data can then be used to estimate the population size and population density within the entire habitat.

For mobile organisms, such as mammals, birds, or fishes a technique called mark and recapture is often used. This method involves marking a sample of captured animals in some way (such as tags, bands, paints, or other body markings), and then releasing them back into the environment to allow them to mix with the rest of the population; later, a new sample is collected, including some individuals that are marked (recaptures) and some individuals that are unmarked.

Population Parameters:
A population has certain parameters which affect the survival of the population

4.4.3 Population Size or Density:It is the number of individuals of a species per unit area or volume

$$\text{Population Density (PD)} = \frac{\text{Number of individuals in a region (N)}}{\text{Number of unit area in the region (S)}}$$

$$\text{PD} = \frac{\text{N}}{\text{S}}$$

4.4.4 Birth Rate (Natality)

It is the rate of production (birth rate) of new individuals per unit of population per unit time. For example, if in a pond, there are 20 lotus plants last year and through reproduction, 8 new plants are added, taking the current population to minimum 28. Then, birth rate = 8/20 = 0.4 offspring per lotus per year.

4.4.5Death Rate (Mortality)

It is the rate of loss of individuals (death rate) per unit time due to death or due to the different environmental changes, competition, predation, etc. For example, if individuals in a laboratory population of 40 fruit flies died during a specified time interval, then, the death rate = 4/40 = 0.1 individuals per fruit fly per week.

4.4.6 Sex Ratio

An individual is either a male or a female but a population has a sex ratio like 60% of the populations are females and 40% are males.

4.4.7 Age Pyramid:

Population at any given time is composed of individuals of different ages. When the age distribution (per cent individuals of a given age or age group) is plotted for the population, this is called age pyramid.

The age pyramids of human population generally show the age distribution of males and females in a combined diagram. Fig. 4.1 the growth status of the population is reflected by the shape of the pyramids.

(i) Growing/ Expanding
(ii) Stable
(iii) Declining.

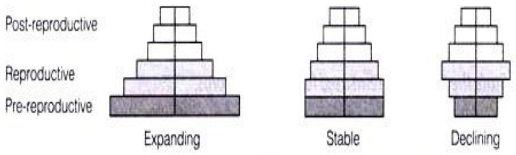

Fig 4.1: Age pyramid of different population structures

4.4.8 Population Growth:

The size of a population for any species is not a static parameter. It keeps changing with time. It depends on the following factors:

(i) Food availability
(ii) Predation pressure
(iii) Weather

The rate of breeding varies from species to species:

a. Some species breed only once in their life time (Pacific salmon fish and bamboo), while some breed many times in their life time (birds and mammals).
b. Some produce large number of small sized offsprings (oysters), whereas other produce small number of large sized offsprings (birds and mammals).
c. Life history traits of organisms have evolved in relation to the constraints imposed by the biotic and abiotic components of habitats in which they live.

4.4.8 Species Distribution

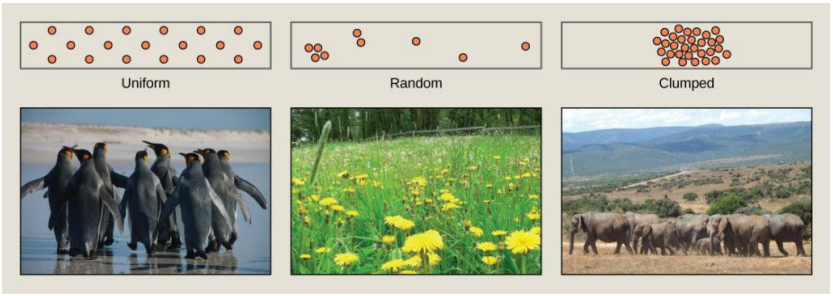

Fig 4.2: Species may have uniform, random, or clumped distribution. Territorial birds such as penguins tend to have uniform distribution. Plants such as dandelions with wind-dispersed seeds tend to be randomly distributed. Animals such as elephants that travel in groups exhibit clumped

In addition to measuring simple density, further information about a population can be obtained by looking at the distribution of the individuals. Species dispersion patterns (or distribution patterns) show the spatial relationship between members of a population within a habitat at a particular point of time. In other words, they show whether members of the species live close together or far apart, and what patterns are evident when they are spaced apart.

Individuals in a population can be more or less equally spaced apart, dispersed randomly with no predictable pattern, or clustered in groups. These are known as uniform, random, and clumped dispersion patterns, respectively. (Figure 4.2) Uniform dispersion is observed in plants that secrete substances inhibiting the growth of nearby individuals and in animals like the penguin that maintain a defined territory. An example of random dispersion occurs with dandelion and other plants that have wind-dispersed seeds that germinate wherever they happen to fall in a favorable environment. A clumped dispersion may be seen in plants that drop their seeds straight to the ground, such as oak trees, or animals that live in groups (herds of elephants). Clumped dispersions may also be a function of habitat heterogeneity. Thus, the dispersion of the individuals within a population provides more information about how they interact with each other than does a simple density measurement.

4.4.9 Exponential Growth

Charles Darwin, in his theory of natural selection, was greatly influenced by the English clergyman Thomas Malthus. Malthus published a book in 1798 stating that populations with unlimited natural resources grow very rapidly, and then population growth decreases as resources become depleted. This accelerating pattern of increasing population size is called **exponential growth**.

The best example of exponential growth is seen in bacteria. Bacteria are prokaryotes that reproduce by prokaryotic fission. This division takes about an hour for many bacterial species. If 1000 bacteria are placed in a large flask with an unlimited supply of nutrients (so the nutrients will not become depleted), after an hour, there is one round of division and each organism divides, resulting in 2000 organisms an increase of 1000. In another hour, each of the 2000 organisms will double, producing 4000, an increase of 2000 organisms. After the third hour, there should be 8000 bacteria in the flask, an increase of 4000 organisms. The important concept of exponential growth is that the **population growth rate**, the number of organisms added in each reproductive generation, is accelerating; that is, it is increasing at a greater and greater rate. After 1 day and 24 of these cycles, the population would have increased from 1000 to more than 16 billion. When the population size, *N*, is plotted over time, a **J-shaped growth curve** is produced (Figure 4.3).

4.4.10 Logistic Growth

Exponential growth is possible only when infinite natural resources are available; this is not the case in the real world. Charles Darwin recognizedthis fact in his description of the “struggle for existence,” which states that individuals will compete (with

members of their own or other species) for limited resources. The successful ones will survive to pass on their own characteristics and traits (which we know now are transferred by genes) to the next generation at a greater rate (natural selection). To model the reality of limited resources, population ecologists developed the **logistic growth** model.

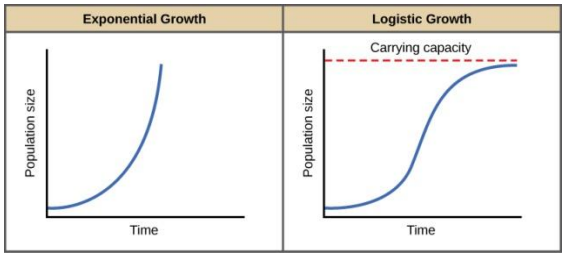

Fig 4.3. When resources are unlimited, populations exhibit exponential growth, resulting in a J-shaped curve. When resources are limited, populations exhibit logistic growth. In logistic growth, population expansion decreases as resources become scarce, and it levels off when the carrying capacity of the environment is reached, resulting in an S-shaped curve.

4.4.11 Carrying Capacity and the Logistic Model

In the real world, with its limited resources, exponential growth cannot continue indefinitely. Exponential growth may occur in environments where there are few individuals and plentiful resources, but when the number of individuals gets large enough, resources will be depleted, slowing the growth rate. Eventually, the growth rate will plateau or level off. This population size, which represents the maximum population size that a particular environment can support, is called the **carrying capacity,**

4.4.12 Role of Intra-specific Competition

The logistic model assumes that every individual within a population will have equal access to resources and, thus, an equal chance for survival. For plants, the amount of water, sunlight, nutrients, and the space to grow are the important resources, whereas in animals, important resources include food, water, shelter, nesting space, and mates.

In the real world, phenotypic variation among individuals within a population means that some individuals will be better adapted to their environment than others. The resulting competition between population members of the same species for resources is termed **intraspecific competition** (*intra–* = "within"; *–specific* = "species"). Intraspecific competition for resources may not affect populations that are well below their carrying capacity—resources are plentiful and all individuals can obtain what they need. However, as population size increases, this competition intensifies.

4.4.13 Human Population Growth

Concepts of animal population dynamics can be applied to human population growth. Humans are not unique in their ability to alter their environment. For example, larger dams alter the stream environment where they are built. Humans, however, have the ability to alter their environment to increase its carrying capacity sometimes to the detriment of other species (e.g., via artificial selection for crops that have a higher

yield). The world's human population is currently experiencing exponential growth even though human reproduction is far below its biotic potential (Figure 4.4). To reach its biotic potential, all females would have to become pregnant every nine months or so during their reproductive years. Also, resources would have to be such that the environment would support such growth. Neither of these two conditions exists. In spite of this fact, human population is still growing exponentially.

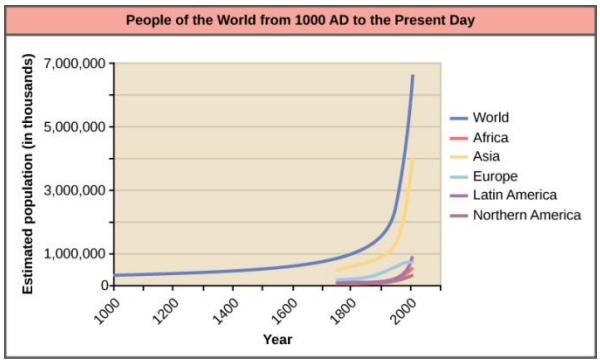

Fig.4.4. Human population growth since 1000 AD is exponential (dark blue line). Notice that while the population in Asia (yellow line), which has many economically underdeveloped countries, is increasing exponentially, the population in Europe (light blue line), where most of the countries are economically developed, is growing much more slowly.

4.4.14 Long-Term Consequences of Exponential Human Population Growth

Many direct predictions have been made about the world's population leading to a major crisis called the "population explosion." In the book *The Population Bomb*,Published in 1968 biologist Dr. Paul R. Ehrlich wrote, "The battle to feed all of humanity is over. In the 1970s hundreds of millions of people will starve to death in spite of any crash programs embarked upon now. At this late date nothing can prevent a substantial increase in the world death rate." While many critics view this statement as an exaggeration, the laws of exponential population growth are still in effect, and unchecked human population growth cannot continue indefinitely.

Efforts to control population growth led to the **one-child policy** in China, which used to include more severe consequences, but now imposes fines on urban couples who have more than one child. In spite of population control policies, the human population continues to grow. At some point the food supply may run out because of the subsequent need to produce more and more food to feed our population. The United Nations estimates that future world population growth may vary from 6 billion to 16 billion people by the year 2100. There is no way to know whether human population growth will moderate to the point where the crisis described by Dr. Ehrlich will be averted.

Another result of population growth is the endangerment of the natural environment. Many countries have attempted to reduce the human impact on climate change by

reducing their emission of the greenhouse gas carbon dioxide. However, these treaties have not been ratified by every country, and many underdeveloped countries trying to improve their economic condition may be less likely to agree with such provisions if it means slower economic development. Thus, we enter the future with considerable uncertainity about our ability to curb human population growth and protect our environment.

4.4.15 Population Regulation

A. In nature, population size and growth are limited by many factors. Some are density-dependent, while others are density-independent.
B. Density-dependent limiting factors

Imagine a population of organisms—let's say, deer—with access to a fixed, constant amount of food. When the population is small, the limited amount of food will be plenty for everyone. But, when the population gets large enough, the limited amount of food may no longer be sufficient, leading to competition among the deer. Because of the competition, some deer may die of starvation or fail to have offspring, decreasing the *per capita*—per individual—growth rate and causing population size to plateau or shrink. Therefore, competition for food is a density-dependent limiting factor. Most density-dependent factors make the *per capita* growth rate go down as the population increases. Density-dependent limiting factors can lead to a logistic pattern of growth, in which a population's size levels off at an environmentally determined maximum called the carrying capacity. Density-dependent limiting factors tend to be Biotic "living organism-related" as opposed to physical features of the environment. Some common examples of density-dependent limiting factors include:

Competition within the population. When a population reaches a high density, there are more individuals trying to use the same quantity of resources. This can lead to competition for food, water, shelter, mates, light, and other resources needed for survival and reproduction.

Predation. Higher-density populations may attract predators who wouldn't bother with a sparser population. When these predators eat individuals from the population, they decrease its numbers but may increase their own. This can produce interesting, cyclical patterns.

Disease and parasites. Disease is more likely to break out and result in deaths when more individuals are living together in the same place. Parasites are also more likely to spread under these conditions.

Waste accumulation High population densities can lead to the accumulation of harmful waste products that kill individuals or impair reproduction, reducing the population's growth.

C. Density-independent limiting factors

The second group of limiting factors consists of *density-independent* limiting factors that affect *per capita* growth rate independent of how dense the population is.

As an example, let's consider a wildfire that breaks out in a forest where deer live. The fire will kill any unlucky deer that are present, regardless of population size. An individual deer's chance of dying doesn't depend at all on how many other deer are around. Density-independent limiting factors often take the form of natural disasters, severe weather, and pollution.

Unlike density-dependent limiting factors, density-independent limiting factors alone can't keep a population at constant levels. That's because their strength doesn't depend on the size of the population, so they don't make a "correction" when the population size gets too large. Instead, they may lead to erratic, abrupt shifts in population size. Small populations may be at risk of getting wiped out by sporadic, density-independent events.

4.4.16 Population fluctuations

In the real world, many density-dependent and density-independent limiting factors can—and usually do—interact to produce the patterns of change we see in a population. For example, a population may be kept near carrying capacity by density-dependent factors for a period then experience an abrupt drop in numbers due to a density-independent event, such as a storm or fire.

However, even in the absence of catastrophes, populations are not always stably at carrying capacity. In fact, populations can fluctuate, or vary, in density in many different patterns. Some undergo irregular spikes and crashes in numbers. For instance, algae may bloom when an influx of phosphorous leads to unsustainable growth of the population.

4.4.17 Population cycles

Some populations undergo cyclical oscillations in size (Figure 4.5). *Cyclical oscillations* are repeating rises and drops in the size of the population over time. If we

graphed population size over time for a population with cyclical oscillations, it would look roughly like the wave below—though probably not quite as tidy!

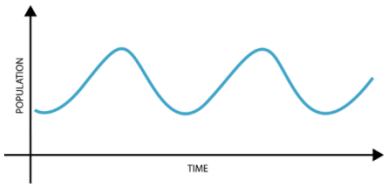

Fig.4.5: Graph with population on the y axis and time on the x axis. Population numbers oscillate over time, producing a wave shape.

Where do these oscillations come from? In many cases, oscillations are produced by interactions between populations of at least two different species.

For instance, predation, parasite infection, and fluctuation in food availability have all been shown to drive oscillations. These density-dependent factors don't *always* create oscillations. Instead, they only do so under the right conditions, when populations interact in specific ways.

4.5 COMMUNITY ECOLOGY

By definition, community represents the population of all species living and interacting in an area at a particular time. Population can, within limits, adapt to changes in environmental conditions. The major driving force of adaptation to environmental changes is believed by most biologists to be biological evolution, the change in a population's genetic makeup through successive generation. No plant or animal lives as isolated individual. Plants and animals generally prefer to live in groups or colonies.

Different plants and animals living in a habitat constitute a biotic community. When only assemblage of plants in a habitat is considered, it is plant community.

4.5.1 Concept of Community:

Each population has characteristics like natality, mortality, age structure, and growth dynamics and so on. But when several populations share a common habitat and its resources, they interact among themselves and develop into a biotic community or simply, a community.Microorganisms, plants and animals populations sharing a common habitat and interacting among themselves develop into biotic communities. The composition of a biotic community in any habitat is dependent upon the prevalence of environmental conditions in that habitat and the ecological amplitude of species populations.

Thus the climate and other abiotic as well as biotic conditions of a habitat determine the type of community which survives and develops. The organisms of a community usually exhibit trophic (feeding) relationships among themselves. They also interact in sharing the space and there may be interactions at a reproductive and behavioral level.
Each biotic community exhibits a number of characteristics, such as diversity, density, dominance, composition and stratification. Each community has its special limit. Sometimes the boundary between two communities may be very sharp or gradual.The transitional zone or junction between two or more diverse communities is called "eco-tone". The eco-tone harbours a community termed eco-tonal community with organisms of overlapping communities and some of unique types.Thus a population is a part of community and populations of different species may be intermingled in a community.

4.5.2 Structure of Community:

Communities may be small, consisting of few species populations in a small space, or large, comprising several species populations in a large area. The community structures, composition and other characteristics can be readily described by visual observation without actual measurement.Communities are usually categorised by the ecologists in various ways primarily based of habitat features like water availability, high exposure, or other habitat features.For instance, depending on the amount of water availability, plant communities may be hydrophytes (aquatic habitats), mesophytes (moderately moist soil habitat) and xerophytes (dry or arid habitat).Similarly communities growing on conditions of abundant light are called heliophytic and those growing in shade sciophytes.

In general, a community is dynamic since it changes over time. This dynamic nature is reflected in the succession of organisms in a habitat. A series of changes results in the development of a relatively stable community, which maintains its structure and influences the climate of the area.Such a stable and mature community is called a climax community, while communities of succession stages are called seral communities.

4.5.3 Species diversity

The biotic community is a natural assemblage of a large number of plant and animal species in an area. Actually it is a part of a larger whole ecosystem in which living and non-living components interact and bring about circulation, transformation and accumulation of energy and matter. Various species of plants and animals living in a community exhibit species diversity. Of the total number of species in a biotic

community a few species are abundant while a large percentage is rare.The common abundant species are called dominants whereas rare species determine species diversity. The ratios between the number of species, their biomass and productivity provide valuable information about community and are called species diversity indices.

Species diversity is high in natural community and low in managed ecosystem such as croplands. Because in any particular habitat there is no considerable variation in environmental conditions, the plants growing together in a community show unique uniformity in their behaviour. Vegetation therefore, is reflection of a climate and, in general, widely separated areas having similar climate have similar aspects of landscape.Some community areas have limits but more often the community boundaries are hard to define. A clearly distinguished area or a type of area with uniform habitat conditions and supporting characteristic type of vegetation is termed "biotope".

4.5.4. Coexistence:

Species occurring in the particular habitat do not live in complete isolation as pure cultures, but they coexist in mutual adjustment. The coexisting populations are interrelated and they show some sorts of interaction. The relationships, between coexisting species may be obligatory in one direction or in both. The trees in a forest community can live just as good as without shrubs and herbs which grow under them. This relationship is obligatory in one direction only. The relationship between plants and animals which pollinate them is obligatory in both directions.

The nature of interaction between two coexisting species may fall into one of the following types:

(i) Exploitation:

In this, one species lives at the expense of another.

(ii) Mutualism:

In this, two or more coexisting populations benefit from the relationship but none suffers.

(iii) Competition:

In this, two populations may compete for same resources of the habitat.

(iv) Neutralism:

In this, two populations may be quite independent and neither population affects the other.

4.5.5. Interdependency:

All the members of a community have ability to live under the conditions of the habitat and they are interdependent upon one another to some extent. It is called dependency. Thallophytes, mosses, ferns and many shade loving herbs that are found on the forest floor are dependent on the forest trees because trees provide shadow and moist conditions. If the trees of forest are removed, the ground vegetation may disappear.Similarly, the fungi and saprophytes found in the forest depend upon the roots of plants and on the rich humus and some fungi form mycorrhizal associations with the plant roots. Some sort of relationship also exists between plants and the insects and other animals which pollinate them.

4.5.6. Species dominance:

Not all the species of a community are found in abundance. Only a few species are found in abundance, either in number or in biomass (living weight) while the majority are rare. The common species which are abundant and contain maximum biomass are considered to be dominants. Dominant individuals influence the associated individuals.

In the forest, tallest trees, for example, influence the understory plants and ground vegetation not only by decreasing the intensity of light reaching the forest floor and increasing the moisture content of air but also by changing the soil structure and its chemical composition. The dominance in the community may be the result of co-action between two or more species. Different communities are generally recognized and named on the basis of dominant species occurring in them.

4.5.7. Stratification:

In a plant community, the plants, which have some sort of relationship among themselves, may be trees, shrubs, herbs, mosses, lichens and thallophytes. These plants form, more or less, distinct strata or layers or storeys on vertical as well as in horizontal planes. This is characteristically known as stratification. The individuals of different layers represent different life "forms". Each layer of community may sometimes include individuals of different morphological classes, as for example, the top layer or canopy of forest may be formed by tallest trees and lianes (woody climbers). In order to overcome this objection, plants belonging to different morphological classes are put in 'sinusiae' (singular—sinusia), as for example, trees are put in sinusia of trees; epiphytes are put in sinusia of epiphytes, and so on.

4.5.8. Succession:

Interacting populations of community are characterized by continuous death and replacement and usually by immigration and emigration (one way movement from

home range to other habitat) of their individuals. In this way, composition and shape of community remains in changing state.The changes in the community go on taking place until a complete balance is established between community and environment. This is called succession. At complete equilibrium state a stable community is established which is called climax community. In the climax community very little or no change in the shape can be anticipated over a long period of time.Thus with the change in the environment the composition of community also tends to change. The sequence of communities showing a gradual change in composition is called continuum. Community in such a gradient can be recognized as a discrete point with uniform floristic composition in the continuum.

4.5.9. Eco-tone:

In nature, there is no sharp line to indicate the end of one community and the beginning of another community. When two communities are adjacent, there is a zone of transition between them where the species of the two communities intermingle. The transition or marginal zone between two major communities presenting a situation of special ecological interest is called an eco-tone or transition zone.The transition zone between grassland and forest or the intermediate zone between any two major land or aquatic communities are the examples of eco-tone. Strictly speaking, a transition zone is an eco-tone only if tension exists between the bordering communities. The eco-tone is colonized by the species that are commonly found in the communities on both the sides, as well as by some versatile species of plants and animals. As a rule, the eco-tone contains more species and often denser populations than the bordering communities. This is known as 'principle of edges'. This edge effect is chiefly due to wider range of suitable environmental conditions.

4.6 HABITAT, MICROHABITAT AND NICHE

Habitat refers to a specific place where a species normally lives. For example, habitat of a tiger is the forest, of a shark is the sea, and of Plasmodium are the red blood cells. More than one animal or plant may live in the same habitat. For example, tiger, deer, wolf, fox, lion, etc. may be found in the same forest.Animals exhibit habitat specificity and require specific environmental conditions to live. For example, a fish lives in an aquatic habitat, but a river fish can live only in freshwater, while a sea fish can live only in a marine habitat. Some organisms are more tolerant than the other.

A habitat can be subdivided into regions with different environmental conditions.These subdivisions are called microhabitat. For example, in a pond, some organisms are surface dwellers while some others are bottom dwellers.For a species to maintain its population, its individuals must survive and reproduce. Certain

combinations of environmental conditions are necessary for individuals of each species to tolerate the physical environment, obtain energy and nutrients and avoid predators.The total requirements of a species, i.e. resources and physical conditions determine where it can live and how abundant it can be at any one place within its range. These requirements are termed abstractly as the ecological niche. In other words, niche is a term used to indicate not only the habitat but also the role played by the organisms in the environment.

Hutchinson suggested that the niche could be modeled as an imaginary space with many dimensions, in which each dimension or axis represents the range of specific environmental condition or resource that is required by the species. Thus, the niche of a plant might include the range of temperatures that it can tolerate, the intensity of light required for photosynthesis, specific humidity regimes and minimum quantities of essential soil nutrients for uptake.A habitat possesses many niches and supports many species. An organism changes its niches as they develop. For example, the common toad, *Bufo bufo* occupies the aquatic environment when it is a tadpole and feeds on algae and detritus. But after it metamorphosis's into an adult it becomes terrestrial and becomes insectivorous.

According to Odum, while the habitat is the organism's 'address', its ecological niche is its 'profession'. Two organisms may be found in the same habitat, but do not occupy the same ecological niche. Each plays a different role in its habitat. Different animals that occupy similar ecological niche in different geographical regions are called 'ecological equivalents'.

4.7 LET US SUM UP

- In **exponential growth**, a population's *per capita* (per individual) growth rate stays the same regardless of population size, making the population grow faster and faster as it gets larger.
- In nature, populations may grow exponentially for some period, but they will ultimately be limited by resource availability.
- In **logistic growth**, a population's *per capita* growth rate gets smaller and smaller as population size approaches a maximum imposed by limited resources in the environment, known as the **carrying capacity** (K*K*K).
- Exponential growth produces a **J-shaped curve**, while logistic growth produces an **S-shaped curve**.

- In nature, population size and growth are limited by many factors. Some are density-dependent, while others are density-independent.
- **Density-dependent** limiting factors cause a population's *per capita* growth rate to change—typically, to drop—with increasing population density. One example is competition for limited food among members of a population.
- **Density-independent** factors affect *per capita* growth rate independent of population density. Examples include natural disasters like forest fires.
- Limiting factors of different kinds can interact in complex ways to produce various patterns of population growth. Some populations show **cyclical oscillations**, in which population size changes predictably in a cycle.

4.8 MODEL QUESTIONS

A. Short Questions (Answer the question in about 150 words)

1. Define population?
2. What are the different parameters of population?

B. Long Questions (Answer each question in about 300-500 words)

1. How can be the population parameters are measured.
2. How does the population grow? How its growth is regulated?

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UNIT-5 POPULATION GROWTH AND CONTROLS

Structure

5.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- Explain optimum control of the **population density** and its role in improving the quality of life.
- Understand the need to achieve a **stable population** at a level consistent with the requirements of sustainable economic growth.
- Understand different methods or factors responsible in controlling **population** growth,
- Understand the impact of urbasination on society.
- Understand the effects of **urbanisation.**

5.2 INTRODUCTION

The word population has its origin in the Latin word *populous* meaning people. Population defined as a group of individuals of a particular species occupying a particular area at a specific time. The population of a species commonly arises as a result of reproduction. Many animal populations have built-in behavioural mechanisms-with-which they restrict their population size. Human populations do not have such mechanisms. In primitive and ancient civilizations, some social practices, such as religious human sacrifice, cannibalism, tribal war, restraining from sexual

things to do for few months after child birth and large-scale infant mortality prevent population growth to a massive extent. But in modern societies these practices have been stopped and because of proper medical care, the infant mortality has been considerably reduced. Since the number of children born was proportional to the size of the population, the increase of population in every year became greater than in the previous year, and gradually the total human population assumed massive proportions.All nations are committed in achieving a higher standard of living for their people—adequate food, good health, literacy, education, and gainful employment.Populations are characterized with such traits as dispersion, fluctuation in numbers, birth rate, death rate etc. The current population of India is at 132.42 crores (as of 2016) and is the second highest in the world. Population growth is determined by the annual growth rate, which is calculated in percent per annum. Like, if there is an increase of two people per 100 people of the population, then the annual growth rate would be 2%.The high population growth rate is associated with lack of education, and prevalence of poverty. Increased population means more requirements of clothes, food, housing and other facilities. Hence increased population puts a lot of strains on the resources of the world. Since all the human requirements like food, fodder etc., are to be raised from the-land, the pressure to produce more food from unit area of land increases and it brings lot of strain on the ecosystem. Besides, we dig out coal, petroleum, iron, copper and so on from the earth and all of the substances will be exhausted within a restricted number of years. The exhaustion time is reduced as the population is increasing and their demand on these resources also increasing.

5.3 POPULATION DENSITY

The uneven population distribution is caused by the country's varying population density. Population density = the total number of people per unit of area. In addition, population density depends mainly on the geographical location and geological factors. Therefore, States like Assam, Himachal Pradesh and other hilly terrains have a reduced population density and the northern plains and coastal areas like Kerala, West Bengal, and Maharashtra have a very high population density.Another important aspect of population study is the change in population. This is largely influenced by three main factors like birth, death, and migration of people in a given year.

- *Birth rate: The number of children born per 1000 people in a year*
- *Death rate: The number of people died per 1000 people in a year.*

The birth rate in India has always been higher than the death rate, which is a major reason for population growth. Migration is the third and one of the most significant variables in demographic change. Migration can be internal (between states) and international

(between countries). While internal migration does not alter the population change, it affects the density of population in the migrated areas.

5.4 CAHARACTERISTICS OF POPULATION IN INDIA

Age Composition

One of the most significant characteristics of population is the age composition that determines the social and economic structure of the country.The total population is divided into three age groups-

- Children- below 15 years
- Working-age- 15- 59 years
- Aged (Senior)- 59 years and above

Adolescent population

It is among significant and influential element of the age composition aspect of the population. Adolescents are people in our country in between the age groups of 10-19 years. Approximately one-fifth of the population include adolescent individuals. They are particularly important for future.

Sex Ratio

The population sex ratio is determined by the number of females for every 1000 males. This helps in understanding the male and female equality in society, thus giving an idea of the nation's culture. India's sex ratio has always been on the lower side, until recently. States like Kerala and Union Territory of Pondicherry have higher sex ratio than the major States.

Literacy Rate

This is another significant feature of the population because a country's literacy rate determines its economic structure and growth. Literacy, according to the 2001 Census is the ability of a 7 year old person to read and write in any language. The census shows the Indian population's literacy rate is nearly74.04% (2016).

Occupational Structure

The number of people in a population involved in different economic activities helps to assess the growth of the country's economy. The occupational structure is the population

distribution across various occupations. This is an important part of the India's population.The work structure has three wide categories-

- Primary occupation- agriculture, fishing, mining, animal husbandry, forestry etc.
- Secondary occupation- manufacturing, building, construction work etc.
- Tertiary occupation- communication, transportation, administration etc.

5.5CONTROL METHODS OF HUMAN POPULATION

India's population is quite large and growing rapidly. One percent growth rate implies an addition of 1 cores people every year but actually speaking 2 cores persons are being adding every year.The need for the hour is therefore efficient population control measures. We understand birth rates are mainly responsible for fast development of the population growth. Hence measures which can reduce the birth rate should be adopted. These measures can be classified into 3 heads.

A. Social measures
B. Economic measures
C. Other measures

A. Social measures:

Explosion of population is a social issue that is deeply rooted in society. So efforts must be done to eliminate this social evils in the country.

1. **Minimum age of marriage:**

As fertility depends on the age of marriage, so the minimum age of marriage should be raised. In India minimum age for marriage is 21 years for males and the law has set 18 years for females. This law should be firmly enforced and publicity should also be made to the people.

2. **Raising the status of women:**

There is still discrimination to the women. They are restricted to four walls of house. They are still restricted to children's rearing and bearing So women should be given opportunities to develop themselves socially and economically. Free education should be given to them.

3. **Spread of education:**

The spread of education changes the perspective of people. The educated people prefer to delay marriage and adopt small family norms. Educated females are aware of health and avoid frequent pregnancies, thereby helping to lower the birth rates.

4. **Adoption :**

Some parents do not have any child, despite costly medical treatment. It is advisable that they should adopt orphan children. It will be beneficial to both orphan children and childrens couples.

5. **Change in social outlook:**

Social perspective of the people should be changed. Marriage should no longer be considered a binding social relationship. It should not be looked down on isolated females

6. **Social security:**

Under-social security schemes should cover more and more people, so that they will not be dependant on others in the event of old age, sickness, and unemployment etc. With these facilities they will have no desire for more children.

B. Economic Measures:

The following are the economic measures**:**

1. **More employment opportunities:**

The first and foremost measure is to increase both rural as well as urban areas job oppurtunities. There is disguised unemployment in rural areas. So efforts should be made to migrate unemployed persons from rural to urban area. This step can monitor the population growth.

2. **Development of agriculture and industry:**

If agriculture and industry are developed properly, there will be employment for large number of people.They would improve their standard of living and adopt small family norms when their revenue is increased.

3. **Standard of living:**

Improved standard of living improved which acts as a deterrent to large family norm. In order to maintain their higher standard of living people prefer to have a small family. According to A.K. Das Gupta those who earn less than Rs. 100 per month have

on the average a reproduction rate of 3.4 children and those who earn more than Rs. 300 per month have a reproduction rate of 2.8 children.

4. Urbanization:

It is recorded that people in urban areas have low birth rate as compared to those living in rural areas. Therefore urbanization should be encouraged and promoted.

C. Other measures:

1. Late marriage:

Marriage should be solemnized at the age of 30 years as far as possible. This will decrease the reproductive period among the females which will reduce the birth rate.

2. Family planning:

This method involves choosing the family not by chance. People can control birth rates by implementing preventive measures,This method is widely used, success of this method depends on the availability of cheap birth control contraceptive devices.

3. Recreational facilities:

Birth rates are probable to drop if there are distinct recreational facilities such as cinema; theatre, sports and dance etc. are available to the people.

4. Publicity:

Communication media such as T.V., radio and newspaper are the right way to spread the benefits of the planned family to the uneducated and illiterate people,particularly in rural and backward areas of country.

5. Incentives:

The govt. showed provide various types of incentives to the people to take birth control measures. It is possible to extend monetary incentives and other amenities such as leave and promotion to the working class that adopts small family standards.

5.6 URBANIZATIONS AND ITS EFFECT ON HUMAN SOCIETY

What is Urbanisation?

Urbanization is the extent to which *urban* character or nature increases. It can refer to a geographical region that combines urban and rural areas, or to transform an individual locality from less to more urban.The term can describe a condition at a specific time, particularly the proportion of total population or area in **urban** localities or areas (cities and towns), or the rise in the proportion of people living in towns and

cities.Urbanization occurs because people move from rural areas to urban areas. This usually occurs when a country is still developing

5.7 CAUSES OF URBANISATION

Various reasons have led to the growth of cities. They are as follows:

i. Industrialization:

Industrialization is an important cause of urbanization. It has expanded the possibility of job. Because of better job possibilities, rural peoples are moving to towns

ii. Social factors:

Many social factors such as attraction of cities, better standard of living, better academic infrastructure and the need for status also induce people to move to cities.

iii. Employment opportunities*:*

Primarily people depend on agriculture for their livelihood in the rural sector. But Indian agriculture depends on monsoon, which is found to be irregular.Hence rural people migrate to cities in drought or natural disasters.

iv. Modernization:

Urban regions are defined by improved infrastructure, communication, and medical facilities etc. with advanced technology.People feel they can live in the cities comfortably and the before migrate to the cities.

v. Rural urban transformation:

It is interesting to note that not only cities are increasing in number but, also rural communities are adopting urban culture, so rural communities are no longer retaining their unique rural culture. Rural people are trying to pursue the material culture of urban people and a rural urban transformation is observed.

vi. Spread of education:

The literacy rate has increased among the rural people. They are showing the following advanced features-

i. Change in habits of dress.
ii. Modern technology adoption

iii. Enlightenment of women.
iv. Modern communication and transportation. E.g.: Cell phones have become common even among rural people.
v. Participation in active politics.

5.8 EFFECT ON URBANISATION

A number of significant changes have taken place with a high level of urbanization. The urbanization impact can be summarized as follows:

Positive effect:

i. Migration of rural people to urban areas.
ii. Opportunities for employment in urban centers.
iii. Facilities for transportation and communication.
iv. Facilities of education.
v. Increase in the standard of living.

Urbanization can have beneficial impacts, if it happens to a desirable limit. Extensive urbanization or indiscriminate growth may have adverse effects, which may be as follows:

i. Problem of over population: Population concentration is a major problem of cities. It has resulted in accommodation problem, growth of slums etc.

ii. Disintegration of Joint family:

Joint family can't be maintained in cities on account of high cost of living: People prefer to live in the nuclear type of families

iii) Cost of living: High cost of living is a major problem of cities. In metro cities like Mumbai, Banglore etc,it is very difficult for lower income group to maintain a decent standard of living

iv) Increase in crime rates: Urban areas are known for high rate of crimes. Theft, Dacoity, Murder, Cheating, Pick pocketing, rape etc. are common in urban areas.

v. Impersonal relations: Urban areas are defined by extremely secondary relationships. The concept of neighbourhood, in cities community life are almost absent. Urban life is highly monotonous. This can have a negative psychological effect

on individual. People are often self- centered and have no concern for fellow human beings.

vi. Problem of Pollution: Pollution is a major problems in industrialized cities. It may be caused by different industries or by excessive movement of vehicles.

viii. Stress: Urban life is characterised by stress that can even strain family relationships. Women's employment in cities is almost inevitable to meet the increasing cost of living. Changing the role of women in the family generates stress in the family that can result in divorce or strained relationship.

Thus urbanization has its own merits and de-merits. Urbanization can not be prevented. But the adverse effect of urbanization can be minimized.

Adverse effects

There is growing competition for facilities due to the high standard of living in urban regions, which has several adverse effects:

- Slums and its consequences of overcrowding.
- Lack of sanitation
- Poverty
- Illiteracy
- Unemployment
- Crime is the worst impact of urbanization.
- Global warming, air, pollution, water scarcity and pollution and loss of forest cover, agricultural land andwildlife depletion as a result of urban sprawl, pose severe threats to the environment.

5.9 LET US SUM UP

- The major challenge of the world today is to minimize the negative effects and build the benefits.
- Infrastructure needs to be improved. Opportunities should be created within rural areas to prevent migration to cities.
- Rural areas face many challenges that result from their sparse populations and the great distances that people must often travel. Among other problems, rural areas have a lack of economic opportunities in today's information age and a general lack of various kinds of human services.
- Rapid population growth and urbanization will have a dramatic effect on the increased demand for jobs, housing, energy, clean water, food, transportation

infrastructure, and social services.

- Urbanization is a consequence of population growth. Cities first developed in ancient times after the rise of horticultural and pastoral societies and "took off" during the Industrial Revolution as people moved to be near factories. Urbanization led to many social changes then and continues today to affect society.

5.10 MODEL QUESTIONS

1. What do you mean by the term density of population of a country?
2. What is the population of India according to the 2011 census ?
3. Describe the different methods for control of population growth ?
4. What is population density and describe different aspects ?
5. Describe characteristic of population of India ?
6. Write down the causes of urbanization ?
7. Briefely describe the effects of urbanization ?

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UNIT-6 DISEASES OF HUMANBEINGS

Unit Structure

6.1 LEARNING OBJECTIVES

After going through this unit, you will be able to,

- To monitor the trends and epidemiological determinants of communicable and non communicable diseases
- Evaluate the progress in their prevention and control

6.2 INTRODUCTION

A communicable disease is one in which the causative organism can move directly or indirectly from one person to another or it is also defined as the disease transmitted by

direct contact with an infected person or indirectly by a vector.It is also called as contagious disease.

6.3 TYPES OF COMMUNICABLE DISEASE

Communicable diseases are Measles, Polio, Chickungunya, Rabies, Leprosy and Plague

6.3.1 Measles

Measles or rubella is a viral infection of the respiratory system.It is the most common, highly communicable and a specific infectious disease affecting children. It is a viral disease which spread by droplet infection and spreads very rapidly. It appears to be due to a virus present in the nasal secretion, scrapings of skin etc. Its onset is characterised by sneezing, laryngitis, cough, running of the nose and eyes, photophobia, fever, muscular eruption, which is dusty red and velvety to touch. The rash does not develop fluid as in small-pox and chickenpox. An early sign is the presence of 'koplik' spots in the mouth, i.e. minute bluish white spot which may be seen on the gums and inside checks not on the palate. It occurs generally in an epidemic form and is infectious from the very beginning. Most people suffer from measles in childhood, and a mother who has had the disease confers passive immunity on her infant for the six months of life. The infection is generalised but the clinical evidence of it is mainly found in respiratory tract, the mouth and the conjunctives.

Epidemiological Determinants:

Agent Factors: Measles is caused by an RNA Paramyxovirus. The virus cannot survive in human body for, any length of time, but retains infectivity when stored at sub-zero temperature

a) **Sources of infection**: The definite source of infection of measles carriers isnot known.

b) **Infective Material**: Secretion of the nose, throat and respiratory tract of the patient during the prodromal stage and the early stages of eruption of the rash.

c) **Communicability:**Measles is highly infectious during the prodermal stage and at the time of eruption of the rash. Communicability declines rapidly after the appearance of the rash. The period of communicability is approximately 4 days before and 5 days after the appearance of the rash. So patient should be isolated for a week during the onset of the rash.

Mode or Transmission or Spread:

Transmission occurs directly as well as indirectly. The disease is transmitted from the sick to the healthy person by means of direct contact through discharges from nose and mouth. Infection through conjunctivae also cause transmission.

Prevention:

Measles is the most difficult disease to handle as it is most infectious in its pre-eruptive stage:

1. The nasal and buccal secretions should be wiped out with pieces of cloth and burnt away
2. Application of carbolised glycerine or Vaseline to the body.
3. Fomites should be disinfected (clothes, bedding and utensils)
4. Sickroom should be disinfected properly with Sulphur- dioxide or formaldehyde. Walls should be white washed.
5. Children should not be allowed to go to school (14 days from the appearance of the rash).
6. Proper sanitation should be maintained.
7. Proper care should be taken. Convalescent patient of measles should be given a bath with disinfectant lotion before mixing with others.
8. Convalescent serum, gamma — globulin or serum of adults has been tried intramuscularly

Immunization

A. Active Immunization: One injection of live attenuated measles virus could be given sub-cutaneously in children over one year old who have not had the disease.Inactivated virus vaccines with attenuated live virus are being tried with good results.

B. Passive immunization: Human immunoglobin given intramuscularly is recommended for the prevention or attenuation of measles particularly for contacts under 18 months of age and for debilitated children. The dose is 250mg for children under one year old and 500mg for those over this stage.

6.3.2 Polio

Acute Poliomyelitis:

Acute poliomyelitis or infantile paralysis is one of the main crippling diseases of childhood. It is an acute viral infection caused by an RNA virus and is highly communicable disease. This disease affects the central nervous system i.e. brain, spinal cord and nerves. So causes paralysis of voluntary muscles mostly the leg muscles. The legs are more affected then arms.

Agent Factor-

a) **Agent**: Polio caused by polios are virus which has serotypes 1, 2 and 3 most of paralytic polio due to type- I virus. Polio virus can survive for long period of cold environment. It can live in water for 4 months and for 6 months.

b) **Reservoir of infection**: Man is the only reservoir of infection. No animal source yet been found. Most infections are subclinical. It is the mild and subclinical infection that play a dominant role in the spread of infection.

Infectious material:

Polio virus is found in nasopharyngeal secretion (discharges of the mouth and nose), urine and feaces of the patients and carriers. The carriers play an important part in the spread of the disease. Faecal carriers are more dangerous than the nasopharyngeal carriers. The causative agent affects the nervous system, especially nerve cells of spinal cord and medulla oblongata.

Period of communicability:

The cases are most infectious in7 to 10 days before and after onset of symptoms. In the faeces, the viruses are excreted for 2 to 3 weeks. Sometimes for 3 to 4 months.

Host factors:

a) Age: It affects children of all ages. Children are more susceptible than adults because of the acquired immunity of the adults. In India, polio is a disease of infancy and childhood. The most vulnerable age is between 6 months and 3 years. Pregnant women, People with weakened immune systems, such as HIV + people and young children are the most susceptible to the polio virus.

b) Sex: Sex differences are in the ratio of three males to one female.

c) Risk factors: Several risk factors have been found to precipitate an attack of paralytic polio in individuals already infected with polio viruses. They include fatigue, trauma, and intramuscular injection.

d) Immunity:Following infection is fairly solid although reinfection can occur since infection with one type does not protect completely against the other two types of Virus. Type 2 virus appears to be the most effective antigen. Neutering antibody is an important index of immunity to polio after infection.

Mode of transmission or spread:

The mode of spread of Polio are

1. Direct mode
2. Indirect mode

1. Direct Mode:

a) Faecal — Oral Route: The infection spreads directly through contaminated fingers where hygiene is poor.

b) Droplets Infection -- This occurs in the acute phase of disease when the virus are present in the throat. Personal contact with an infected person helps droplet

2. Indirect Mode:

The infection may spread indirectly through contaminated water, milk, foods, flies and fomites (articles of daily use). Polio virus is transmitted from person to person through faecal matter. People living in areas with limited access to running water or flush toilets often gets the virus from drinking water contaminated by human waste that contain the virus.

Prevention and Control

1. Immediate or prompt notification of the case to the health authorities.
2. Isolation: The patient should be isolated. He/She should be given complete rest.
3. Proper disposal of excreta of the patient (urine and faeces) suffering from polio is to be done.
4. Drinking water should be chlorinated and all sources of water should be protected.
5. Milk should be properly boiled.
6. Fresh fruits and vegetables should be washed in a dilute permanganate solution.
7. Anti-fly measures should be adopted.

8. Immunization is the only means of preventing poliomyelitis.

It is essential to immunize all infants by 6 months of age to protect them against polio. There are

two types of vaccines.

a) Inactivated (Salk) polio vaccine (IPV)
b) Oral (Sabin) polio vaccine (OPV)

Pulse polio immunization:

The best way to prevent polio is to get vaccinated. Children should get polio shots according to the CDC vaccination schedule. Rarely the shots can cause mild or severe allergic reactions such as: breathing problems, high fever, dizziness, hives, swelling of throat, rapid heart rate.

Disease control Vaccination Schedule:

Age:
2 months — one dose
4 months — one dose
6 to 18 months — one dose
4 to 6 years — Booster dose

6.3.3 Chikungunya

The word 'Chikungunya' is believed to have been derived from a description in the Makonde language, meaning "that which bends up". The posture of people is affected with the severe joint pain and arthritic symptom with this disease, Chikungunya has been present mostly in developing countries.

Epidemiology:

Agent factor Chikungunya is a dengue like disease caused by a group of virus, the chikungunya virus and transmitted by Aedes, Culex and Mansonia mosquitoes. During outbreaks, due to high concentration of virus in the blood of those in the acute phase of infection, the virus can circulate from humans to mosquitoes and back to humans. In recent outbreaks in urban areas, the virus has transmitted by circulating between humans and mosquitoes.

Mode of transmission:

Chikungunya is generally transmitted from mosquitoes to humans though mosquito bites. Less common modes of transmitted include vertical transmission, which is transmission from mother to child during pregnancy or at birth and also transmitted via infected blood products. The disease occurs in the rainy season when the mosquito vector population is at its peak.

Chikungunya spreas through bites from Aedes mosquitoes and the species *A. aegypti* was identified as the most common Vector, though the virus has recently been associated with many other species, including *A. albopictus*. Other species potentially able to transmit the chikungunya virus include *A. albopictus, Ae. furcitfertaylori* and *Ae. africanus*

Incubation period: The incubation period of Chikungunya fever is 4 - 7 days.
Signs and Symptoms:

Symptoms usually begins or appears 4 - 7 days after being bitten by the infected mosquitoes.

Characteristics symptoms include:

1. Sudden onset of high fever, headache, insomnia, exhaustion up to 5 to 7 days.
2. Rashes occurs in 40 — 50% of cases
3. Inflammation of eyes may occur in the form of iridocyclitis, retinal lesions and conductivitis.
4. Digestive symptoms, including abdominal pain, nausea, vomiting, diarrhoea may also occur.
5. Pain, swelling and stiffness especially of the metacarpo phalangeal, wrist, elbow, shoulder, knee, ankle and metatarsal points
6. Pain may also occur in the muscles or ligaments.
7. Most patient feel better within a week. In some people the joint pains may persists for monthsand even years.
8. Chikungunya may cause long-term symptoms following acute infection. Common predictors of pro-longed symptoms are increased with age and prior rhermatological disease.This condition has been termed as chronic chikungunya virus

Prevention or Control:
Vector Control- The mosquitoes are the main target of control activities. Mosquito control focuses on eliminating the standing water where mosquitoes lay eggs and develop as larvae. If elimination of the standing water is not possible, insecticides or biological control agents can be added.It requires active community involvement to keep water storage containers free of mosquitoes and to eliminate the other breeding places of mosquitoes in and around houses and dwellings.

The organo-phosphorus insecticides, Abate is used as a larvicide which can prevent breeding up to 3 months, when applied on sand granules.It does not harm man and

does not affect the taste of water. Anti larval measures can prevent an epidemic, but do not give immediate results when an epidemic has already broken out. In such cases anti-adult measures can bring about a rapid interruption of transmission.

Treatment:

There is no vaccine to prevent or medicine to treat chikungunya virus. There is no specific treatment of chikungunya. Only supportive case is recommended and symptomatic treatment of fever and joint swelling is done.

1. The patient should take plenty of rest.
2. Enough fluid should be taken to prevent dehydration.
3. Analgesics, antipyretics like paracetamol, diclofenac, chloroquine along with fluid supplementation
4. Drugs like aspirin and steroids should be avoided. pyrethroids (for example in mosquito coils) are also insect repellents. As infected mosquitoes often feed and rest inside homes, using screens on windows and doors will help to keep mosquitoes out of the house.

6.3.4 Rabies

Rabies is also known as hydrophobia. It is an acute infectious disease and highly fatal viral disease caused by a virus that affect the central nervous system causing inflammation of brain. Rabies is communicated from a rabid animal to a susceptible animal usually through a wound produced by biting or even licking of a rabid animal on a scratche or an abraded surface. Domestic dogs, cats and rabbits and wild animal such as Jackals, wolves and bats are able to transfer the virus to human via bites and scratche. It is a viral disease and infection is localized in the nervous system and the salivary glands. When it affects man, the most characteristics symptom produced is hydrophobia, i.e. fear of water.

Epidemiological determinants

Agent Factor

Agent: The causative agent (lyssavirus type l) is a bullet shaped neurotropic RNA containing virus. It belongs to the family rhabdoviridae — serotype - I (Lyssavirus, Type -I) and is a causative agent of rabies. Serotype 2, 3 and 4 are rabies related. They cause rabies like disease in man and animals. Available anti rabies vaccine may not be effective against the rabies - related virus.

Rabies virus particles contain two distinct, major antigens:

1. Antigen from the virus membrane and an internal nucleo protein antigen. The glycoprotein seems to be the only antigen capable of inducing the formation of virus-neutralizing antibodies. The presence of neutralizing antibodies in the blood of man and animals is considered an index of protection against inaction with rabies virus.
2. Virus has been cloned and expressed in E-coil in a bid to develop genetically engineered rabiesVaccine.

Reservoirs of infection:

Rabies exists in 3 epidemiological forms. They are:

a) Urban
b) Wildlife (Sylvatic) rabies
c) Bat rabies

a) **Urban Rabies**: The transfer of infection from wild life to domestic dogs results in the creation of the urban cycle which is maintained by the dog and is responsible for of human cases in India. A single rabied dog is capable of biting a large number of humans, animals and may involve an area of over 40km in its short span of clinical illness.
b) **Wild life Rabies**: Wild life or sylvatic form of rabies presents an intractable problem. It is an unidentified reservoir of infection. The wild life cycle is perpetuated by the Jackal, fox, hyena and other wild life carriers which are the main reservoir and transmitters of rabies. In South Africa, the disease is enzootic in the mongoose. These animals maintain a cycle amongst them and transmit the infection to dogs and domestic animals. Man may occasionally contract rabies by intrusion into the wild life cycle of rabies.
c) **Bat Rabies**: In certain Latin American countries and parts of U.S.A. the vampire bat is an important host and vector of rabies. These bats feed exclusively on the blood of animals and man. They can transmit rabies to animals and humans. Rabies transmitted by the vampire bat is thought to kill hundreds of thousands,of cattle annually. Human are also affected when they sleep outdoors. Vampire bats have not been reported in India. The epidemiological importance of bats is that they provide a constant source of infection for wild animals and men, then enabling the virus to persist in nature.

Host factors:

All warm blooded animals including man are susceptible to rabies. Rabies in man a dead-end infection and has no survival value for the virus. The overwhelming number of victims in India belong to the age group 1-24 years. Laboratory staff working with

rabies virus, veterinarians, dog handlers, hunters and field naturalists face bigger risks of rabies than do general public.

Mode of transmission

The various modes of transmission are:

a) Animal bites

b) Licks

c) Aerosols

d) Person to Person

a) **Animal bites**: In India most of the human rabies cases have resulted from dog bites. Transmission of rabies virus to man is through rabid dog bites. The saliva of the dog contain the virus at the time of bite. Besides dogs, other animals such as cats, monkeys, horses, cows, goats, rabbits, sheeps, foxes, bats and woodchucks are the main sources of rabies infection in humans.

b) **Licks**: Licks on abraded skin and mucosa can transmit the disease. Dogs have the habits of licking

c) **Aerosols:**Aerosol (respiratory transmission may have observed in nature only in certain caves harboring rabies infected bats and in the laboratory, where aerosols created during homogenization of infected animal brains can infect lab workers.

d) **Person to Person**: Transmission of rabies from person to person is also possible for e.g. through bites. There are also transmission of rabies by corneal and organ transplants.

Incubation period:

Incubation period is extremely variable.

Risk factors:For most people the risk of contracting rabies is relatively low. However there are certain situations that may put the person at a higher risk. These include:

1. Living in an areas that is populated by bats.
2. Travelling to developing countries.
3. Living in rural area where there is greater exposure to wild animals and little or no access to vaccines and immunoglobin preventive therapy.
4. Frequent exposure to wild animals.

Symptoms of Rabies:

As the virus continues to attack the central nervous system, there are two different types of the disease can develop. They are:

(a) Furious Rabies

(b) Paralytic Rabies

a) **Furious Rabies**: Infected people who develop furious Rabies will be hyperactive and excitable and may display erratic behavior. Other symptoms include: insomnia, anxiety, confusion, agitation,hallucination, excess salivation problems of swallowing and fear of water.

b) **Paralytic Rabies:** This forms of rabies takes longer time to set in, but the effects are very severe. Infected people slowly become paralyzed, will eventually slip into a coma and die. According to the World Health Organisation (WHO), 30 percent of rabies cases areparalytic. Animals with rabies, transfer the virus to other animals, to people via saliva following a bite or via a scratch. Any contact with the mucus membranes or an open wound can also spread the virus. The transmission of this virus is considered to be exclusively from animalto animal and animal to human, but human to human transmission of the virus is extremely rare..

Rabies in man:

The symptoms are progressively aggravated and swallowing of liquid becomes difficult. At later stage the mere sight or sound of water may provoke spasm of the muscles of deglutition. This symptom of hydrophobia (fear of water) is seen in men and is absent in animals. The duration of illness is 2 to 3 days but may be prolonged to 5 — 6 days in exceptional cases. The patient may die during one of the convulsions or may pass on to the stage of paralysis and coma. Intensive care may allow an occasional patient to survive.

Diagnosis: A clinical diagnosis of hydrophobia can be made on the basis of history of bite by a rabid animal and characteristic signs and symptoms.

Rabies can be confirmed in patients early in the illness by antigen detection using immune fluorescence of skin biopsy and by virus isolation from saliva and other secretions

Prevention:

1. The patient should be isolated in a quiet room protected as far as possible from external stimulisuch as bright light, noise or cold draughts which may precipitate spasms or convulsions.
2. Relieve anxiety and pain by liberal use of sedatives.

3. If spastic muscular contractions are present, use drugs.
4. Intensive therapy in the form of respiratory and cardiac support may be givenPatients with rabies are potentially infectious because the virus may be present in the saliva,vomits, tears, urine or other body fluids. Persons attending rabid patients should be warned against possible risk of contamination and should wear face masks, gloves, goggles and aprons to protect themselves. Persons having bruises, cuts or open wounds should not look after the patient Rabies is a preventable disease.

Get a rabies vaccine before travelling to developing countries, working closely with animals.

Vaccines or Immunization of man:

All vaccines are tested in accordance with the control procedures laid down by WHO. Following Pasteur's initial development of rabies vaccine, a variety of rabies vaccines have been developed. The vaccines are of 3 types.

These are:

a) Nervous Tissue Vaccines (NTV)
b) Derived from adult animal nervous tissues (e.g.sheep)
c) Derived from suckling mouse brain.

6.3.5 Leprosy

Leprosy is also known as Hansen's disease (HD) after the scientist discovered M. Lepra in 1873. It is a chronic infectious disease caused by the bacilli *Mycobacterium Leprae* and *Mycobacterium Lepromatosis* is a relatively newly identified mycobacterium isolated from a fatal case of diffuse *lepromatous leprosy* in 2008.It causes severe, disfiguring skin sores and nerve damage in the arms and legs. It also affects the skin, muscles, eyes, bones, testes and internal organs. Leprosy is clinically characterized by one or more of the following cardinal features :

a) Hypo pigmented patches,
b) Partial or total loss of cutaneous sensation in the affected areas (the earliest sensation to be affectedis usually light touch).
c) Presence of thickened nerves

These are two varieties of Leprosy:

1. Infective Leprosy
2. Non-infective leprosy

1. **Infective Leprosy**: It is called 'Lepromatous Leprosy'. Infective patients shed germs from the nose, throat and skin.

2. **Non-infective Leprosy**: Non-infective leprosy is generally known as Neural of 'Non-Lepromatous'. It is of two kinds.
   These are :
   a) Leprosy without patches on the skin.
   b) Leprosy with patches on the skin.

Epidemiological determinants:
Agent Factors:

a) **Agent**: Leprosy is caused by *M. Leprae*. They are acid-fast and occur in humal host both intracellularly and extracellularly. They occur characteristically in clumps or bundle called globi). They have an affinity for Schwann cells. As many as 2 to 7 billion were estimated in one gram of numerous antigens (more than 20) have been detected in *M. Leprae* by dielectrophoretic techniques

b) **Source of infection**: The current view is that all patient with 'active leprosy' must be considered infectious. Until recently man was considered to be the only host and source of infection. There is now evidence that natural infections with *M. Leprae* are present in wild animals i.e. armadillos, sooty mangabey monkey, African chimpanzees, Cynomolgus macaque and red squirrels. It is not yet known if leprosy in wild animals is a threat to public health.

c) The nose is the major portal of exit. Lepromatous cases harbor millions of M. Leprae in their nasal mucosa which are discharged when they sneeze or blow the nose. The bacilli can also exit through ulcerated or broken skin of bacteriologically positive cases of leprosy.

d) **Infectivity**: Leprosy is highly infectious disease but of low pathogenicity. It is claimed that an infectious patient can be rendered non-infectious by treatment with dapsonefor about 90 days or with rifampicin for 3 weeks..

e) **Attack rates**: Among household contacts of Lepromatous cases, a varying proportion 4 percentto12 percent is expected to show signs of leprosy within 5 years.

Risk factors:The greatest risk factor for developing leprosy is contact with another case of leprosy. Contacts of people with leprosy are 5 to 8 times more likely to develop leprosy than members of the general population. Other risk factors are poorly understood. However conditions that reduce immune function, such as malnutrition, other illness or host genetic difference may increase the risk of developing leprosy. Despite this infection with HIV does not appear to increase the risk of developing leprosy.

Host factors:

Age: Leprosy is not particularly a disease of children as was once believed.Infection can take place at any time and at any age depending upon the opportunities for exposure. In epidemic areas, the disease is acquired commonly during childhood. In areas where leprosy is rare, the first contact may not take place early in life, and consequently the disease may appear late.

Sex: The prevalence of Leprosy is higher in males than in females in most regions of the world. Sex difference is found least in children below 15 years and more marked among adults.

Migration: In India Leprosy was seen mostly in rural areas. But due to movement of people from rural to urban areas. Leprosy is seen in urban areas also.

6.3.6 Plague

The plague is a serious bacterial infection which can be deadly. It is sometimes referred to as the"black plague", and is caused by the bacterium Y. pestis.This bacteria is found on animals throughout the world is usually transmitted to humans through rodents and fleas.In medieval times, the plague or 'black death' was responsible for the deaths of millions of people in Europe.Today the risk of developing plague is quite low with only 1,000 to 2,000 cases reported to World Health Organization (WHO) each year with the highest incidence in Africa.

Types of Plague:
There are three basic forms of plague. They are:

1. Bubonic Plague
2. Pneumonic Plague
3. Septicaemic Plague

1. **Bubonic Plague**: The most common form of plague is bubonic plague. It occurs when an infected rodent or flea bites the person. In very rare cases the person can get the bacteria from the material that has come into contact with an infected person.
2. **Pneumonic Plague**: When the bacteria spreads to the lungs, pneumonic plague occurs. When the person with pneumonic plague coughs, the bacteria from their lungs are expelled into the air. Other people who breathe that air can develop this form of plague, which can lead to an epidemic. Pneumonic plague

is the only form of the plague that can be transmitted from person to person. It is not spread by rat or fleas.

3. **Septicaemic Plague**: When the bacteria enter the blood stream directly and multiply there, it is known as septicemic plague. When they are left untreated, both bubonic and pneumonic plague can lead to septicemic plague. It is rare and is invariably fatal.

Epidemiological determinants:

Agent Factors:

a) **Agent:** The causative agent is Y.Pestis which is a Gram - negative, non-motile, coceo-baccilus that exhibits bipolar staining with special stains (e.g. Way son's stain). The bacilli occur in great abundance in the buboes of all cases of bubonic, in sputum of pneumonic plague and blood of septicemia cases. It is also present in spleen, liver, kidney, lungs and other viscera of infected persons and in blood in small number. The plague bacilli can survive and multiply in the soil of rodent burrows where the climatic and other conditions are favorable.

b) **Reservoir of infection**: Wild rodents (e.g. field mice, gerbils, skunks and other small animals) are the natural reservoirs of plague. These are found in the mountains, deserts cultivated areas, forests in temperate and tropical regions of India. The wild rodent, *Tatera indica* is the main reservoir, not the domestic rat. Y.pestis circulates in animal reservoirs,particularly in rodents

c) **Source of infection**: Infected rodents, fleas and case of pneumonic are the source of infection.

Host factors:

a) Age and sex: All ages and both sex are susceptible to plague.
b) Human activities: Man may come into contact with natural foci in the course of hunting grazing, cultivation, harvesting, construction activities or while engaging in outdoor recreational activities. These activities offer opportunities for flea-man contact.
c) Movement of people: Plague is associated with movement of people and cargo by sea or land.
d) Rats and rat fleas are transported in this way.
e) Immunity: Man has no natural immunity. Immunity develops after recovery.

Risk factor: The risk of plague is highest in areas that have poor sanitation, overcrowding and large population of rodents.

Complications

Complications of plague may include:

- **Death.** Most people who receive prompt antibiotic treatment survive bubonic plague. Untreated plague has a high fatality rate.
- **Gangrene.** Blood clots in the tiny blood vessels of fingers and toes can disrupt blood flow and cause that tissue to die. The portions of fingers and toes that have died may need to be removed (amputated).
- **Meningitis.** Rarely, plague may cause inflammation of the membranes surrounding the brain and spinal cord (meningitis).

Control of fleas:

The most effective method to break the chain of transmission (Rodent - flea-man) is the restriction of rat fleas by the proper application of an effective insecticide. Flea control must coincide anti-rodent measures. DDT and BHC should be used as dusts containing 10 percent and 3 percent of the active ingredient respectively. In areas where resistance to one or both of these insecticides occurs, dusts of carbonyl (2%) on malathion (5%) should prove effective.

Vaccination:

- Immunization with plague vaccine is a valuable preventive measure. The WHO recommends that under all circumstances, vaccination should be only for the prevention, not the control of human plague. To be effective, vaccination should be carried out at least a week before an anticipated outbreak and the vaccine should be given in 2 dose.
- The vaccine is given subcutaneously in two doses of 0.5 and 1.0ml at an interval of 7 to 14 days. A single dose will not result in dependable protection. In an emergency when it is desired to carry out primary immunization by means of a single injection, the dose should be double. The second dose that is 3ml for adult males. Immunity starts 5 to 7 days after inoculation and lasts for about 6 months. Booster doses are recommended six-monthly for persons at continuing risk of infection.
- The reactions after inoculations are pain, tenderness, headache etc, appear few hours and subside in 1 to 2 days.

Prevention

No effective vaccine is available but scientists are working to develop one. Antibiotics can help prevent infection if you're at risk of or have been exposed to plague. Take the following precautions if you live or spend time in areas where plague outbreaks occur:

- **Rodent-proof your home.** Home should be kept free from stacks of cluttered firewood or piles of rock, brush or other debris that could attract rodents take steps to control it.
- **Keep your pets free of fleas.** Pets should be protected from fleas using plea control protects. Pets that roam freely outdoors may be more likely to come into contact with plague infected fleas or animals: So pets should not be allowed to room freely outside the home. If the pet becomes sick,veterinary doctor should be consulted.
- **Wear gloves.** When handling potentially infected animals, wear gloves to prevent contact between skin and harmful bacteria.
- **Use insect repellent.** Closely supervise the children and pets when spending time outside in areas with large rodent populations. Use insect repellent.

6.4 NON-COMMUNICABLEDISEASES

What is non-communicable diseases?

Non Communicable Diseases (NCD) continue to be important public health problem throughout the world. It is a medical condition or disease that is non-infectious or non-transmissible. (Non communicable diseases refer to chronic diseases which lasts for long periods of time and progress slowly. Sometimes NCDS are referred as "chronic diseases" but it is not true. Those are distinguished only by their infectious cause, not necessarily by their duration. Some chronic diseases, of long duration such as HIV/ AIDS are caused by infections. Chronic diseases require chronic care management like all other diseases that are slow to develop and of long duration. Non-communicable diseases (NCDS) include cardiovascular, renal, nervous and mental diseases, musculoskeletal condition such as arthritis and allied diseases, chronic nonspecific respiratory diseases e.g. bronchitis, asthma, permanent results of accidents, blindness, cancer, diabetes, obesity and various other metabolic and degenerative diseases and chronic results of communicable diseases. Disorders of unknown cause and progressive course are often labelled "degenerative".

6.5 TYPES OF NON-COMMUNICABLE DISEASES

Noncommunicable diseases are Hypertension, Coronary heart disease, stroke,diabetes.

6.5.1 Hypertension (High Blood Pressure)

Hypertension is increasing day by day throughout the world. The number of people living with high blood pressure is predicted to be 1.56 billion worldwide by the year 2025. The World Health Organisation estimated that High Blood Pressure is responsible for one in every 8 deaths worldwide, making hypertension the third leading killer in the world. High blood pressure is a common disorder amongst the middle and the old age groups i.e.40 to 60 years. It may sometimes be secondary to diseases of kidneys or endocrine glands like supra-renals or pituitary that may respond to treatment. Blood Pressure is at its highest, when the heart beats and pumps that blood called systolic pressure. When heart is at rest between the beats, the blood pressure falls i.e. called diastolic pressure .The normal blood pressure is 120mm Hg/80mm Hg ('mm Hg'- stands for millimeters of mercury, a unit of pressure). Blood Pressure is measured by . using an instrument known as **sphygmomanometer**.

Different types of hypertension:

i. **Mild hypertension** (diastolic pressure 90 to 104).

   This condition may be found accidentally in the course of a life insurance or routine medical examinations and the patient may complain of no symptoms. But it is good to check in future, in case it shows a tendency to rise.

ii. **Moderate hypertension:**

   The common symptoms are headache, cardiac discomfort and breathlessness. If the patient is over for loss of weight i.e. about 1 to 1.5 Kg/week should be done to bring a significant fall in blood pressure. This is very important because it may leads to cardiac heart disease if High Blood Pressure and Obesity co-exist. Patients should be trained how to avoid emotional stress and excessive physical activity.

iii. **Severe hypertension** (diastolic pressure over 120 to 130mm Hg & Above)

iv. **Malignant hypertension**: This occurs along with diseases of heart, retina, kidneys orPeripheral arteries; two lines of treatment are useful.

Table No.1:Classification of blood pressure for adults age of 18 years or older

Category	Systolic BP (mmllg)	Diastolic BP (mmllg)
Optimal	< 120	< 80
Normal	120-129	80-84 85-89
High-normal	130-139	
Hypertension		90-99
Stage 1	140-159	100-109
Stage 2		110-119
Stage 3	160-179	
	180-209	> 120
Stage 4	>210	

Source: Whelton PK. Epidemiology of hypertension. Lancet 1994

Symptoms:

Persons with hypertension have symptoms and the condition is discovered in the course of a routine physical examination as per life insurance. Among the symptoms which are frequently observed when the blood pressure is rising are;

Headache, Dizziness, Impaired vision, Loss of memory, Pain over heart,unexplained tiredness,Cardiac failure-60% and Renal Failure.

Treatment:

The treatment consists of the following (l) Rest (2) Administration of drugs to reduce blood pressure & (3) diet.

1. Rest: Rest is essential in advanced cases of hypertension. Over work, worry and emotional stress tend to aggravate the condition.
2. Medicine : Tranquilizers and sedatives are useful for relief of anxiety and emotional tension. Those should be taken only in limited doses. Rauwolfia alkaloids, ganglion blocking drugs, and sympathetic blocking drugs.
3. Diet : Diet is an important factor in the management of hypertension. A low sodium rice diet suggested by Kempher (1948) has been extensively used in the treatment of cases with hypertension. The beneficial effects of this diet have been attributed to its low calorie, low protein, low fat and low sodium contents. The modifications required in the diet are as follows:

a) Calories: Calories should be just adequate to meet the daily requirements.

b) Proteins: A diet of 60gm protein is necessary to maintain proper nutrition. In severe hypertension protein restriction to 20gm may be necessary as temporary measure as foods rich in protein are also rich in sodium.

c) Vitamins: Vitamin intake should be subjected to take one-multivitamin mineral tablet daily.

d) Minerals: Low sodium diet may be beneficial. Kempher rice diet is given to thepatient because it contains low sodium content Severe restriction of sodium in diet may be harmful e.g. in some cases, it may lead to renal failure.In a resistant case the diet has to be very low in sodium (i.e. not more than 0.5 gm sodium chloride a day). It is difficult for an ambulatory patient to follow poor sodium diet.

e) Sodium:Ingestion of excessive sodium tends to increase the blood pressure and vice-versa. Hence, sodium intake should be restricted between 200-400 mg depending on the severity of disease. Usually, in hypertension odema is seen. When odema is not present then sodium can be increased slowly when the patient recovers from odema then 1 - 1.5 gms Na/day is given. In normal person diet sodium is given 3-6 gm per day.

f) Potassium: If diuretics are administered to a hypertensive patient, then diet should be supplemented with potassium salts, to make up for the potassium excreted in the urine such as2-4 gm Potassium 3 times a day. Cereals, vegetable soups, fruit juice etc. are given.

g) Fluids: With a free flow of urine, fluid restriction is not necessary. With odema, fluids are restricted, mild but in the absence of odema, fluids are given in adequate amounts.

h) Kempher rice diet :

   For a hypertension patient Kempher give a diet of rice, fruit and sugar. It provides about 2000 Kcal, 20 gm fat, 20 gm proteins, 150mg sodium and 200 mg chloride. All fruits and fruit juices are permitted. The fluid intake is limited to 700-1000 ml to meet the daily needs. Vitamin supplement are given to meet the daily needs of different vitamins.

Foods not permitted:

Cheese, peanut butter, salted butter, frozen peas, shell fish and dry fish,

Prepared mixes.Biscuits, cakes, breads, pastries, salt in cooking or at the table.

6.5.2 Coronary Heart Disease

Coronary Heart Disease (CHD) is a disease in which a waxy substance called plaque build up inside the coronary arteries. These arteries supply oxygen-rich blood to heart muscle. When plaque builds up in the arteries, the condition is called atherosclerosis. The plaque take many years to build up over the time, the plaque can harden or/rupture. The hardened plaque narrows the coronary arteries and reduces the flow of oxygen-rich blood to the heart. If the Plaque ruptures a blood clot can form on its surface. A large blood clot can mostly or completely block blood flow through coronary artery. Over time ruptured plaque also hardens and narrows the coronary arteries.Coronary Heart Disease (Ischaemic heart disease) maybe defined as "impairment of heart function due to inadequate blood flow to the heart compared to its needs caused by obstructive changes in the coronary circulation to the heart." It is the cause of 25 to 30 percent of deaths in most industrialized countries. The WHO has drawn attention to the fact that CHD is our modern epidemic. The other names of coronary heart Disease are

- Artherosclerosis, coronary artery disease, hardening of the arteries , Heart disease, Ischemic (IS-KE-Mik) heart disease and narrowing of the arteries

Risk Factors:

Coronary artery disease has a number of well determined risk factors, some are modifiable and others are immutable. Age, sex, family history, genetic factors and personality are not modifiable. Certain traits, conditions or habits which raise the risk for CHD) are modifiable which help to prevent or delay.Those are: Smoking,High blood pressure (Elevated serum cholesterol of Diabetes Obesity), sedentary habits, slack of exercise and stress.

Smoking: Smoking can damage and tighten blood vessels leading to unhealthy cholesterol levels and raising of blood pressure. It has been identified as a major CHD risk factor with several possible mechanisms - carbon monoxide induced artherogenesis, nicotine stimulation of adrenergic drive raising both blood pressure and myocardial oxygen demand, lipid metabolism with fall in "protective" high density lipo-protein etc.

Hyper tension: It is single most useful test for identifying individuals at a high risk of developing CHD. It accelerates the atherosclerotic process, especially if hyper-lipidemia is also present and contributes importantly to CHD. Blood pressure is considered to be high if it stay at or above 140/90 mm Hg over time. If you have diabetes or chronic kidney disease high blood pressure is defined as 130/80 mm Hg

or higher. (The mm Hg is millimeters of mercury, the units used to measure blood pressure).

Unhealthy blood cholesterol level: Elevation of serum cholesterol is one of the important factors which carried an increased risk for development of myocardial infarction. It includes high LDL cholesterol (bad cholesterol) and low HDL cholesterol (good cholesterol).The level of low-density lipoprotein (LDL) cholesterol is directly associated with CHD) while Very Low Density Lipoprotein (VLDL) is associated with premature artherosclerosis which is more strongly associated with peripheral vascular disease than with CEIL)' High density lipoprotein (HDL) cholesterol is protective against the development of CHD).

Diabetes: The risk of CHD is 2-3 times higher in diabetics than in non-diabetics. It is responsible for 30 to 50 percent of deaths in diabetics over the age of 40 years in industrialized countries.

Physically inactive: Physically inactive worsen the risk factors for CHD such as unhealthy blood Cholesterol levels, high blood pressure, diabetes and obesity.

Genetic Factors: A family history of CHD is known to increase the risk of premature death, specificallyifa father or brother diagnosed before age 55 and a mother or sister before age 65.

Alcohol: High alcohol in-take is an independent risk factor for CHD, hypertension and all cardiovascular diseases i.e. 75 gms or more per day.

Oral Contraceptives: Women using oral contraceptives seems to increase risk of myocardial infarction.

Sleep apnea: It is a common disorder in which one may have one or more pauses in breathing or shallow breathing. Untreated sleep apnea can increase the risk of high blood pressure, diabetes and even a heart attack or stroke.

Stress: Research shows that the most commonly reported "trigger" for heart attack is an emotionally upset event i.e. anger

Heart attack: A heart attack occurs if the flow of oxygen rich blood to a section of heart muscle is cut off.The most-common symptom of heart attack is chest pain or discomfort in the centre or left side of the chest that often lasts for more than a few minutes or goes away and comes back. The discomfort can feel like uncomfortable pressure, squeezing, fullness or pain.

Heart Failure:

Heart failure is a condition in which heart cannot pump enough blood to meet body's needs. Heart failure does not mean that heart has stopped or is about to stop working The most common signs and symptoms of heart failure are shortness of breath or trouble breathing . fatigue and swelling in the ankles, feet, legs, stomach and veins in the neck.

Arrhythmia: It is a problem with rate or rhythm of the heart beat. Some people describe it as fluttering feeling in the chest. Sometime it may cause Sudden Cardiac Arrest (SCA).

Diagnosis of Coronary Heart Disease:

Doctors diagnose coronary heart disease based on medical and family histories. No single test can diagnose CHD. If doctor thinks that one has CHD, they may recommend for ECG (Electrocardiogram) which shows rate and rhythm of heart beat and also strength and timing of electrical signals pass through the heart, stress testing, electro cardiographs, chest x-ray, blood tests, coronary angiography and catheterization.

Prevention

Upto 90% of cardiovascular disease may be preventable if established risk factors are avoided. Prevention involves: exercise, decreasing obesity, treating hypertension, a healthy diet decreasing cholesterol levels and stopping smoking medications and exercise are roughly equally effective. High levels of physical activity reduce the risk of coronary artery disease by about 25%.

Healthy diet: This includes

- Fat free or low fat dairy products such as fat free milk.
- Fish rich in omega-3 fatty acids such as salmon, tuna and trout about twice a week.
- Fruits such as apples, bananas, oranges, pears and prunes.
- Legumes such as kidney beans, lentils, chickpea, black-eyed peas, and lima beans.
- Vegetables such as broccoli, cabbage and carrots.
- Whole grains such as oatmeal, brown rice. .

Medical Procedures and Surgery

Both PCI (Percutaneous Coronary Intervention) and CABG (Coronary Artery Bypass Grafting) are used to treat blocked coronary arteries.

(i) **Percutaneous Coronary Intervention (PCI): It** is commonly known as angioplasty. This is a non surgical procedure that opens blocked or narrowed coronary arteries.

(ii) **Coronary Artery Bypass Grafting (CABG):** It is a type of surgery in which arteries or veins from other areas of body are used to bypass (that is go around) narrowed coronary arteries. CABG can improve blood flow to heart, relieve chest pain and possibly prevent a heart attack.

(iii) **Cardiac Rehabilitation:** Cardiac rehabilitation is a medically supervised programme that may help to improve the health and well being of people who have heart problems. The cardiac rehabilitation team includes doctors, nurses, exercise specialists, physical and occupational therapists, dietitians or nutritionists and psychologists or other mental health specialists.

Parts of rehabilitation:

Education, Counselling and Training:This part of rehabilitation helps to understand heart condition and find ways to reduce risk for future heart problems. The rehabilitation team help the patient to cope with stress of adjusting to a new life style and to deal with fears about future.

Exercise: This helps to learn how to exercise smoothly, strengthen muscles, and improve stamina. Exercise should be done according to personal abilities, needs and interests.

6.5.3 Stroke

"Stroke" occurs when the supply of blood to the brain is either interrupted or reduced due to rupture of blood vessels within the brain or blockage of blood supply to the brain. When this happens, the brain does not get enough oxygen or nutrients which cause brain cells to die. WHO defined stroke as "rapidly developed clinical signs focal disturbances of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin.. About half of people who have a stroke live less than one year. Advanced age is one of the most significant risk factor, 950/0 of strokes occur in People age 45 and older and two thirds of strokes occur in those over the age of 65.

Different typesof Stroke

a) **Ischemic Stroke:** It is the most common form of stroke accounting for around 85% of strokes. In this type of stroke blood supply to a part of the brain is decreased due to blockages or narrowing of the arteries leading to dysfunction of the brain tissue in that-area. There are four reasons for this stroke.Classification is based on clinical symptoms as well as results of further investigations. On this basis a stroke is classified as being due to:

i. Thrombosis or embolism due to atherosclerosis of a large artery.
ii. Embolism originating in the heart
iii. Complete blockage of a small blood vessels.
iv. Other determined cause
v. Undetermined cause

Uses of stimulant drugs such as cocaine and methamphetamine are at a high risk for ischemic Strokes.

b) **HemorrhagicStroke**: These are caused by arteries in the brain either due to leaking blood or bursting openthe leaked blood puts pressure on brain cells and damages them. Blood vessels can burst or spill blood in the middle of the brain or near the surface of the brain, sending blood into the space between the brain and the skull.The ruptures may be due to hypertensions,trauma and blood thinning.There are mainly two types of hemorrhagic stroke.

(i) Cerebral haemorrhage (also known as intracerebralhemorrhage): It is the most common type hemorrhagic stroke. It occurs when there is bleeding within the brain itself (when an artery in brain bursts, nodding the surrounding tissue with blood), due to either intraparenchymalhemorrhage (bleeding within the brain tissue) or intraventricularhemorrhage (bleeding within the brains ventricular system).

(ii) Subarachnoid hemorrhage: It is the second type of hemorrhagic stroke and less common. In this type of stroke the bleeding occurs in the subarachnoid space the area between the brain and the thin tissues that cover it. Basically bleeding occurs outside of the brain tissue but still within the skull and precisely between the arachnoids matters and pia matters (the delicate innermost layer of the three layers of the meninges) that surround the brain.

CAUSES OF STROKE:

A.Risk factors: Stroke does not occur at random, these are preceided by several years. These are:

i. Hypertension - the main risk factor
ii. Cardiac abnormalities
iii. Diabetes
iv. Elevated blood lipids
v. Obesity
vi. Smoking
vii. Glucose intolerance
viii. Blood clotting & viscosity
ix. Oral contraceptive

B. Host factor

a) Age: Stroke can occur at any age. In developed countries over 80% of deaths occur related to stroke in above 65 years. In India about one-fifths deaths occur due to stroke below the age group of 40 years.

b) Sex: The incidence rates are higher in males in comparison to female.

Recent developments of causes of stroke are:

- Poor thinking skills related to planning, problem solving and reasoning.
- Longer working hours i.e. 55 hours or' more per week may lead to greater risk.
- Older men who take alpha blockers are at high risk of stroke.
- Broken sleep i.e. elderly people who sleep poorly and awaken frequently are more likely to have hardened blood vessels or oxygen starved tissue in the brain.

Signs and symptoms

Strokes occur suddenly over second to minutes, without warning. The symptoms depend on the area of the brain affected. Some forms of stroke can cause additional symptoms.

The main symptoms of stroke are as follows:

i. Confusion which includes troubles with speaking and understanding.
ii. Headache possibly with altered consciousness or vomiting.
iii. Numbness of face, arms or leg particularly on one side of the body.
iv. Trouble with seeing, in one or both eyes.

v. Trouble with walking, including dizziness and lack of co-ordination.

TYPES OF DIAGNOSIS

a) Physical examination: Which includes medical history, symptoms checking blood pressure, listen to carotid arteries in the neck, and examine blood vessels at the back of the eyes, all the check for indications of clotting.

b) Blood Tests: Blood clotting time and blood clotting factors.

c) C.T. Scan : A series of x-rays that can show hemorrhages, stokes, tumors and other conditions within the brain.

d) MRI Scan: Radio waves and magnets create an image of the brain to detect damaged brain tissue.

e) Carotid ultra sound: to see blood flow of the carotid arteries and to see if there is only plaque present.

f) Carotid angiogram: Dyes are injected into the brain's blood vessels to make them visible under X-ray in order to give a detailed view of the brain and neck arteries.

g) Echo cardiogram: A detailed image of the heart is created to check presence of clot in the brain.

TREATMENT

Ischemic and hemorrhagic stroke: require different forms of treatment as we know ischemic strokes are caused by arteries being blocked or narrowed and so treatment focuses on restoring an adequate flow of blood to the brain.Treatment can begin with drugs to breakdown clots and prevents further clot formation. Aspirin can be given as a tissue plasminogen activator (TPA). TPA is very effective at dissolving clots but should be injected within 4 to 5 hours of stroke manifestation.

Hemorrhagic Stroke: Hemorrhagic strokes are caused by bleeding into the brain and so treatment focuses on controlling the bleeding and reducing the pressure on the brain that it is causing. Drugs should be given accordingly. If the patient is taking anticoagulant or anti-platelet medication like warfarin or clopidogrel, can be given drugs or blood transfusions to counter the medications effect Surgery can also be used to repair any problems within blood vessels.

Rehabilitation: Strokes change the life of a person both physically as well as emotionally temporarily or permanently. Specific rehabilitative activities may help one to get recovery after a stroke such as :

Speech therapy: It helps one to handle with problems in producing and understanding speech. Practice, relaxation and changing communication style, using gestures and difference tones help one to recover.

Physical therapy: It helps a person to re-learn movement and co-ordination. It is important to get out and move about even if difficult in the beginning.

Occupational therapy: It helps a person to improve its ability to carry out routine daily activities, such as bathing, cooking, dressing, eating, reading and writing etc.

Joining a support group: It helps to get rid of depression by sharing common experiences and exchanging information.

PREVENTION:

The best way to prevent a stroke is to address the underlying causes with the following means:

- Eating a healthy diet.
- Maintaining a healthy weight
- Exercise regularly.
- No smoking
- Avoiding alcohol or moderating consumption
- Keeping blood pressure under control.
- Maintaining normal blood lipid/cholesterol level
- Managing diabetes

6.5.4 Diabetes Mellitus

Diabetes has been defined as genetically and clinically heterogeneous group of disorder all of which shows glucose intolerance: It is a syndrome characterized by a raised glucose concentration in the blood, due to deficiency or (defective) diminished effectiveness of insulin. The disease is chronic and also affects metabolism of fat and protein. This disorder prevent body from using up energy giving sources i.e. carbohydrate. As a result the carbohydrate turned into sugar by the digestive system, accumulate in the blood and are then passed out into the urine. They would normally

used up as energy, or else stored in the body as fat, but instead they are excreted. In Greek "diabetes" literally mean passing through.

Types of diabetes:

The two major forms of diabetes are type 1 (previously called insulin-dependent diabetes mellitus, IDDM, or juvenile-onset diabetes) and type 2 (previously called noninsulin- dependent diabetes mellitus, NIDDM, or maturity-onset diabetes).Both type I and type 2 diabetes share one central feature: elevated blood sugar (glucose) levels due to insufficiencies of insulin, a hormone produced by the pancreas. Insulin is a key regulator of the body's metabolism. It works in the following way: During and immediately after a meal the process of digestion breaks down carbohydrates into sugar molecules (including glucose) and proteins into amino acids.

Type 1 Diabetes - In type I diabetes, the body does not produce insulin. Onset is usually in childhood or adolescence. Type I diabetes is considered an autoimmune disorder that involves Beta cells in the pancreas that produce insulin are gradually destroyed. Eventually insulin deficiency is absolute. Without insulin to move glucose into cells, blood glucose levels become excessively high, a condition known as hyperglycaemia. Because the body cannot utilize the sugar, it spills over into the urine and is lost. Weakness, weight loss, frequent urination, and excessive hunger and thirst are among the initial symptoms. Patients with type 1 diabetes need to take daily insulin for survival.

Type 2 Diabetes- It is the most common form of diabetes, accounting for 90 - 95% of cases. In type 2 diabetes, the body does not respond properly to insulin, a condition known as insulin resistance. The disease process of type 2 diabetes involves: To produce enough insulin to overcome resistance. In type 2 diabetes, the initial effect of this stage is usually an abnormal rise in blood sugar after a meal (called postprandial hyperglycemia). Eventually, the cycle of elevated glucose further damages beta cells, thereby drastically reducing insulin production and the first stage in type 2 diabetes is insulin resistance. Although insulin can attach normally to receptors on liver and muscle cells, certain mechanisms prevent insulin from moving glucose (blood sugar) into these cells where it can be used. Most patients with type 2 diabetes produce variable, even normal or high amounts of insulin. In the beginning, this amount is usually sufficient to overcome such resistance.

Symptoms of diabetes: symptoms of both type 1 and type 2 diabetes include:

- Frequent urination (Polyurea)
- Excessive thirst (Poly Dyspepsia)

- Extreme hunger (Poly phasia)
- Sudden weight loss
- Extreme fatigue, Irritability
- Blurred vision

Secondary Complications of diabetes:
People with type 2 diabetes are also at risk of nerve damage (neuropathy) and abnormalities in both small and large blood vessels (vascular injuries) that occur as part of the diabetic disease process. Such abnormalities produce complications over time in many organs and structures in the body. Although these complications tend to be more serious in type I diabetes, they still are of concern in type 2 diabetes. Most people with diabetes should aim for fasting blood glucose levels of less than 110 mg/dl and hemoglobinHbA I C of less than 7%.

Nephropathy- Kidney disease (nephropathy) is a very serious complication of diabetes. With this condition, the tiny filters in the kidney (called glomeruli) become damaged and leak protein into the urine.

Neuropathy- Diabetes reduces or distorts nerve function, causing a condition called neuropathy. Neuropathy refers to a group of disorders that affect nerves.

The two main types of neuropathy are: Peripheral (affects nerves in toes, feet, legs, hand, and arms). Autonomic (affects nerves that help to regulate digestive, bowel, bladder, heart, ulcer and sexual function).

Retinopathy and Eye Complications - The most common eye disorder and in certain typesis retinopathy. People with diabetes are also at higher risk for developing cataracts of glaucoma, such as Primary-Open Angle Glaucoma (POAG). The risk for POAG is especially high for women with type 2 diabetes. Retinopathy is a condition in which the retina in the eye becomes damaged. The two primary abnormalities that occur are a weakening of the blood vessels in the retina and the obstruction in the capillaries probably from very tiny blood

Cardiovascular risk - Cardiovascular disease is a major complication of and the leading cause of early death among people with diabetes. About 65 percent of people with diabetes die from heart disease and stroke. High blood glucose in adults with diabetes increases the risk for heart attack, stroke, angina, and coronary artery disease.

Foot ulcers and amputations - Diabetes is responsible for more than half of all lower limb amputations. Related conditions that put people at risk include peripheral neuropathy, peripheral artery disease, foot deformities, and a history of ulcers.

Osteoporosis- Type I diabetes is associated with a slightly reduced bone density, putting patients at risk for osteoporosis and possibly fractures. It is a major cause of disability in adults. Degeneration of cartilage and bones in joints is a common disorder that affects the knees, hips, shoulder and lower back.

Infections:

Respiratory Infections- People with diabetes face a higher risk for influenza and its complications, including pneumonia, possibly because the disorder neutralizes the effects of protective proteins on the surface of the lungs. Everyone with diabetes should have annual influenza vaccinations and a vaccination against pneumococcal pneumonia.

Urinary tract infections - Women with diabetes face a significantly higher risk for urinary tract infections, which are likely to be more complicated and difficult to treat than in the general population,

Depression- Diabetes doubles the risk for depression. Depression, in turn, may increase the risk for hyperglycemia and complications of diabetes.

Diabetic Ketoacidosis (DKA) - Diabetic ketoacidosis (DKA) is a life-threatening complication caused by insulin deficiency. Until recently, it was a complication almost exclusively of type I diabetes. In such cases, it is nearly always due to noncompliance with insulin treatments.

DIAGNOSIS:

Healthy adults of age 45 and older should get tested for diabetes every 3 years. Patients who are younger than age 45 years and who have certain risk factors should ask their doctors about testing. These risk factors include.

- A weight that is 20% more than ideal body weight.
- Age greater than equal to 30yrs and sedentary lifestyle.
- Central Obesity, Waist Hip ratio: Men greater than 0.90, Women greater than 0.85.Previously identified Impaired fasting Glucose (IFG) or Impaired Glucose Tolerance (IGT).
- High blood pressure (greater than 140/90) or unhealthy cholesterol levels - especially for patients with low HDL("good") cholesterol and high triglyceride levels
- History of heart disease, stroke, peripheral artery disease and a close relative (parent, sibling) with diabetes.
- Having delivered a baby weighing over 9 pounds or having a history of gestational diabetes (in women)
- Polycystic ovary disease (in women)

Testing for Diabetes and Pre-Diabetes:

Fasting Plasma Glucose-The FPG test, alone or in combination with the Oral Glucose Tolerance Test (OGGT) can help diagnose pre-diabetes and diabetes, the fasting plasma glucose (FPG) test is the standard test for diabetes. It is a simple blood test taken after 8 hours of fasting. FPG levels indicate:

Normal: 100mg/dL (5.5m mol/L)orbelow.

- Pre-Diabetes: Between 100 - 125 mg/dL (5.5-7.0 mol/L).
- Diabetes. 126 mg/dL or higher.

Random Blood Sugar test-A blood sample will be taken at a random time. Regardless, of when you last ate, a random blood sugar level of 200 milligrams per deciliter (mg/dL) or higher suggests diabetes.

Glycatedhemoglobin (A I C) test-This blood test indicates your average blood sugar level for the past two to three months. It measures the percentage of blood sugar attached to hemoglobin, the oxygen-carrying protein in red blood cells. The higher your blood sugar levels, the more hemoglobin you'll have with sugar attached. An A 1 C level of 6.5 percent or higher on two separate tests indicates that you have diabetes. An A 1 C between 5.7 and 6.4 percent indicates prediabetes.

Autoantibody tests- Type I diabetes is characterized by the presence of a variety of antibodies that attack the islet cells. These antibodies are referred to as autoantibodies because they attack the body's own cells, not a foreign invader. Blood tests for these autoantibodies can help differentiate between type 1 and type 2 diabetes.

Prevention:

There is an urgent need for strategies to prevent the emerging epidemic of diabetes apart from diabetes and associated complications. Several factors are thought to contribute towards the acceleration of the epidemic, the most important being the rapid epidemiological transition due to urbanization and life style changes seen in developing countries. Prevention of diabetes has several windows of opportunities. The three stages of prevention are:

Primary Prevention targets people by early diagnosis through screening programmes before the onset of disease. All people at risk should be regularly screened and encouraged at each health care visit to pursue a healthy life style. Including healthy diet, adequate exercise and health control.

Secondary Prevention is to prevent the onset of complications in those who are already diagnosed to have diabetes. This can be achieved by meticulous control of diabetes with the help of diet, physical activity, drugs and lifestyle modification process.

Tertiary Prevention of diabetes should aimed at limiting physical disability and rehabilitation measures in those who have already developed diabetic complications and to prevent them from going into end stage complications of diabetes.

6.6 LET US SUM UP

- Communicable diseases are illnesses that can be transmitted from person to person or animal to person.
- With any communicable disease, it is important to understand how the illness is transmitted and use appropriate preventative measures to stay healthy.
- Tobacco use, physical inactivity, the harmful use of alcohol and unhealthy diets all increase the risk of dying from a non communicable diseases
- Detection, screening and treatment of non communicable diseases , as well as palliative care, are key components of the response to non communicable diseases
- To establish national policies and plans for the prevention and control of non communicable diseases

6.7 MODEL QUESTIONS

1. What are communicable diseases give examples
2. Write down the prevention and control of non communicable diseases
3. Symptoms of communicable diseases
4. What are the difference between communicable and non communicable diseases

6.8 REFERENCES

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ENVIRONMENTAL STUDIES

Block -3

Resources of Environment and their Management

UNIT-7 NATURAL RESOURCES

UNIT STRUCTURE

7.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- get some idea about what is meant by natural resources
- discuss the different types of natural resources
- distinguish between renewable and non-renewable sources of energy
- reflect on the problems of deforestation
- acquire knowledge about the proper use of water resources
- realize the dangers of over exploitation of mineral resources
- get an idea about food resources and food-chain equilibrium
- discuss energy resources and their use for the welfare of human beings
- discuss how land resources can be properly utilized for agriculture
- discuss why natural resources should be conserved
- describe sustainable development and its necessity

7.2 INTRODUCTION

The world we live in is full of different resources. These resources are naturally created or produced. The various requirements of man can be fulfilled through these natural resources. Some of these resources are exhaustible and some are inexhaustible. Of the exhaustible resources, some are renewable and some non-renewable. Water resources, air, rainfall, solar energy etc. are inexhaustible. Man cannot exhaust these through continuous use although he can degrade them or make them scarce through his harmful activities. Water, wood, grasslands, forests, wild animals, soil and biotic matter etc. are recreated by nature. On the other hand, fossil fuels such as coal, petroleum, natural gas are never reproduced. So these are called non-renewable resources.

The continuation of mankind and the human civilization depends upon proper use of natural resources. Therefore, it is essential to have a holistic knowledge about the suitable use of natural resources for the development of man. This unit deals in detail with some of the abovementioned issues.

7.3 NATURAL RESOURCES

Resources are the storehouse of supply. The necessary requirements of men which can be fulfilled from materials derived from nature are called natural resources. The basic needs of men such as food, clothes and shelter can be met from natural resources.

7.4 TYPES OF NATURAL RESOURCES

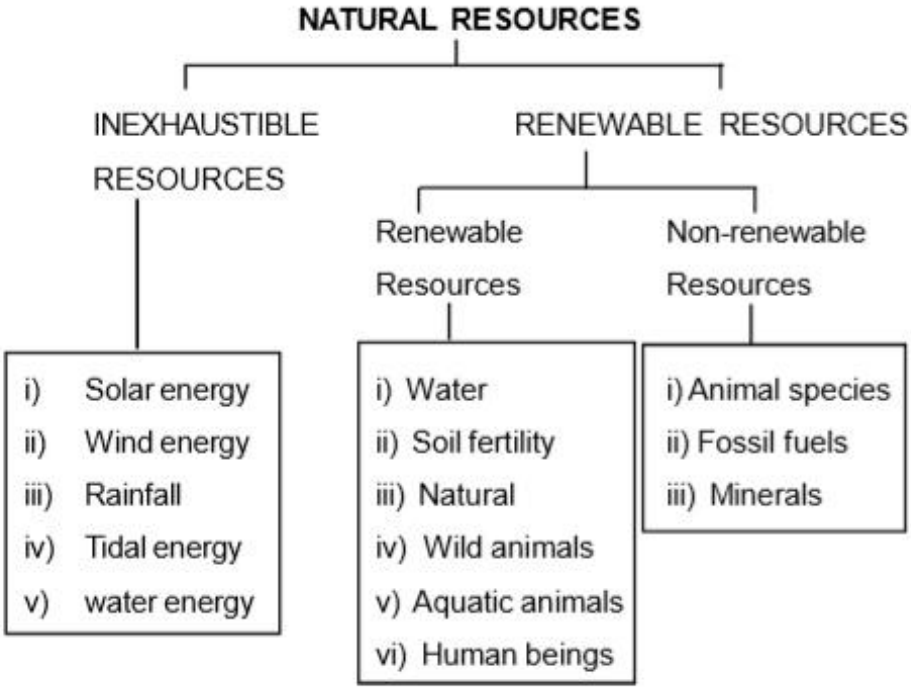
Depending on their availability, natural resources can be divided into two types— Inexhaustible resources and Exhaustible resources.

- **Inexhaustible Resources:** These resources are in great abundance. Men cannot exhaust them even through their continuous use. Air, sand and solar radiation are some examples of inexhaustible sources of energy.
- **Exhaustible Resources:** These are of two types –
  - Renewable Resources
  - Non-renewable Resources.
  - **Renewable Resources**: As these resources are relentlessly used by men, nature keeps renewing these resources. For example, – water, wood, natural grasslands, soil and bio-elements, forest, wild animals

etc. The resources are renewed as a result of sudden relocation, rebirth, change and reformation within a certain period of time.

- **Non-renewable Resources**: These resources do not reappear once it is exhausted and nature also does not reproduce them. For example - fossil fuels (coal, petrol), minerals like copper, iron, animal species, etc.

Figure 7.1: Division of Natural Resources



7.5 FOREST RESOURCES

The biological group which consists of trees, shrubs, vines and other plants and which forms a thick canopy over the earth's surface, sometimes preventing light from penetrating below, is called forests.

40% of the earth's surface is covered by forests. The open and closed forests constitute 1/3rd of the earth's land mass. India is rich in flora and fauna, and most of these species are to be found in forests. There are different kinds of trees in forests. The forest resources of the world shown in the table below.

Table 7.1: Change in Forested Land 1990-2000 by Region

Region	total land area (million ha)	total forest 1990 (million ha)	total forest 2000 (million ha)	% of land forested in 2000	change 1990-2000 (million ha)	% change per year
Africa	2 963.3	702.5	649.9	21.9	-52.6	-0.7
Asia and the Pacific	3 463.2	734.0	726.3	21.0	-7.7	-0.1
Europe	2 359.4	1 042.0	1 051.3	44.6	9.3	0.1
Latin America and the Caribbean	2 017.8	1 011.0	964.4	47.8	-46.7	-0.5
North America	1 838.0	466.7	470.1	25.6	3.9	0.1
West Asia	372.4	3.6	3.7	1.0	0.0	0.0
world	**13 014.1**	**3 960.0**	**3 866.1**	**29.7**	**-93.9**	**-0.24**

Source: compiled from FAO 2001b Note: numbers may not add due to rounding

- Uses of Forest Resources: The main uses of forests are –
  - **Food**: The tribal people acquire their staple food – like roots, shoots, leaves, fruits – from the forests.
  - **Fuel**: The wood required for cooking and protection from cold are derived from forests. Nearly 1500 million people around the world depend upon forests for their livelihood. Almost 1000 million tons of wood are used as fuel around the world.
  - **Wood**: The wood required to build houses, bridges, different kinds of furniture, doors and windows, berths in trains, boats, ships, sports goods, agricultural equipment etc. are collected from forests.
  - **Paper**: Bamboo pulp is used to produce different types of paper like newsprint, packing paper, papers for writing etc.
  - **Necessary Materials**: The flora and fauna of the forest provide the raw materials for different kinds of essential goods. e.g. different kinds of oil (pure sandal) for the production of camphor, soaps and cosmetics, gum and soap based materials like shikakai etc. for industrial use; worms and insects needed to produce lac, honey, wax, silk etc. horns and hides; Ivory etc. The raw materials for the production of different medicines, spices, poisonous substances, insecticides etc. are derived from forests.
  - **Protection of the Environment**: Forest cools the climate of the environment and controls the rainfall. The moist climate of summer is conducive for the survival of plants.
  - **Oxygen Production**: When plants produce food through photosynthesis, they also at the same time release the necessary oxygen for animals to breathe.

- **Shelter:** The trees in the forests provide shelter and support to different species like insects, reptiles, birds, mammals, moss and lichen, creepers etc.
- **Soil Conservation**: Forests prevent soil erosion. The reasons are –
    - Roots hold the elements of the soil.
    - The fallen leaves reduce the surface runoff.
    - The trees also help to reduce the speed of winds.
- **Soil Fertility**: The decomposition of fallen leaves creates a layer of humus and this increases soil fertility
- **Control of Water-cycle**: The layer of humus in the forests keeps the currents of rivers, streams, lakes etc. under control. It acts like a giant sponge and absorbs a lot of water, and releases it slowly
- **Reduction of Pollution:** The carbon dioxide gas used during photosynthesis reduces air pollution.
- **Necessary for Beautification:** The natural beauty of forests has recreational and aesthetic value.

- **Deforestation**: According to a survey, the forests of India dwindled from 7000 million hectares in 1900 to 2890 million hectares in 1975. This further came down to 2300 million hectares in 2000. Tropical rainforests are the most productive regions of the world. In 1975, this region saw a decrease from 1600 million hectares to 938 million hectares.
    - The Main Causes of Deforestation are:
        - Forests are cleared in order to meet the food requirements of the increasing population in the developing countries of the world.
        - Forests are exploited to procure the wood necessary for establishing industries, construction of roads and buildings. Forest fires also destroy trees.
        - Some insects and pests eat the leaves, spread diseases, and destroy trees.
        - Grazing animals and those that live underground feed upon tender, unripe plants.
        - Forests are also reduced as a result of Jhum cultivation in different states which consume 5 lakh hectares of the forest area yearly.

- The Results of Deforestation are:
    - There is always a possibility of loss of land due to deforestation
    - Possibility of floods and drought.
    - Loss of animals and plants.
    - Shortage of wood and energy sources.
    - Negative effects on climate and less rainfall leading to increase in atmospheric temperature.

7.6 WATER RESOURCES

Water is a renewable source. Like air, water is also extremely essential for the various physical, biological and chemical processes of plants and animals. Water is always necessary for human beings to live, and also for their economic development. Three-fourths of the earth's surface are covered with water. Water also constitutes 60-70% of man's total weight.

- **Types of Water**: Water is generally found in two states – Groundwater and surface water,
    - Underground Water: Ground water constitutes 9.86% of the total freshwater. **Aquifer** is a sediment or rock layer which is highly permeable. This layer contains water and transmits water. Sand and gravel are good examples of aquifer. Aquifer is of two types – unconfined aquifer and confined aquifer.
        - **Unconfined Aquifer**: In unconfined aquifer permeable materials are laid and it gets re hanged by rainfall and seasonal melt water that seeps down.
        - **Confined Aquifer**: Confined aquifers are pereable aquifers like sand that lie between two impermeable layers of rock and sediment.

          If withdrawal of ground water is more than the recharged water, sediments get compacted which leads to ground subsidence. Following situations may occur in ground subsidence –
          (a) Land surface may sink
          (b) Damage of structure in building
          (c) Pipes may rupture
          (d) Reverse flow may occurs in sewers and canals

(e) Tidal flood may occur

- Surface Water: Surface water is found in various states like streams, rivers, lakes, ponds, wetlands, artificial water reservoirs, etc. When rainwater and water from melting snow do not penetrate below the earth's surface, they flow as surface Runoff or accumulate in the depression on the surface of the earth, and form the surface water.

  Surface water is used for different purposes. Some of them are– (a) Public water supply, (b) Irrigation, (c) Industrial use,(d) water transport.

- **Floods**: In 90% of the regions in our country rainfall occurs in certain months of the year (generally from June to September). Rainfall is not equal throughout the year. During the monsoons, due to excessive rain, the rivers overflow and create floods. There are many reasons because of which floods occur. Those which are worth mentioning are –
  - Excessive rainfall
  - Drainage cougesion
  - Deforestation
  - Excessive animal grazing
  - Urbanization and Industrialization
  - Global warming.

- **Drought**: When evaporation of water is more than the amount of rainfall, then a drought situation occurs. The scarcity of water leads to drought. If rainfall is 75% less than the normal rainfall, drought occurs. The main causes of drought are as follows :
  - Less rainfall
  - Increase of population in drought areas and decrease in soil fertility
  - Deforestation, excessive animal grazing's, mining etc. which create a desert like situation.
  - Excessive drought reduces the water levels in streams and other water bodies.

  The following steps need to be taken in order to control drought situation:
  - Growing mixed crops
  - Social forestry and water land development
  - Stop plantation of eucalyptus and similar kinds of trees – as these species of trees lower the surface water levels.

7.7 MINERAL RESOURCES

The discovery, extraction, purification and use of mineral resources is a great means of support for developing countries, including India. These minerals normally have characteristic chemical and physical properties.

- **Types of Mineral Resources**: Mineral resources are of two types –
  - Nonmetallic e.g. Diamonds, graphite, quartz.
  - Metallic, e.g. Bauxite, pyrite etc.
- **Extraction and Use of Mineral Resources:** Minerals are found in ores. The ores are extracted from the earth's crust, and after purifying and refining them through different processes, the minerals become suitable for use, Minerals are used for different purposes. Examples–
  - For industrial purposes and development of mechanical systems.
  - Used in coal, lignite and uranium energy production
  - Making of weapons and ammunition
  - For cable, telephone and other communication systems
  - Preparing medicines
  - For making gold, silver and diamond jewellery
  - Use of silver in preparing photographic plates, electronics and jewellery.
  - For use as fertilizer and insecticide in agriculture.
- **Environmental Impact of Mineral Extraction and Use**: After mining and extraction, when minerals are disposed of, it leads to pollution of air, water and soil. Some examples of the ill-effects of mining are as follows :
  - Because of the uranium mining field in Jaduguda, the people of Jharkhand and nearby areas are in danger of being exposed to nuclear radiation.
  - Because of fire outbursts in the coal mines, the people around the Jharia coalmine region have been forced to flee to other places.
  - In Karnataka's Kudremukh region, iron ore mining has led to pollution of rivers.
  - Because of open-cast mining in the coal mines of upper Assam, the environment of the surrounding areas has been polluted to a great extent. The sulphur content in ground water has increased.

  There are two types of mining –
  (a) Surface mining
  (b) Underground mining

- **Harmful Effects of Mining**: The harmful environmental effects of mining are as follows –

- Destruction of plants
- Geographical changes
- Depression of the earth surface
- Pollution of ground water
- Air pollution.
- Surface water pollution
- Affecting the health of miners.

The harmful effects of mining are to be controlled in order to keep the environment clean. Mining should always be conducted keeping in view the health of the environment. Microbial backing process is used when extracting minerals from low quality ores. Trees should be planted in the regions where mining takes place. The flow of toxic substances after refining the ores should be controlled.

There are gold mines in Karnataka and Kerala. When the minerals available for the usage of human beings are measured against the timeline, it is called "the lifetime of earth's minerals".

Table 7.2 : Essential Minerals and their Lifetime

Minerals	Lifetime
Coal, Iron, Chromium	2500-2800 AD
Aluminum, Cobalt, Manganese	2100-2200 AD
Crude oil, natural gas, Uranium, lead, Zinc, gold, Silver, tin	2000-2100 AD

7.8 FOOD RESOURCES

Food is a basic necessity for living beings. Only green plants can produce their own food. Food contains carbohydrates, proteins, fats, bio acids, vitamins, mineral salts etc.

According to the Food and Agricultural Organization (FAO), the minimum calorie intake for a person is 2500 calories per day, Malnutrition people get only 80-90% of this amount. People suffering from severe malnutrition get even less than 80% of the daily calorie intake.

Deficiency of the required nutrition is called malnutrition. Lack of adequate quality and quantity of the requisite food leads to malnutrition.
World Health Organization is an international organization.

- **World Food Problem**: Even though food production in the developing countries is increasing, it is not yet proportionate to the increasing population. The result is that some people do not get a balanced diet and suffer from lack of nutrition. Lack of nutrition creates physical disorder in human beings. This is known as nutritional deficiency disease. 300 million people in Indian suffer from malnutrition. There is a direct relation between population explosion and food problem.

  Some harmful effects of malnutrition are as follows:

  - Increase in child mortality
  - Increase in mother mortality
  - Retarded brain development
  - Low academic performance

  In the World Food Summit held in 1996, a resolution was taken to the effect that by 2015, the percentage of people suffering from malnutrition will be reduced by half. Poverty is the main cause of malnutrition. The parents of poor families cannot provide the requisite food to their children.

- **Agricultural Methods**: In the prehistoric age, people procured the necessary food by hunting wild animals and eating edible plants. They made different stone implements using great skill in order to hunt animals. They led a nomadic life as they were continuously in search of food. They spent most of their time in hunting animals and procuring food. Agriculture means cultivating and growing crops in a piece of land. As time passed, the prehistoric people learnt to produce their own food, and consequently they changed from "food gatherers" to "food producers". It has been found that agriculture was first started in Thailand. Excavation works in Thailand have revealed the remains of rice and soybean cultivation. These are said to be 10000 years old.

  Traditional agricultural methods have three harmful effects:

  Deforestation, Soil erosion, Decrease in nutrition

- Effects of Modern Agricultural Methods: The Green Revolution is a success story of Indian agriculture. Its success was due to the following reasons :
  - Use of more productive seeds
  - Use of skilled machinery
  - Use of fertilizers, pesticides and nutritional aids for irrigation.

  But the use of modern agricultural methods has also created some Problems. They are–

  - When highly productive seeds are sown equally in all the plots of land, the chances of the spread of diseases in them are relatively high.
  - Two problems arise when chemical fertilizers are used –
    (a) **Blue Baby syndrome** as a result of nitrate pollution.

(b**) Eutrophication**: If huge amounts of nitrate from the fertilizers are dissolved in water, it creates a thick layer of algae. These algae use a lot of liquefied oxygen in the water. Consequently, the living beings in the water get less oxygen and suffer untimely death. The decreased productivity in the pond sand lakes is due to increasing of algae and weeds called eutrophication. Eutrophication has resulted in the decrease of the area of Srinagar's Dal Lake from 15 km2 to 12 km2.

- Some of the problems arise due to the use of pesticides. For example, the excessive use of **DDT** can create certain pesticide resistant insects. Besides, the use of pesticide beyond the permissible limit may cause death to lives.
- Lack of proper drainage system and accumulation of water due to excessive irrigation.
- Increase in soil salinity when saline compounds like sodium chloride, sodium sulphate, calcium chloride etc. are deposited in the soil. When saline water is used for irrigation, the effect is doubled. The saline soil decreases crop productivity. Different methods can be used to reduce soil salinity –
  (a) Use of better quality water
  (b) Spreading the inland network through open canals.

  The Central Soil Saline Research Institute in Kerala has succeeded in making a saline village called Jarika Biran into a salt free one. This has made the village richer in crop production.

  Excessive animal grazing has also adversely affected the soil. For example, the quality of soil is degraded, useful plants become extinct and various harmful plants like parthenium, lantina and jenthiam and other cacti prosper.

7.9 ENERGY RESOURCES

The capacity to do work is called energy. The economic development of a country depends on the per capita energy use. Nobody can seize energy; it can only be used for work. Energy is never destroyed; rather it transforms from one state to another.

There are different types of energy –

- Solar energy
- Hydro power
- Nuclear energy
- Wind energy
- Bio mass energy

The main sources of energy like the physical energy of men and animals, wind energy, the oils produced from wood and forest reserves etc. do not create pollution. But after the industrial revolution, industries extracted energy from the sources like coal, crude oil, natural gas etc. When these products are burnt it creates pollution of the environment. In trade and industry, 95% of the energy comes from fossil fuels. But in the near future, fossil fuels will face the danger of extinction. The total national Production in case of countries like America, Switzerland, and Norway etc. is quite high. In these developed countries, the per capita use of energy is250000 kg calories. In that case, in a developing country like India, the per capita use of energy is 10000 kg. Calories.

- **Sources of Energy**: There are two sources of energy: Renewable source and Non-renewable sources.
    - **Renewable Source**: These resources do not dwindle even with continuous use, as these are replenished by nature. These resources are inexhaustible e.g., solar energy, wind energy, tidal energy, geo thermal energy, biogas etc.
    - **Non-renewable Sources:** These resources are exhaustible, and once the sources are finished, they can never be replenished. Nature also cannot replenish such resources, e.g. coal, petroleum and petroleum products, nuclear minerals like uranium and thorium.

- **Renewable Source:**
    - **Solar Energy**: Among the nonconventional sources of energy, solar energy constitutes a large part. The heat and light radiated from the sun is called solar energy. The amount of the sun's radiation on the earth's atmosphere is 170 trillion kilowatt. We get the sun's rays profusely for at least 250-300 days of the year. The easiest and simplest mode of using solar energy is through the solar heat conversion method. Solar energy is already used in cookers, heaters, solar batteries etc. Efforts have been made to use solar energy refrigerators, air conditioners etc. Street lamps run with solar power are available in the market today. The quality of these products needs to be improved and the prices should be reasonable so that the common man is able to purchase them.
    - **Wind Energy:** Wind energy can be used in the production of power and for spraying water. Wind energy can be converted to mechanical and electrical energy. Wind driven water pipes have been installed. Since in the coastal areas like the Kutch region of Gujarat, Okha, Puri and Tuticorin, the wind speed is very high, wind driven turbines are used to generate electricity.

- **Tidal Energy**: In Gujarat's Kutch region and west Bengal's Sundarban Delta, experiments are being made on the usefulness of tidal energy. The most powerful tidal energy production Centre in the world is located in France.
- **Hydro Power**: Dams are constructed in fast flowing rivers in order to create hydro energy. River water is collected by constructing dams. The accumulated water is allowed to flow through the dams where the water energy is converted from static to dynamic form. These rapid flowing waters start rotating the turbines and the attached generators which lead to electricity production. The amount of hydroelectricity production in India is nearly 23800 megawatt.

  Some problems arising out of hydroelectricity generation through dams are –

  - The flow of water may be stopped if sediments accumulate in the dams.
  - Obstruction due to migration of fish
  - Preventing river water flow, and preventing the use of higher lands due to floods.
- **Ocean Thermal Energy**: The energy which is created due to fluctuations in temperature between the surface and depth of the oceans is called ocean thermal energy. This energy is used to generate electricity.
- **Geothermal Energy**: The heat generated by the hot molten materials inside the earth's core is called geo-thermal energy. Hot springs are to be found in Manikaran, Kullu (Himachal Pradesh), Sohna(Haryana), Garampani (Assam) etc. The warm water which flows at high pressure can sometime be used to rotate the turbine in the generator in order to produce electricity.
- **Biomass Energy**: Biotic elements like wood, garbage, agricultural wastes etc. constitute the biomass The energy released from these elements are as follows–
  - Energy Producing Agriculture Lands: Photosynthesis uses carbon dioxide and water, and through solar energy, transforms it into essential foods. Through this process, solar energy is transformed into bio mass energy. Some fast-growing plants are also directly burned to produce energy. Decomposition turns it into fuel.
  - Petro-plants: Plants like euphorbias, Jatropha have been identified as the source of liquid hydrocarbons. It supplements liquid fuel. These oily particles can be used to produce diesel

or gasoline. Liquid fuel can also be extracted from the seeds of the 'nahar' tree.

- Agricultural and urban refuse, when burnt, produces energy which can be used for different purposes.

- **Bio-gas:** The reaction of bacteria on biomass produces bio gas. The number of biogas plants in India is 30, 00,000. Bio gas is formed from a mixture of methane, carbon dioxide, hydrogen sulphide and ammonia. The composition of plant and animal refuse also creates these gases.

  In different parts of the country dung cakes are used for cooking and other purposes. The wastes of animals contain certain nutrients which are helpful if returned to the soil. The dung cakes do not get fully burnt, and therefore, they create a lot of smoke, and pollute the air. Instead of directly burning the dung cakes, it helps to transform it into biogas first. This fuel is clean and also generates heat. While producing fuel, the residue left behind can be used as fertilizer for agriculture.

- **Bio-gas Project**: The plant and animal waste rot easily in water when microbes work on them. This process also produces methane, carbon dioxide, hydrogen and hydrogen sulphide gases. The mixture of these gases is called bio-gas. Methane constitutes 65% of this gas. It is one of the best fuels. This mixture of dung and water, when poured into a part of the project, produces a gas which is let out through an outlet pipe for the users. In order to have a continuous supply of biogas, it is necessary to fill the mixture room with wastes from the biotic community. Human waste can also be added to it. In some places, household refuse can also be used as raw material for the biogas project. In our country, we have basically two types of biogas projects– (i) Fixed pile bio gas project, (ii) Floating gaseous biogas project.

  - Advantages of Bio-gas Project:

    (a) Its use in gas stove

    (b) Its use in street lights and mechanical engines.

    (c) It prevents water pollution

    (d) The burning of biogas does not produce smoke, but produces much heat.

    (e) The residue left after the extraction of gas can be used as fertilizer. It contains a lot of nitrogen and phosphorous compounds.

- **Bio Fuel**: Types of alcohol like ethanol and methanol can be produced by the decomposition of biotic microorganism. Ethane can be produced from sugarcane. Like ethanol, methanol is also a clean, non-polluting fuel. Methane can be produced frome woody plants. It burns

in a lower temperature than gasoline and diesel. The mixed product of ethane and methane is gasoline. In many countries, it is also used as car fuel.

- **Hydrogen**: The burning of hydrogen in the atmosphere creates a lot of energy. Hydrogen can be produced through two methods –a) Thermal dissociation and b) Photolysis or electrolysis of water.
    - The advantages of the use of hydrogen as fuel: a). it is nonpolluting. b). It can be produced very easily c. Since it has a huge amount of improved calories, it is suitable for use as fuel.
    - The disadvantages are as follow :
      a). It is highly inflammable and explosive
      b). it is difficult to store and transport

- **Non-renewable Sources of Energy:**
    - **Coal:** Energy produced through the burning of coal can be used in various ways. Coal is a nonrenewable source. The earth's crustal layer contains nearly 6000 million tons of coal. Till now, almost 200 million tons have already been used for various purposes. Some of the big coal mines in our country are – Raniganj, Jharia, East Bokaro, West Bokaro, Pulse Kungkom, Singrauli, Talser, Chanda, The states which have huge amount of coal are – Bihar, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh, and Maharashtra. Assam and Meghalaya also have coal. India constitutes 5% of the world's coal. Coal is of 3 types – a) Anthracite (Hard coal), b) Bituminous (Soft coal) c) Lignite.

      Coal is a huge source of energy and is very useful for industries. The amount of coal at present in India is about 123000 million tons. 75% of the produced coal is used in trains, industries and thermo-electric projects.
    - **Petroleum**: It has been estimated that the crude oil source will last only for the next 40 years or so. The 13 countries of the OPEC constitute 67% of the world's petroleum. Saudi Arab contains 25% of the crude bio resource. Crude oil is refined through the partial distillation process and thereby different fuel products such as petrol, diesel, kerosene gasoline, plastic etc. are produced. Compared to coal, petroleum is a clean fuel and can also be transported.
    - **Liquefied Petroleum Gas (LPG**): Petroleum gas can be liquefied through high pressure. This is known as LPG, which is used as cooking fuel. Now-a-days, it is also used to run vehicles.
    - **Natural Gas**: Natural gas mainly contains methane but also some amount of propane and ethane, In India, natural gas is a gift of nature. It can be used both as an energy source and as industrial raw material in petrochemical industries. Natural gas is also used in fertilizer production centers. This gas burns without producing smoke. Natural

gas is of two kind – Compressed Natural Gas and Synthetic Natural Gas.

- Compressed Natural Gas (CNG): CNG is presently used as fuel for vehicles. Use of CNG in Delhi has reduced pollution to a large extent.
- Synthetic Natural Gas (SNG): SNG is produced from a mixture of carbon monoxide and hydrogen. Low quality coal can be converted into artificial gas.

- **Nuclear Gas**: A very little amount of radioactive products can produce a large amount of energy. Atomic energy is produced through nuclear emission. Two methods are used to produce energy. These are– nuclear fission and nuclear fusion. In India, there are 4 nuclear energy production centers, and these produce 2005 megawatt energy. Nuclear energy is used for –
  - Electricity production
  - Fuel for ocean liners
  - Heat producers in chemical reaction projects.
  - To fly aeroplanes

7.10 LAND RESOURCES

The upper surface of the earth is called land. Everything that is required for sustenance on this earth can be acquired from it. 43% of India's land mass is constituted by plains, 27% by plateaus and 30% by mountains. When physical elements like eroded hills, rain, air, temperature etc. react with biotic elements like plants, animals, and microorganisms, land is formed. There are four elements which constitute land –

Mineral elements – 50-60%
Biotic elements – 10%
Water – 25 – 35%
Air - 15-25%

600 million hectares of agricultural land in India are ruined due to various factors such as – soil erosion, increased salinity in the soil, mixing of poisonous substances with the soil etc.

7.11 SUSTAINABLE DEVELOPMENT

All the essential requirements of man such as air, water, food, shelter etc. can be acquired from the environment. The economic development of man has adversely affected the resources given by nature such as minerals, plants and animal kingdom,

which in consequence has led to a depletion of these resources. Population explosion is also a contributing factor towards environmental imbalance.

Environment cannot be separated from economic development. Different developmental works contribute to the destruction of natural resources. The degradation of natural resources has a harmful effect on the economic development. There is an intimate relation between environmental imbalance, disaster and scarcity of fuel etc. Such imbalances create problem and cause disasters. The accelerated rates of development have brought immense pressure on the use of raw materials from forests and other land areas.

If this development process continues, then it will be most difficult to maintain an environmental balance in the world. Therefore, in recent times a new concept has emerged worldwide, which is called sustainable development. Sustainable development means the capacity to cater to the present needs of the people of a certain geographical region without affecting the interests of the future generations. The sustenance capacity depends upon land area, its productivity and the proportion to the essential requisites of man.

Therefore, when a country or a region marches towards economic progress or development through the proper use of its resources and by maintaining the environmental balance sustainable development occur sand it meets the essential requirements of men and ensures their availability in the future without destroying the environmental resources.

According to the world organization of environment and development, the following areas need to be considered for sustainable development in the local, regional and national levels.

- **Political System**: Citizens should take decisions through active participation.
- **Economic System**: Increase in production through the use of technology.
- **Social System**: Removal of the anxiety and concern which stem from unequal development.
- **Productive System**: Preserving the ecosystem for progress, and to recognize our responsibility towards it.
- **Technical System**: Find solutions through research
- **Government System**: To have the capacity for self-correction, and to become humble.
- **National Foreign Policy**: To sustain business and economy through international agreements.

It is feared that unsustainable economic development will destroy the environment as it causes great strain on the resources. Therefore, the policy makers of the country

need to be motivated by the thoughts of sustainable development. This will enable the growing economy to have a firm grip on the roots of the ecosystem. This system needs to be protected and cared for, in order to continue it till posterity.

7.12 LET US SUM UP

- After going through this unit, we have acquired a holistic idea of natural resources. We have come to know about the types of natural resources and where these resources are to be found and in what state.
- Besides knowing about renewable and non-renewable resources, we have also understood how to use them in a proper manner.
- We have learnt about environmental imbalance as created by deforestation.
- Natural gases and the reserves of petroleum and petroleum products will become extinct one day. So, we have been acquainted with the means to use the resources in a proper way in order to maintain the natural balance. Finally, we also got some idea about sustainable development which is closely related to the above mentioned issues.

7.13 POSSIBLE QUESTIONS

VERY SHORT ANSWER QUESTIONS

Q 1. What are resources?
Q 2. What are the natural resources?
Q 3. What is pesticide?
Q 4. Give the full form of DDT.
Q 5. Write the names of some inexhaustible natural resources.
Q 6. What is energy? Why is it necessary?
Q 7. What is deforestation?
Q 8. What is a drought situation?
Q 9. Write the names of some alternative sources of energy.

SHORT ANSWER QUESTIONS
Q 1. What are the uses of forest resources?
Q 2. Describe the reasons for deforestation.
Q 3. Discuss the impacts of the construction of dam's forests and man.
Q 4. What are the different types of water? Describe its importance.
Q 5. What are the problems of modern methods of agriculture?
Q 6. What are the environmental effects of mineral extraction?
Q 7. Write short notes on:
(a) Floods, (b) Drought, (c) Marine resources (d) Solar Energy

(e) Geo thermal energy (f) Bio-gas (g) Bio-fuel.

LONG ANSWER QUESTIONS

Q 1. Account for the importance of forest resources.
Q 2. Write an essay on water resources.
Q 3. Describe the mineral resources in terms of their types, use and the Environmental impact of their extraction.
Q 4. Discuss the renewable and non-renewable sources of energy.
Q 5. Elaborate on the land resources.
Q 6. Discuss the different types of energy.
Q 7. Write short notes on:
(a) Soil erosion, (b) Soil conservation,
(c) Responsibility of man towards conservation of natural resources,
(d) Sustainable development.

UNIT-8 MANAGEMENT AND CONSERVATION OF NATURAL RESOURCES

Unit Structure

8.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- Learn about the management and conservation of natural resources.
- learn about the concept of biodiversity
- acquaint yourself with the ecological and economical values of biodiversity
- know about the hotspots of biodiversity with reference to Indian subcontinent
- learn about the threats to biodiversity
- know about the common endangered and endemic species of the Indian subcontinent
- Know about the biodiversity conservation strategies.

8.2. INTRODUCTION

Environmental resources management aims to ensure that ecosystem services are protected and maintained for future human generations, and also maintain ecosystem integrity through considering ethical, economic and scientific (ecological) variables.

In order to sustain the growing population, natural resources are being used recklessly, which in turn, has reduced their quantity. Nature takes a lot of time to remedy the wrongs done by man. Afforestation after deforestation requires both time and energy. After plantation nature requires time to nurture the saplings and bring them up.

- **Conservation Practices:**
  - Keep a balance between resources and man's needs
  - Proper planning for proper use of resources.
  - Environmental knowledge and awareness.
- **Objectives of Conservation of Natural Resources:** Natural resources need to be conserved both for our own good and the good of our future generations. Its objectives are –
  - The conservation of the natural resource is essential for controlling the environmental system. This means the controlling of various environmental system such as food-chain, renewal of mineral resource, maintenance of the supporting condition like soil, wind, water, animals.
  - It makes the resources available and their existence perennial so that all living beings can lead an undisturbed life.
  - To keep conservation at a specific level in order to maintain the biodiversity for ensuring safe evaluation of life.

8.3 METHODS FOR CONSERVATION OF NATURAL RESOURCES

- For *Conserving Water:*
  - We should not keep the water taps open unnecessarily. When not in use, the taps should be tightly closed.
  - Use of water for domestic purposes should be properly regulated.
  - We should water the plants only in the evening.
  - Store rain water for later use.
  - Controlled use of water for irrigation and sprinkling of water on the green.
  - Clean water should be used in irrigation.
  - We should be careful and thrifty while using water both at home and in industries.

- *For Conserving Energy:*
    - We should develop alternative sources of energy like solar energy, nuclear energy for everyday use.
    - We should be careful while using fuel for extracting energy so that the fuel is not wasted. Only when there is no alternative fossil fuels should be used. In this way, fossil fuels can be preserved.
    - Misuse of energy can be stopped by the following ways –
      (a) As far as possible we are to use the most efficient fuels.
      (b) For burning fuels, efficient cooking implements like stoves and chulhas should be used.

  Excessive use of coal, crude oil and natural gas has led to a depletion of these resources. It is necessary to find renewable sources of energy as an alternative, and to stop the misuse of these types of fuels. In the today's context, it is necessary to modify the models of houses, industries, business, hospitals, schools, colleges, factories etc. Change in life style will encourage energy conservation, as saving energy will create energy.

- *For Conserving Soil:*
    - It is necessary to preserve soil fertility to grow more food grains for the increasing population. Soil fertility can be increased in the following ways – Supplying fertilizers; using green fertilizers, stabilizing organic nitrogen. The decomposition of fallen leaves, dead animals etc. can provide mineral fertilizers.
    - Soil Erosion Can be Stopped in the Following Ways –
      i) Crop rotation methods
      ii) Planting grass, pulses, groundnuts etc.
      iii) Drains or canals should be dug to drain out floodwaters
      iv) Afforestation
      v) Controlled animal grazing
      vi) Cutting steps on slopes in order to stem the flow of water.

- For *Conserving* Forest :

Considering the ever growing demand of fuel wood and timber as well as realizing the importance of conserving our forest resources, it has become necessary to find alternative fuel as well as raw materials to manufacture paper, sports goods, packing cases, furniture and beams used in buildings. Research is going on to develop alternate sources; in some cases, plastic and composite materials have been successful in replacing the use of timber. The other way is to cultivate quick growing trees and herbages in large numbers in selected farms of degraded or wastelands. This will

provide us fodder, fuel wood, timber, fruits and seeds. If deforestation has to be stopped, some necessary steps have to be taken:

i) Adoption of a scientific method of harvesting forest stocks.
ii) Developing a reliable mechanism of regular monitoring of forest growth and,
iii) Establishing an effective system of fighting forest fires,
iv) Strictly enforcing laws to deal with unauthorized cutting of trees.

- **Tree Plantation:** Plantation, on a mass scale, of fast growing tree species such as poplar, casuarinas etc. should be undertaken. The productivity of tree plantations is found to be greater than that of a neutral forests. In a well irrigated tree farm, the productivity may be as high as 45 tonnes per hectare per year.

- **Social Forestry:** Villagers can partly meet their needs for fire wood and small timber by growing fast growing trees planted within the limits of his village, along the footpaths, roadsides, alongside railway tracks, side roads or canals and steams, boundaries of fields and empty spaces. The aim of social forestry is to meet the needs of fuel, fodder, fruits, timber and other requirements.

- **Equitable Distribution of Fuel:** America, Canada, Japan, Australia and other developed countries constitute only 22% of the world's total population. But this population utilises 88% of the total resources. They control 73% of the power and 85% of this their earnings. It is seen that there is a vast difference between developing and developed countries in fuel use. Because of this imbalance, the rich countries are becoming richer.

  For this reason, it is necessary to share the natural resources equitably between the rich and the poor. Equitable distribution is required especially for the basic necessities– water, food and fuel. It will be difficult, rather impossible to control pollution, unhygienic conditions etc. in the developing countries without the intervention of the developed countries.

  Developed countries should therefore intervene in favour of shifting resources to the poor countries. This will lead to equitable sharing of developmental works, bridging the gap between the rich and the poor and establishing balanced, equal development everywhere.

8.4 WILD LIFE CONSERVATION:

India is very rich in various bio geographical provinces, ranging from the cold deserts of Ladakh to the hot deserts of Thar, temperate forests in the Himalayas to

the lush green tropical rain forests of the low lands. India has also large freshwater bodies such as Wular and Manasbal lakes in Kashmir, Chilka Lake in Orissa and Kolleru Lake in Andhra Pradesh and the rugged and rich coastline and coral reefs of Deccan. Protected Areas are ecological/bio geographical areas where wildlife is conserved. Their habitats and natural resources are conserved and poaching is prevented. They are delimited to protect biological diversity. They are cold desert (Ladakh), hot desert (Thar), wetland (Assam and N.E. States), saline swampy areas (Sunderbans, Rann of Kutch), mangroves, temperate forests, subtropical forests, tropical forests, tropical wet evergreen forests, tropical moist deciduous forests, tropical deciduous forests, tropical thorn, coral reef, etc. Protected Areas include national parks, sanctuaries and biosphere reserves.

1. National Parks:

They are strictly reserved areas meant for the betterment of the wildlife. They are reserved for improvement of wildlife. In them cultivation, grazing, forestry operation and habitat manipulation is prohibited.

2. Sanctuaries:

In them protection is given only to the fauna (animals) and harvesting of timber, collection of MFP and private ownership rights are permitted, but interference with the well-being of animals is not allowed. Here wild animals can take refuge without being hunted. Here collection of forest products, harvesting of timber, private ownership of land, tilling of land, etc., are allowed. Sanctuary is declared by the State Government under Section 18(1) of Wildlife (Protection) Act, 1972, whereas National Park is declared under Section 35(1) of the Act. In sanctuary the boundary is demarcated at the time of declaration. In national park boundary is well-defined and accurate.

3. Biosphere Reserves:

Man and Biosphere Programme (MAB) of the UNESCO evolved the concept of Biosphere Reserves. In biosphere reserve, multiple land use is permitted designating various zones.

(i) Core zone in which human activity is not permitted. All forestry and harvesting operations are prohibited and even entry is restricted. Only population studies and scientific investigations are allowed.

(ii) Buffer zone in which limited human activity is permitted. Here no shooting is allowed, but no professional graziers are allowed to establish cattle pens. Camping for tourists are allowed.

(iii) Manipulation zone in which large number of human activities is allowed, but ecology is not permitted to be disturbed.

In a biosphere reserve, wild population, traditional tribals and varied domesticated plant and animal genetic resources are protected. India has identified 14 areas as Biosphere Reserves. Nilgiri Biosphere Reserve includes parts of Karnataka, Kerala

and Tamil Nadu. It was declared in 1986.Similipal in Odisha is also designated as a biosphere reserve by UNESCO in 2010.

(iv) Restoration zone is a degraded area for restoration to near natural form.

4. Zoo:

An area set aside for exhibiting the wild animals kept in cages and artificial enclosures. Here animals' freedom is restricted.

5. Zoological Park:

It is a zoo where animals are comparatively free and are shown in the natural surrounding with barriers and restrictions hidden from view. It is best located on the outskirts of cities where enough land is available.

- ***Conservation of Wildlife:*** The management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generation and to maintain it's potential to meet the needs and aspirations of future generations is called the conservation. It is scientific management of wildlife to maintain it at its optimum level. The conservation of wildlife is directly related to healthy and better forests. Wildlife conservation includes protection, preservation, and perpetuation of rare species of plants and animals in their natural habitats.

Conservation of living resources has three specific objectives:

1. To maintain essential ecological processes and life supporting systems.
2. To preserve diversity of species.
3. Sustainable utilisation of species and ecosystems which support rural communities and major industries.

- **Conservation Strategies:** For wildlife conservation and its propagation, proper management techniques should be employed. Sanctuaries, national parks, biosphere reserves, projects, etc., have been created for exclusively protecting the wild flora and fauna in India as well as in other countries of the world. Scientists of 100 countries of the world have evolved comprehensive "World Conservation Strategies" for the judicious use of resources. To save the existing species of wildlife they proposed some steps which are as follows:

1. Efforts should be made to preserve the endangered species. Species that are sole representative of their family or genus should receive special attention. Endangered species should be given priority over a vulnerable one, a vulnerable species over a rare one and a rare species over other categories. All the threatened species should be protected. Priority be given belonging to monotypic genera, endangered over-vulnerable, vulnerable over rare and rare over other species.

2. Wildlife should be protected in their natural habitat in situ and in zoo and botanical gardens (ex situ). The threatened species should be conserved in situ as well as in ex situ.
3. Identify the habitats of wild relatives of the economically valuable and useful plants and animals and preserve them in protected areas like sanctuaries, national parks and biosphere reserves.
4. The critical habitats of the species like feeding, breeding, nursery and resting areas should be protected (safeguarded).
5. In case of migratory or wide ranging animals, protected areas should be established to preserve their habitats.
6. For migratory or wide ranging animals, pollution and exploitation of the environment along their migration routes should be controlled.
7. Unique ecosystem (national parks and biospheres) should be protected as a matter of priority. The national protection programmes have to be coordinated with international programmes like biosphere reserve programme of UNESCO. Man and Biosphere Project and National Parks and Protected Areas of International Union for Conservation of Nature and Natural Resources (IUCN). National Wildlife (Protection) Act was enacted in India in 1972. Wildlife protection strategies were formulated in India in 1983. Biosphere reserves have also been put into practice since 1986. Wildlife Institute of India is located at Dehradun (Uttaranchal). Indian Board for Wildlife (IBWL) was established in 1952.
8. The productive capacities of exploited species and ecosystems have to be determined and their utilisation should not exceed from those capacities.
9. International trade in wild plants and animals has to be regulated by appropriate legislative and administrative measures.

   India is a signatory to the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

Project Tiger:

Tiger is our National Animal. It is found in diverse habitats and in different parts of the country. Tiger is at the apex position as top carnivore of the complex food-chain in most of our forest ecosystems. Over the years, the over-exploitation of the forest areas, merciless hunting, unscientific management, etc., reduced the habitat of tiger as well as leading to a rapid decline has, therefore, been in India not only as effort to save an endangered species but also with equal importance as a means of preserving biotopes. Project Tiger has been inspired by such an approach. The Indian Board for Wildlife (IBWL) set up a Task Force for studying the condition of tiger population and its status. On the recommendation of this Task Force, Project Tiger was initiated a Central Sector Scheme in 1973 with 9 Tiger Reserves (total area: 13,017 sq. km.) located in different habitat types in 9 different states, but two more reserves have since been subsequently added to it constituting 11 Tiger Reserves in 10 different

states of the country (total area: 15,800 sq. km.). But this number is not last and increasing always.

The main aim of the project was to conserve and improve the natural habitat of the tiger under different habitat types. The management practices and strategies in the reserves are controlled in such a way that all the limiting factors of habitats are removed. The steps to be taken in this direction are intensive anti-poaching drive, fire prevention, elimination of cattle-grazing, soil conservation, water management, eradication of weeds, non-interference by human activities, and relocation of human habitation and so on. The project started initially as a Central Sector Scheme and expenditure incurred by the States was provided by the Central Government till 1979-80. After this, the project had been given the status of Centrally Sponsored Scheme and the Centre and States are sharing cost on a 50:50 basis. The Worldwide Fund for Nature and Natural Resources (WWF) is also extending financial and technical help.

8.5 DEFINITION OF BIODIVERSITY

Earth, the lone living planet of the universe harbors a great variety of life. These diverse living entities, which include plants, animals and microorganisms, occurring in varied environment, have been supporting the growth and development of human civilization since its inception. Out of 7000 different kinds of domesticated plants that have been used by the human as food, only about 20 species supply 90 percent of the world's total food requirement. Domestication is an age-old practice of human civilization.

Wild species with different genetic make-up still have the potential to play a prominent role in world food security and make substantial contribution to the development of medicine and industry. This information depicts the importance of biological diversity for better health care and industrial growth. This knowledge has been helping in planning sustainable livelihood and conserving natural resources in the growing world.

Biological diversity does not mean the assemblage of plant and animal species in any man made biological parks or agricultural field. Biodiversity is the total variability within all the living organisms and ecological complexes where it exists. In other words, biodiversity may be defined as an inherent quality of all living organisms occurring in any area or ecosystem. Biodiversity too is absolutely essential for stability of the concerned ecosystem and proper maintaining of the food chain or food web therein. UNESCO (1994) defined biodiversity as "an umbrella term for variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part".

Biodiversity is conceived at various levels, but the commonest are at genetic, species and ecosystem levels.

- **Genetic Diversity:** Genetic diversity refers to the variation of genes within a species of any plants, animals and microorganisms. Each variety within a species is the repository of unique genetic information, and the diversity of genes within the species increases its ability to adapt pollution, diseases and other changes in the environment. With the loss of any varieties and populations of a species, genetic diversity within the species is diminished resulting in the loss of 'gene pool' that exists within that species. With the help of modern biotechnological tools, the genetic information present in some wild animals could be made use of for the improvement of the characteristic traits of the species. Such genetic information is used for the necessary medical knowledge required for preparing medicines and also for the production of industrial goods.
- **Species Diversity:** Species diversity refers to the variety of species within a region that could be measured on the basis of the number of species occurring in the region. It is considered one of the basic taxonomic units of the biological world. The diversity is seen both in natural and man- made (agricultural) ecosystems. Natural vegetation patches have much greater species richness than that of agricultural or silvicultural patches. Species richness is also high in tropics than in temperate biomes.
- **Ecosystem Diversity:** The Earth itself is a great ecosystem within which there exists different landforms or landscapes. Each landform constitutes one unique ecosystem that supports varied and specific type of vegetation, resulting to in large variety of ecosystems on our planet. All these varied ecosystems are the important sources of biodiversity of the region. Ecosystem diversity thus could be best understood as a specific geographical region having distinctive vegetation formation and land mass formation including aquatic bodies.

8.6 VALUES OF BIODIVERSITY

We are aware of the immense potentials of the biodiversity existing on the Earth. The biological resources not only provide us nourishment, clothing, housing, fuel and medicine but also meet our several other requirements. Biodiversity is also essential for maintaining ecological processes starting from food preparation to soil formation and from watershed management to climate change. It is considered a socioeconomic and monetary asset of a nation. The knowledge of biodiversity is, thus, of immense value in planning sustainable livelihood and conserving nature and natural resources. Values related to biodiversity can be grouped into direct values and indirect values. Direct values are assigned to the products harvested by the beneficiary people, and

the indirect values are assigned to the benefits obtaining from biodiversity without harvesting and destroying the resources.

- **Consumptive Use Value:** Direct utilization of biological diversity or wealth as food, fodder, fuel wood, timber, medicine and game by the local beneficiary peoples come under this category. Consumptive value is related to natural biological products that are collected and consumed directly by the local communities and they do not figure in trade and market. Forest dwellers and fisher folks are completely dependent on biological resources for their sustenance.
- **Productive Use Value:** This is assigned to the products that are harvested or collected from the wild to be sold in markets at local, national and international levels. This value of biological wealth is linked with national income. Biodiversity provides us commercial products like fuel, fish, food supplements, fruits, fodder, skin, fur, wool, fiber, cereals, medicinal plants and many more. Conservation of biodiversity is, therefore, necessitated for further growth of industry and commerce.
- **Social Value:** Traditional societies are always closely associated with and depended on biodiversity. Cultural diversity is linked up with biodiversity and cultural values of biodiversity have been recognized in religion, art and literature from the earliest days of the recorded history. One cannot ignore the social value of betel-nut (tamul) among the traditional societies of Assam.
- **Ethical Value:** Sacred groves are the rampant patches of the old groves of forests preserved by the indigenous tribes as a part of their age-old culture and religious beliefs. These are almost intact forest communities. They provide the refuge for a large number of endemic and rare plants and animals of the region. Thus, locally protected forest patches harbor a good number of medicinal and other plants of economic importance. In other words, one can say that the sacred groves of the temple forests have been acting as gene banks for wild plants in natural environment.
- **Aesthetic Value:** Biodiversity is one of the beautiful and wonderful aspects of nature. From imagination to creativity, and from aesthetic to ethics, biodiversity attracts people for its inherent value and beauty. Aesthetic values such as the taste of wild fruits and sweet fragrance of wild flowers compel people to think about them. Recreation and eco tourism is now an emerging trend due to this value of landscape biodiversity.

  All the native species constitute the genetic reservoir. This has the potential to provide an economic benefit to mankind at some point in the near or remote future. Studies are going on to assess the bio prospecting potential of different plants and microbes to tackle pollution and to fight with cancer, AIDS etc. with the use of the inherent genetic characteristics therein.

- **Existence Value:** This value is assigned to protect the biodiversity of an area. People offer monetary contribution for conservation such rare animals as rhino, golden languor and migratory birds. Because these are also a source of income for the recreation and tourism industry of the nation. Government too spend money on the conservation the total biodiversity along with landscapes and the wild animals.

8.7 BIODIVERSITY AT A GLOBAL, NATIONAL AND LOCAL LEVELS

It has been estimated that more than 50 million species of plants, animals and microorganisms exist in the world. Out of these, the scientists have so far documented about 1.8 million organisms. Data so far available indicate that only a small fraction of the organisms is known as yet. Scientists are also aware of the immense potential of biological wealth of the Earth and they consider it a 'global resource'. The social, ethical, economic and cultural values of this biological wealth have also been recognized by the modern civilization. Different species along with their unique genetic makeup have made substantial contribution to the development of agriculture, medicine, industry, as well as to the stabilization of climate, protection of watershed, protection of soil and the protection of breeding and roaming grounds at the global level.

Each geographical region is characterized by its own biodiversity depending mainly on its climate. The species occurring in the tropical forests potentially contain cures to many diseases that afflict the modern world. India, with a very wide range of climate and habitat types have harbored about48,000 species of plants which represent almost 11 percent of the total world flora and 81,000 animal species representing 6.4 percent of the world's fauna. One estimate says that the Indian subcontinent ,which is also know as 'Hindustan Centre' of origin and diversity of crop plants, is the centre of the origin of at least 167 species of agri-horticultural crops. The Indian subcontinent is rich in germ plasm reserve too having around 34,000 cultivars of cereals,27 breeds of cattle and eight indigenous breeds of buffalos. Like India, Brazil, Malaysia and Indonesia are also rich in biodiversity. These biologically rich areas of the contemporary world have been attracting appreciation for the unimaginable value that exists with their biodiversity.

Assam is one of the largest states of the North east India and is characterized by distinct habitats, landscapes, broad valleys and hills. The forest types are mostly tropical and sub-tropical, which harbor one of the richest biodiversity. An estimate says that the state flora alone comprise3017 species. Assam is also the abode of some rare species of wild animals and birds like one horned rhinoceros, pygmy hog, golden languor, hillock gibbon, white winged wood duck, adjutant stroke and many more. With its rare variety of biological wealth along with distinctive habitat types, Assam

Contributes a lot to the global status of biodiversity.

8.8 HOTSPOTS OF BIODIVERSITY

Life on our planet Earth is now facing an acute crisis. Limitless consumption of the natural resources in the modern world and increasing poverty have contributed to the destruction of these resources. As a result, biodiversity has been exposed to a severe threat. Extinction is the gravest aspect of the biodiversity crisis. Though extinction is a natural process, human action have accelerated the rate of extinction many times over the natural rate. In the world today efforts are on to preserve the valuable species, but the budgets required for this are insufficient in relation to the number of species threatened with extinction. So, identification of the conservation priorities has become very crucial. In this regard one question may come to our mind as to the biodiversity of which area of the world call for conservation.

To address the crisis, one British ecologist Norman Myers introduced the 'Biodiversity Hotspots' concept in the year 1988. Biodiversity hotspots hold especially high number of endemic species, yet their combined area of the remaining habitat covers only about 2.3 percent of the Earth's surface. In 1988, Norman Myers for the first time identified ten tropical forest "hotspots" characterized both by exceptional levels of plant endemism and by serious levels of habitat loss. To qualify as a hotspot, a region must meet two strict criteria: it must contain at least 1,500 species of vascular plants (> 0.5 percent of the world's total) as endemics, and it has to have lost at least 70 percent of its original habitat.

Hotspot analysis is in constant evolution i.e. hotspots may changeover time. Recently Myers identified altogether 34 biodiversity hotspots covering the entire globe. Over 50 percent of the world's plant species and42 percent of all terrestrial species are endemic to these 34- biodiversity hotspots.

India with rich biodiversity has now become a part of three biodiversity hotspots: the Himalaya, the Indo-Burma and the Western Ghats and SriLanka.

- **The Himalaya Hotspot:** The Himalaya Hotspot is the home to the world's highest mountain range having a diversity of ecosystem ranging from grasslands, subtropical broad leaf forest to alpine meadows. This hotspot is the home to 3160 endemic plant species, 8 endemic threatened birds and 4 endemic threatened mammals.
- **Indo Burma:** Indo-Burma with its immense biological treasure has covered more than 12 million km2 of tropical Asia. A wide variety of distinctive, localized vegetation formation including low land floodplain, swamps, mangroves and seasonally inundated grasslands is represented in this hotspot.

Indo-Burma hotspot holds remarkable endemism in plants with 7000 species, threatened mammals with 25 species and threatened birds with 18 species. This hotspot is the home to a good number of freshwater turtle species.

- *Western Ghats and Sri Lanka:* The remaining forests of the Western Ghats of southwestern India and the highland of southwestern Sri Lanka, which are similar in their geology, climate and evolutionary history, have been heavily fragmented due to tremendous population pressure. This hotspot region houses 3049 species of endemic plant, 10 species of threatened birds and 14 species of threatened mammals. Freshwater fish endemism is extremely high as well, with over 140 native species in this hotspot area.

- **North Eastern Region of India:** A Bio-rich Area: The North Eastern Region of India is rich in biodiversity. The rich biosphere in this region has been immensely contributing to the agriculture, animal husbandry, fisheries, forestry and pharmaceutical industry. Geographically the region is situated at the confluence of two biodiversity hotspots- the Himalaya and the Indo-Burma. Stretching in an arc over 3,000 kilometers from northern Pakistan, the Himalaya hotspot extends up to northern Myanmar. It covers hills and mountains of Sikkim, Assam and Arunachal Pradesh. The Indo-Burma hotspot again begins in eastern Bangladesh and then extends across North East India and south of the Brahmaputra River up to Vietnam and Malaysia. The Hot spot confluence is the home to the important populations of numerous birds and mammals, including vultures, tigers, elephants, rhinos and wild water buffalos. This region has been identified by ICAR as a center of rice germplasm, while NBPGR (India) has highlighted the region as being rich in wild crops.

8.9 ENDANGERED AND ENDEMIC SPECIES

- **Endangered Species:** Speciation and extinction are two inevitable natural processes. Though extinction is the ultimate fate of a species in the struggle for survival, habitat loss mainly due to human intervention does expedite the process of extinction. Since 1600, the world has lost about 62 mammals, 117 birds and 596 plant species due to human interference. Considering the relative importance of threat to species extinction, IUCN has categorized six major groups of threatened species in the Red Data Book: extinct, endangered, vulnerable, rare, indeterminate and less know.

  The endangered species are those that are in danger of extinction if the current causal factors continue to operate. The population size of these species has been reduced to almost 50 % over the last 10 years. The prime factors for the

rapid decline in number of the species are loss of habitats and breeding grounds, harvesting and hunting, predation, disease, climate change etc.

According to the Indian Red Data Book published by Botanical Survey of India, ten per cent of the total flowering plants in the country are endangered. Out of 1500 endangered flowering plants, 800 are reported from North East India. As per IUCN Red Data Book about 12out of 19 primates and about 28 out of 36 carnivores of India are endangered.

Some endangered species of North Eastern Region are given below:

Plants	**Animals**
Arundia graminifolia	Rhinoceros unicornis
Dipteriswallichii	Hylobateshoolock
Dendrobiumaurantiacum	Presbytisgeei
Dendrobiumhispida	Cervus unicolor
Brainaeinsignis	Pantheratigris
Livistonia Jenkinsiana	Elephusmaximus
Clematis apiculata	Cairinascutulata
Ophiorrhizahispida	Eupodotisbengalensis

- **Endemic Species:** Endemism means the confinement of a particular species to a particular geographical location. It means that it is found only in that part of the world and nowhere else, and such species are known as 'endemic species'. Endemic species can easily become endangered or extinct because of their restricted habitat and the actions of men. The factors responsible for endemism are: geographical barriers and poor adaptability of the species to a wide range of environment. The NER alone have 1,500 endemic plant species.

  Given below is a list of some endemic plants of Assam:

Mesuaassamica	Camellia sinensis
Aquilariaagalocha	Dipterocarpousmanii
Impatiens manii	Ixoragoalparensis
Mabacacharensis	Derris cuneifolia

8.10THREATS TO BIODIVERSITY

Human activities are the major threat to biodiversity. Man is responsible for the deforesting of natural patches and the grasslands resulting in the loss of thousands of valued species along with their habitats. With the explosive growth of human population, the requirement for food, fodder, fuel and fiber has increased manifolds which has put great stress on the natural wealth. Overexploitation of natural

resources, habitat loss and pollution are contributing to a greater extent towards the rapid degradation of environment quality along with irreversible loss of biodiversity.

- **Habitat Loss:** The primary cause of loss of biodiversity is the habitat destruction. No habitat-no life. Explosion of human population and expansion of human activities are responsible for the habitat destruction. As a consequence of this, the native species must either adopt to changes or move elsewhere or succumb to predation, starvation and disease and eventually die. Habitat fragmentation may limit the potential of the species for dispersal and colonization. Fragmented forest patches have now become hurdles threatening the survivality of the Hillock Gibbon community in upper Assam. Bengal Florican and Pygmy Hog are again on the verge of extinction due to habitat destruction in Assam. Construction and expansion of roads, extension of agriculture and industrial firms have drastically affected the density and abundance of Pitcher plant (Nepenthes'khasiana) in Meghalaya.

- **Poaching of Wildlife:** The wild animals are being killed for their products like hides and skins, tusks, fur, meat, medicine and perfumes etc. Assam rhino is now on the verge of extinction due to poaching for its horn. In Africa and Canada, excessive killings of rhinos and elephants in the last century have resulted in the extinction of these species in their native ranges. In Assam too, the elephant is hunted for its ivory and meat; cats are killed for their skins and bones, dolphins for meat and fat, migratory and some resident birds for feathers and meat, and snakes and lizards for their skin. Several species of the wild ungulates thus have been endangered by their demand in national and international trade. Being the signatory of CITES (Convention on International Trade in Endangered Species), India is now working for the protection of species at national, as well as international level. CITES regulations have reduced illegal international trading to a great extent. But, poaching is still continuing in the bio- rich zones at local level.

- **Biopiracy:** Biopiracy is a kind of procurement of biological resources from a country or place and the subsequent patentisation of their products. Indigenous societies of the developing and underdeveloped countries are the repository of traditional knowledge and beliefs. Scientists and sometimes the industry people of some developed regions of the world unethically collect living life materials and information on them from the local people of the countries rich in biodiversities and subsequently proceed for patent documentation claiming that the products are the information on their own. Thus through false advertisement they acquire the rights of marketing these products. 'Turmeric' and 'Basmati rice' which have been used by Indian societies over centuries have been accorded the US patent. These are some

clear cases of 'biopiracy'. The Government of India should challenge against these countries for such unethical patent right indulged in by them.

- **Man-Animal Conflict:** Man-animal interactions have always had profound consequences on their very existence. With the shrinkage and destruction of the natural habitat, this interaction has taken an ugly turn. This leads to conflict between the two resulting in loss to human and wildlife. Man Ungulate animal conflict has now become a sensitive issue overwhelming in its magnitude and complexity. Population explosion, expansion of human habitation, expansion of agriculture and industries, extraction of timber and non timber forest resources are the root causes behind the increasing cases of conflict between wild animals and human beings.

  For example, the infiltration of leopards the Guwahati city has also been rising with the expansion of the city since 1990. The incidence of human-elephant conflict again has been on the rise in Assam. More than40 people on an average have lost their lives to elephants every year in Assam. It has been reported that more than a hundred people and over90 elephants have lost their lives in the last decade in the Sonitpur District of Assam alone.

8.11 CONSERVATION OF BIODIVERSITY

Conservation of biodiversity is the rational management of the biological wealth along with its interacting ecological systems for the benefit of all lives including humankind, in the entire biosphere. It has to be so managed that it may yield sustainable benefit not only to the present generation, but may also meet the needs and aspirations of the future generations. A few ethical arguments behind the conservation concept are: each species has a right to exist; it renders specific ecological service to mankind irrespective of its size; the loss of the species may have far reaching consequences for nature.

Conservation of biodiversity is of two types:

- In-situ conservation
- Ex-situ conservation

- **In-situ Conservation:** The conservation of biological diversity along with its habitat and ecosystem where they naturally occur is called in situ conservation, i.e. on site preservation. It is one of the advantageous and feasible methods to conserve natural biodiversity of a geographical area. 'The Protected Area' concept has been suggested for in-situ conservation of the threatened plant and animal species. The IUCN (1985) has categorized eight different types of protected areas with distinct management objectives. These are: the scientific reserves/strict nature reserves, national parks, national monuments/landmark, managed nature reserve/wildlife sanctuary, protected landscapes, resource

reserve, natural biotic area/anthropological reserve and multiple- use management areas.

At the initiative of Government and some non Governmental Organizations, Assam now has 5 National Parks, and 22 Wildlife Sanctuaries. The Kaziranga National Park and the Pobitora Wildlife Sanctuary are protecting the remaining population of the Asiatic Rhino.

The wet alluvial savannah grassland habitat of Kaziranga is also the home of large herds of swamp deer, hog deer, elephants and birds like Bengal Florican. The Pobitora Wildlife Sanctuary offers a wonderful opportunity to observe rhinos from elephant back. The Manas National Park, which is also declared as 'Biosphere Reserve', is the home for rare Golden Langue and Pygmy Hog.

- Ex-situ Conservation: Ex-suit conservation is the conservation of vulnerable species outside its natural habitat in a carefully managed and controlled situation such as botanical garden for plants and zoo or zoological park for the animals. These gardens and parks are artificially managed to allow the species to multiply. Preservation of germ plasm of any species in a gene bank is also an experimental situation in monitored conditioned. Though expensive, gene banks provide an excellent opportunity to preserve genetic diversity, so that it can be used, if needed, in future breeding programmes. In Assam, successful ex-situ conservation programmes have been undertaken for Pygmy Hog, the smallest wild bore of the world at Basistha, Guwahati.

8.12 LET US SUM UP

- Biodiversity refers to the variability among the living organisms.
- Biodiversity concept can be subdivided into three levels- genetic diversity, species diversity, and ecosystem diversity.
- The knowledge of biodiversity is of immense utility in planning sustainable livelihood and conserving natural resources as a whole.
- Each species has value of its own in nature.
- The loss of biodiversity may have far reaching consequences for nature.
- Biodiversity is a valuable resource that should not be wasted.
- Loss of biodiversity means the extinction of species and erosion in gene pool.
- Human activity is the major threat to biodiversity.
- People should take responsibility for conserving biodiversity.
- Attempts have already been made to identify the areas of the world that have rich biodiversity and high level of endemism and are facing immediate threat of species extinction and habitat destruction.
- Biodiversity with intact ecosystem can be preserved in-situ by taking adequate measures to cover the under protected area network.

- Protected areas like Natural parks and Sanctuaries have been created to protect the highly endangered species of wild plants and animals in their homeland itself.
- Botanical gardens, Zoological parks and Gene banks are a few measures of ex-situ conservation.

8.13 FURTHER READING

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8.14 POSSIBLE QUESTIONS

VERY SHORT ANSWER QUESTIONS

Q 1. What is biodiversity?

Q 2. What are the causes of the extinction of biodiversity?

SHORT ANSWER QUESTIONS

Q 1. What are the consumptive and non-consumptive values of biodiversity?

Q 2. Write short notes on

a. National Parks of Assam

b. Endemic Species

c. Biodiversity Hotspots and North Eastern Region of India

LONG ANSWER QUESTIONS

Q 1. Explain the various threats to biodiversity and the mode as for its conservation.

Q 2. Why should we conserve biodiversity?

Q 3. Write a note on man-animal conflicts of Assam.

UNIT-9 ENVIRONMENTAL POLLUTION

Unit Structure

9.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- Define environmental pollution
- Classify the different forms environmental pollution like air, water, soil, noise and thermal pollution
- Identify the various sources of environmental pollution
- List the pollutants causing pollution to the environment
- Describe the effects of different forms of pollution on men, animals, and vegetation and on physical structures like historical monuments
- Explain the different pollution control measures.

9.2 INTRODUCTION

Environmental pollution has become a major concern today. You have heard very frequently about the global warming, climate change, melting of ice in the poles, extinction of some species etc. All these are due to environmental pollution caused mainly by human activities. In this unit we shall discuss environmental pollution, the causes and sources of various forms of pollution, its effects on human and other

organisms. Also, some preventive measures for pollution control will be discussed. Thus, this unit will give you a comprehensive idea about environmental pollution.

9.3 ENVIRONMENTAL POLLUTION-DEFINITION

An undesirable change in the physical, chemical, or biological characteristics of the natural environment brought about by man's activities may be termed as environmental pollution. Such a change may be harmful to human and the environment. Pollution may affect all kinds of essential substances for man like soil, water and air etc.

9.4 AIR POLLUTION

Air pollution is the contamination of air by the addition of some harmful substances. Air pollution can cause damage to all plants, animals and men as well as the entire habitat.

- **Sources of Air Pollution**: Air pollution occurs mainly from two types of sources. These are:
  - Natural Sources
  - Manmade Sources
  - **Natural Sources**: The natural sources include many natural environmental events like forest fire, volcanic eruption, soil erosion, landslide, loss of biomass and radiation etc. These contribute to air pollution.
  - **Manmade Sources**: Manmade sources include the various kinds of human activities which cause air pollution. These sources are:
    - Industrialization: With increasing urbanization the rate of industrialization is also rising each day. The smoke emitted from the chimneys of the industries contain huge amount of CO, CO_2, SO_2, H_2S etc. Especially coal, petroleum industries and thermal plants emit these gases in high amount. Many chemical industries also release high amount of HCI, CL, N_2O, Zn, As, Cu_2O, H_2S etc. and thereby cause air pollution.
    - Combustion of Fuels: The combustion of coal and petrol generates high amount of CO_2 in the air and if the combustion is incomplete then it releases CO, CH_4 and many other hydrocarbons. These gases contribute to air pollution.
    - Vehicular Traffic: With the increase of vehicular traffic the amount of combustion of petroleum also increases and the emission of high amount of smoke from the vehicles containing CO, CO_2, and SO_2 penetrates into air, water, soil and settles on the food chain. This causes severe air pollution.

- Explosion: Explosion occurs on account of wars that take place between two or more countries and also for various nuclear research activities. As a consequence, high amount of toxic radioactive substances are mixed with the air and thereby cause air pollution.
- Agricultural Activities: The use of pesticides for agricultural activities starting from fungicide to herbicides which are composed of highly toxic chemicals like phosphate, chlorinated hydrocarbon and, arsenic and lead. These are mixed with the air and cause damage to the environment. Besides, the clearing of forests and grasslands for agriculture produces about 60% 65% of CO_2 that causes air pollution.
- Suspended Particulate Matter (SPM): These types of pollutants mainly include pollens, germs, bacteria, viruses, aerosols and small particulates which are released by the splintering of rocks.

- **Air Pollutants - Their Types:** The air pollutants may be divided into two groups:
  - Primary Pollutants: Primary pollutants are those substances which enter into the air without any physical and chemical change and pollute the air. Examples of this type of pollutant are - CO, NO, SO_2 VOCs and suspended particulate matter (SPM).
  - Secondary Pollutants: These are produced from the various types of interactions among the primary pollutants in the atmosphere e.g. ground level ozone, Chlorofluorocarbons (CFC) etc.
- **Effect of Air Pollution on Animals**: Air pollutants affect the health of the animals in various ways. These are described below
  - Carbon dioxide enters in the blood stream through lungs and produces carboxy hemoglobin. As a consequence, the oxygen carrying capacity of blood is reduced.
  - NO_2 causes various respiratory diseases besides producing acid rain in the environment .Absorption of this chemical causes eye irritation, oedema etc.
  - SO_2 increases the possibility of the incidence of some diseases like asthma, bronchitis etc.
  - Benzene is known as a main cause of Cancer. The temporary elements may cause irritation to eyes, nose and throat.
  - Some smoky substances (aerosols) may cause breathing problems for a long time besides producing skin, throat and nose irritation as allergens.
  - Lead damages the liver, the nervous system and the reproductive system. It also causes anemia, neurological problem, eccentric behavior and high blood pressure.

- Due to the toxicity of mercury and cadmium the central nervous system, liver, heart and fetus get damaged.

- **Air Pollution and its Effects on Plants:**
  - Because of the absorption of hydrocarbon, the leaves of trees become yellowish and along with the fruits fall off in an immature stage.
  - **Lichens** are very sensitive to pollution and these are a pollution indicator.
  - Ozone destroys the chlorenchima in plants and thereby causes the rotting of a plant.
  - Fluoride causes necrosis of the side and front portion of the tree leaves and helps in the rotting and falling of the leaves.
- **Air Pollution and its Effects on Climate:**
  - Greenhouse Effect and Global Warming: The radiation from the sun controls the earth's weather and climate and after heating the earth's surface the remaining amount is radiated back into the space. The atmospheric greenhouse gases (water vapour, carbon dioxide and other gases) trap some of the outgoing energy, retaining the heat somewhat like the glass panels of a glasshouse. These gases are called green house gas and the phenomenon is known as "greenhouse effect." However, the problem arises when atmospheric concentration of greenhouse gases increases .Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide and CFS has increased 50% and 20% respectively. These increases have enhanced the heat-trapping capability of the earth's atmosphere resulting in global warming and change in climate.
  - *The Negative Aspects of Global Warming :*
    - Glaciers in the poles will melt by the end of this century and the sea level will rise up to 1-3 meters. As a consequence, the cities in the coastal areas like Mumbai, Chennai, Kolkata, London, New York, Shanghai, Dhaka, and Venice will be submerged. Many island nations like Maldives, West Indies etc. and Southern part of Bangladesh, Coastal areas of India will be drowned.
    - Production of crops will be highly affected.
    - Forests, national parks will be affected and loss of biodiversity will be noticed.
    - Intensity and frequency of the occurrence of cyclones, tsunami in the sea shore area will increase.
    - The Indian Monsoon system will be affected which in turn will affect major crops like rice and wheat.
- **Control of Air Pollution:** It is to be noted that once the air gets polluted, it is almost impossible to purify it. The best way to control air pollution is to

prevent the pollutants at source from being mixed up with air. This involves the following strategies:

- All those fuels used in vehicles should be free from sulfur and lead. It can reduce air pollution up to 50%.
- The height of the chimneys in the industries should be increased.
- When smokes emitted from the chimneys are allowed to pass-through a filter or a small metallic room some amount of pollutants are absorbed in the walls and the rate of pollution is decreased.
- Rate of afforestation should be increased.
- The sources of incombustible energy should be found

9.5 WATER POLLUTION

When the biotic and abiotic substances are mixed into water and bring about physical, chemical and biotic changes into it then the water becomes impure. This is called water pollution, which causes harm to human health.

- **Causes of Water Pollution**: Water pollution spans a wide range of chemical, physical and microbial factors. The major causes of water pollution are the raw sewage, garbage, fertilizers and pesticides used in agriculture, oil spills and wastes from industrial units. Sewage and fertilizers bring in nutrients to the water bodies. In excess levels, nutrients over stimulate the growth of aquatic plants and algae causing eutrophication. Excess growth of these types of harmful plants consequently clog the waterways, use up dissolved oxygen as they decompose and block penetration of light into the deeper level of water. This in turn proves very harmful to the aquatic organisms.
- **Major Water Pollutants-their Sources and Effects:** The sources can be categorized as –
  - Effluents from Industries
  - Excessive Heat
  - Agricultural Activities
  - Domestic Wastes
  - Effluents from Industries: The effluents from the chemical industries carry high amount of various heavy metals, mercury, lead, copper, arsenic, cadmium which are highly toxic .When these are disposed in the water bodies, the quality of the entire aquatic system is affected and environment is polluted.

    Effects of industrial wastes:
    - Nitrates (more than 90 ppm) from the industrial wastes cause “Blue baby syndrome” disease.
    - Hg, As, Pb cause damage to the central nervous system.

- When the mercury-toxicated fishes in the Minamata bay of Japan were eaten by people they suffered from the disease called ‘Minamata disease”.
- The fibers of asbestos cause a form of Lung cancer known as Asbestosis.
- Cadmium causes lung cancer and bone deformation.
- Excessive nitrate causes methamoglobenamea.

- Excessive Heat: Due to certain human activities, rising of water temperature is very common. High amount of heated water from is thermal plants and nuclear plants is released to the nearby water bodies as wastes as a result of which the water bodies get heated and the aquatic organisms there like fish and plants are severely affected.
- Agricultural Activities: The pesticides and chemical fertilizers used in the agricultural fields flow to streams thereby polluting the entire water system. P.C.B, **D.D.T** types of chemicals found in the bones of organisms and even in the endocrine gland do not decompose and consequently cause serious damage to the organs. The increase of nitrates causes algal bloom in the water body for which the aquatic system is degraded.
- Domestic Wastes: The organic decomposition of human, animal and domestic wastes, garbage, soap, detergent, bacteria and viruses etc are mixed with water and the whole system is polluted.
  - The domestic sewage drains supply high amount of algae, fungi, virus, bacteria which are the root cause of certain diseases like cholera, jaundice etc.
  - Phosphate in the detergents causes the increase of algal blooms.

- **Control of Water Pollution:**
  - It is possible to control water pollution at the point of generation in the plant. Water cooling pond, tower may help in this regard.
  - The waste water can be reused by applying some chemical techniques. Soda, bleaching powder can be used for cleaning the water used for domestic purposes.
  - Toxic and dirty water from drains and canals should be prevented from being released into the water bodies.
  - Instead of using chemical pesticide, people should be encouraged to use herbal ones which do not have side effects.

9.6 SOIL POLLUTION

The fertility of soil decreases owing to the addition of some toxic elements into it. This leads to the pollution of the environment and it is called soil pollution.

- **Sources of Soil Pollution:**
  - Domestic Wastes: All household wastes that include kitchen wastes, broken bottles, plastic, polythene bags and miscellaneous waste materials when indiscriminately thrown into the land cause the gradual loss of fertility of the soil.
  - Industrial Wastes: Industrial wastes are basically the effluents released by industries. These effluents cause the pollution of the soil. Some industries and their pollutants are mentioned below.

Industries	Pollutants
Oil industry	Unrefined oil, hydrocarbons
Plastic industry	Dioxide
Refinery centers	potassium salt
Cloth industry	chloride ion

  - Agricultural Activities: Varieties of pesticides, fungicides, herbicides etc. cause the decrease in fertility of soil.
  - Germs: Viruses, bacteria etc. disposed by hospitals, laboratories etc. contribute to the pollution of the soil.

- **Effects of Soil Pollution:**
  - Varieties of soil transmitting diseases like giardiasis, tetanus etc. are caused by soil pollution.
  - Some metals like As, Hg, Cd etc. Mix with soil and toxicity occurs. When the crops are treated with these chemicals, the chemicals enter the plant body and destroy the body functions. In 1970, 200 people in Japan died due to cadmium toxicity caused by the itai-iti disease.
  - The pesticides not only decrease the fertility of the soil but also enter into the food chain and thus cause diseases.
  - The capacity of crop production of the soil is decreased gradually.
  - The excessive use of chemical pesticide destroys the natural bacteria of the soil.
- **Control of Soil Pollution:**
  - Proper action should be taken before the disposal of domestic wastes and chemical wastes into the soil.
  - Solid wastes can be segregated from the garbage dumps and can be reused by using chemical techniques.

- High level of technology should be used to improve the agricultural production instead of using chemical pesticides.
- Afforestation will help in soil fertility.
- Microbial degradation of biodegradable substances is also one of the scientific approaches for reducing soil pollution.
- Necessary enactment of laws should be made for penal action against those who indulge in the act of polluting the soil.

9.7 NOISE POLLUTION

Noise is a loud or unpleasant sound or series of sounds. Noise pollution is caused by such unpleasant sounds created by man, animals or machines. Such noises sometime create an unbearable situation affecting the peace and tranquility of a place. Since noise travels through air, all forms of noise are considered an air pollutant.

- **Measurement of Noise:** The intensity of sound is measured in sound pressure levels (SPL) and common unit of measurement is decibel, dB.
- **Sources of Noise:** The sources of noise may vary according to our daily activities. The sources may be
  - Domestic: It involves the sound created by the air conditioner, home appliances, pressure cooker, television etc.
  - Natural: Wind, earthquake, volcano, storm, landslide, waterfalls are the natural sources of noise.
  - Commercial: Various types of construction works, automobiles, aeroplanes, factories, machinery etc.
  - Industrial: generator sets, boilers, plant operations, trolley movement, transport vehicles, pumps, motors etc..

    In Indian conditions, indiscriminate use of the public address system and diesel generator set, has given a new dimension to the noise pollution problem.

- **Effects of Noise:**
  - Annoyance: It creates annoyance to the receptors due to the fluctuations in the sound level. It annoys and frightens the hearer besides causing discomfort and headache to him.
  - Physiological Effects: The increasing physiological effects include blood pressure, sleeplessness, heart-beat and acute headache.
  - Loss of Hearing: Continuous exposure to high sound levels causes loss of hearing besides affecting the air drum.
  - Nervous System: Pain in ears, feeling of tiredness, disorder of nervous system.
  - Suicide Cases: Sleeplessness, high blood pressure, suicidal cases are also evidenced. Accidents may occur due to the trauma sleeplessness

caused by noise pollution. There are instances of suicides attributed to noise pollution.

- **Control of Noise Pollution:**
  - Educational institutions, hospitals, residential areas should be declared as Silent Zones and there should be no noise pollution in those areas.
  - New techniques should be used to reduce the sounds from the heavy machines.
  - Use of radio, television in low volume.
  - Airports, industries should be established in areas away from residential places.
  - Increase of afforestation.
  - The playing of high volume speakers, microphones should banned. To invoke legal provisions in banning the use of loud speakers and bursting crackers at night.

9.8 ROLE OF INDIVIDUAL IN PREVENTION OF POLLUTION

The role of individuals in preventing pollution is very important because if every individual is conscious about the ill effects of pollution, there will be less impact of pollution. The following measures at citizen level will help in reducing pollution:

- **Preventing Air Pollution:**
  - Use of public transport to workplace or sharing vehicles
  - Walking or cycling for relatively short distance travels
  - Economic use of electricity and fuel
  - Use of low-energy or energy saving light bulbs
  - Turning off the engine of the car when waiting.
- **Preventing Water Pollution:**
  - Reducing unnecessary water use
  - Not allowing any type of waste or dirty clothes to go to the drains
  - Removing any stagnant pool of water in the backyard
  - Ensuring hygiene and proper sanitation
  - Using biodegradable or environmentally friendly soap and other cleaning supplies
- **Preventing Soil Pollution:**
  - Using reusable containers and bags
  - Use of biodegradable materials
  - Controlling the use of hazardous chemicals such as pesticides
  - Taking precaution while disposing used goods such as radio, TV, other electronic goods, mobiles, cameras, electrical bulbs, plastic furniture. etc.
- **Preventing Noise Pollution:**
  - Keeping the volume of musical instruments to low level when playing

- Avoiding the unnecessary use of loud speakers at residential places.

9.9 LET US SUM UP

- An undesirable change in the physical, chemical, or biological qualities of the natural environment brought about by man's activities is termed as environmental pollution. From this unit we have learnt about all kinds of pollution and their sources, their effects and the measures to control them.
- This unit describes all kinds of health problems and loss and damage caused by the pollution of air, soil, water, noise. The major soil pollutants are domestic and industrial wastes, pesticides, petroleum hydrocarbons, plastics, heavy metals, acid rain, fly ash etc. Besides, the control measures for all these kinds of pollution have been briefly dealt with.
- Due to the increasing urbanization and industrialization, the rate of pollution is increasing day by day degrading the quality of the environmental components. Therefore each and every citizen should be aware about the harmful effects of environmental pollution and the measures to be adopted for its control.

9.10 FURTHER READING

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9.11 POSSIBLE QUESTIONS

VERY SHORT ANSWER QUESTIONS

Q 1. Define “Environmental Pollution”.

Q 2. What are the major Air Pollutants?

SHORT ANSWER QUESTIONS

Q 1. What do you mean by Greenhouse Effect?

Q 2. Write notes on

(a) Noise Pollution (b) Water Pollution

LONG ANSWER QUESTIONS

Q 1. What are the major sources of water pollution? How does water Pollution affect man and other animals?

Q 2. Enumerate the measures that can be adopted at citizen level to Prevent air, water and noise pollution.

ENVIRONMENTAL STUDIES

Block -4

Problems and Practices of Conservation of Nature

UNIT-10 ENVIRONMENTAL MOVEMENTS IN INDIA

Unit Structure

10.1 LEARNING OBJECTIVES

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

- explain the conceptual understanding of environmental anthropology and its development;
- have clarity on different environmental movements in India that took place in different parts of the nation and in different time periods;

- have brief understanding on various regulations and legal framework on environment in India;
- know the impact of environmental movement in India which have influenced the development approaches of the country; and
- Know the significance of studying environmental anthropology in day to day life of the people.
- The traditional role of women as caretakers of environment;
- Various debates on the role of women and
- The concept of eco-feminism.

10.2 INTRODUCTION

During the last couple of decades one finds a plethora of materials in social sciences relating to ethno-ecology, ecological anthropology, environmental economics, human ecology, and political ecology. The naming of ecological anthropology came during 1960s by the thinkers like Alfred Kroeber and Julian Steward. The concept of cultural ecology influenced ecological anthropology, but one finds a shift from the concept of cultural population to the ecological population. The ecological anthropology was influenced by functionalism, systems theory and focus on negative feedback. For anthropologists role of cultural practices and beliefs in enabling human population to optimize their adaptations to their environments and in maintaining un-degraded local and regional ecosystems are important. Rappaport (1971) used the word 'ecological population' as an aggregate of organisms having a common set of distinctive means by which they maintain a common set of material relations within the eco-system in which they participate. The earlier ecological anthropology was based on cultural relativism, while the new ecological or environmental anthropology blends theory and analysis with political awareness and policy concerns. This led to the new field of applied ecological anthropology and political ecology (Greenberg and Park, 1994). Orlove (1980), while reviewing the literature on ecological anthropology, noted the processual ecological anthropology as a stage gradually supplementing neo-functionalist approach. Within the processual ecology human system ecology (Bennett, 1976) emphasized on human ecology as human behavior. Anthropological political ecology established relation with geography and political economy in which concepts such as claims, rights, power and conflicts predominate. Anthropological human ecology established relation with biological sciences and concepts like energy flows, knowledge systems, subsistence and adaptation.

Development of an ecological theory that incorporates natural and cultural dimensions within a single, broad paradigmatic framework seems to be quite urgent. Vayda and Walters (1999) maintain that ecological research should not make prior judgments concerning the causes of environmental change, but must be willing and able to assess all possible factors of biological and social origin. In anthropological

and ecological research different kinds of generalizations are obtained from different levels of analysis (Bennett, 1976). In biological terms the distinction is made between 'eco-system people', whose subsistence is tied to particular local level eco-systems, and 'bio-sphere people', who drew their support from resources obtained at a planetary level (Dasmann, 1988). Ecological anthropology faces methodological difficulties to understand geological, biological and cultural temporalities developed over many years.

Changes in ecological anthropology is observed in research focusing on single community or culture perceived as more or less isolated and unique, to recognize the linkages between the people, technology, power and status and the impact of post-modern on local abilities. The earlier concept of ethno-ecology included society's traditional perceptions and cultural model of the environment and its relation to people and society. This has changed due to interconnectedness of the today's market, people, and physical ecology due to migration, commercial expansion and national and international incentives to degrade the environmental and ethno-ecological systems.

The term environment is often used as a synonym for the Nature (i.e., the biophysical and non-human environment) and includes both cultural and bio-physical elements (Rappaport, 1979). The term environmentalism refers to an explicit active concern with the relationship between the human groups and their environments, while environmentalists refer to political activists. Thus, anthropologists and other social scientists who are involved in environmental research can be considered as representing the environmental wing of the irrespective disciplines. The present research in anthropology has two different issues and methodologies. The first one, ecological anthropology, uses ecological methodologies to study the interaction between human groups and their environment and the second, anthropology of environment, uses ethnographic methodologies to study environmentalism as a type of human action (Little, 1999).

10.3 ANTHROPOLOGY OF ENVIRONMENTALISM

Last few decades have witnessed environmental governance at local, national, and international levels. Brosius (1999) viewed that the contemporary environmentalism as a new discursive regime is emerging and giving shape to the relationships between and among natures, nations, movements, individuals and institutions. Anthropology contributes to the understanding of human impact on the physical and biotic environment and also in showing how that environment is constructed, represented, claimed, and contested. Of late environmental issues have influenced the local struggles, national and international debates for a diverse vision of the environment and environmental problems. National elites and multinational capital during the last

two decades have redefined the concept of environment and environmentalism by displacing moral and political ethics of development. So any attempt to understand the social movement aspect of environmentalism must be addressed within a set up of complex relationship between the historical and contemporary forms of domination, existing or emerging structures or institutions, politics of representations, processes of production, and emerging forms of political agency (Ibid). Anthropological understanding on environment drawn its inspiration from the field of ecology, i.e., the interest in localized adaptations to specific eco-systems, while the anthropology of environmentalism draws its insights from various sources like post-structuralism's social and cultural theory, political economy, and globalization. Thus, this new area is more concerned with the issue of power and inequality, cultural and historical formations, knowledge production and acceleration of trans-local processes. Anthropologists have come to this field of environmental issues much late; however, scholars like Douglas and Wildavsky (1982) have published considerably in this regard. The increase in environmental scholarship across different disciplines in late 1980s, like science and technology, media studies, geography, political science, history, legal studies, political ecology, led to inter-disciplinary understanding of the issue of environmental problem. The local communities adopted the elements of new transnational environmental discourses (Brosius, 1979a).

10.4 ENVIRONMENTAL MOVEMENTS IN INDIA

The increasing confrontation with the nature in the form of industrial growth, degradation of natural resources, and occurrence of natural calamities, has resulted in the imbalances in the bio-spheric system. The publication of 'The Limit of Growth: A Report for the Club of Rome's Project in the Predicament of Mankind' (Donella H Meadows et al., 1972) and other reports, such as World Commission on 'Environment and Development' (1987), and State of India's Environment: A Citizens Report (1982), have led to the monitoring of the contradiction of growth and the erosion of the environment. The Defence of the Planet and Save the Earth Movement, formation of the Earth's Friends Society reflects the growing concern for the future of mankind. In India also the ecological and environmental issues have received quite considerable attention from different scholars. Ecological themes have been published by different scholars like Guha (1989), Gadgil and Guha ((1992), etc. All the scholars made an in-depth inquiry of the ecological problems in India and developed an understanding of both the nature, strategy and methods of people's mobilization around environmental issues (Ibid) as well as the consequences of environmental degradation for the society, economy and culture of people (Agarwal, 1986; Agarwal and Narayan, 1998).

The data presented by Guha (1989) and Shiva (1993) on the causes and consequences of the erosion of natural resources reflect the composite ideology of environmental

issues in India. Together they reflect the social science perspectives backed by natural sciences. The social and ecological dimension of bio-diversity, environmental management (Shiva, 1993) and Gandhian perspective on resolving the dilemma of development without hurting the ecological balance (Jain, 1988) constitute the themes of continuing debate on the contradictions of ecology and development problems in India.

Environmental movements in India, centering on dams, displacement and resettlement effectively articulated their agenda on the human consequences of tampering with the courses of natural resources, have initiated protest action against the forces and agencies responsible for environmental degradation. Further, the issues raised by the actors of the ecology and environment movement by the "Friends of the Earth" and by the natural and Social Science scholars in defense of the nature and the planet earth, suggests that the ecology movement is not a mere exercise in romanticism nor a movement relating to food, fodder and fuel alone. In India it is also seen that the ethnic practices of worshipping planets, trees, forest, and rivers reflects the natural and social domains and the wisdom of seeing unity in the living and the non-living world in the Indian tradition. The ecological movements in India encapsulate all categories of caste, class, race, religion, nations and also categories of species divisions and the divisions of the organic and inorganic world.

Environmental movements in India have contributed in defining the models of development, shifting from a resource intensive and ecologically unstable state to an ecologically symbiotic state of functioning. A couple of environmental movements experienced in India so far include Chipko Andolan (Barthelemy, 1982), Save the Bhagirathi and stop Tehri project (Manu, 1984), Save the Narmada movement (Narmada Bachhao Andolan) in Madhya Pradesh and Gujrat; Youth organisation and Tribal people in the Gandhamardan Mines against Balco, the opposition of Baliapal Test Range, Bauxite mining in Kashipur and Niyamgiri; the Appiko movement in the Western Ghats; the campaign against the Silent Valley Project; reclaiming wastelands in Bankura district, and the opposition to the Gumti Dam in Tripura, etc., are some examples.

Many local movements centering deforestation, water logging, salinization and desertification in the command areas of major rivers of Kosi, Gandak, and Tungabhadra and in canal irrigated areas of western India, like Punjab and Haryana, have established the efficient use of water as a source of natural commodity. All these movements have reflected the ill-conceived natural resource consumption by the so called development projects, which have resulted in devastations in the natural resource base of the nation. In the following section we describe couple of major environmental movements that have occurred in different parts of India across time.

10.5 ENVIRONMENTAL MOVEMENTS; FEW CASE STUDIES

10.5.1 The Silent Valley Movement, Kerala

The silent valley is located in Palghat district of Kerala. It is surrounded by different hills of the State stretched over a total area of 8950 hectares. The flora and fauna of the valley is natural and very rich in biodiversity. The valley has contributed varieties of genes for pest and disease control of rice. The idea of a dam on river Kunthipuja in this hill system was conceived by the British in 1929, while the technical feasibility survey was carried out in 1958 and the project was sanctioned by the Planning Commission of Government of India in 1973 with a cost estimation of Rs. 25.00 cores, which enhanced to 80 cores in 1980. The project had dual purpose of generating 240 MW of power, to irrigate 10,000 hectares of additional crop land and to create jobs for 2000 to 3000 people during the construction period.

Peoples Response

Local people lobbied for the project under the erroneous assumption that their prospects would improve as a consequence of a big scheme being located in their area (Darryl, 1985: 19). All political wings of major political parties also favored the process of development identical with that of industrial development. However, the silent valley issue in Kerala demonstrated all party ignorance of ecological balance (Krishna Iyer, 1992). In subsequent period the Kerala government passed an ordinance in the second half of 1978 to protect the ecological balance in the "Silent Valley Protected Area". By the time the movement against the project from all corners was raised from all sections of the population, the environmentalists came forward to oppose the project from a wider perspective. The significance of Western Ghats as an important asset in the western Peninsula was raised.

In Stockholm Prime Minister of India made several commitments to the rest of the World regarding the protection of environment. The Task Force report came in 1977 which highlighted the genetic value of an undisturbed rain forest like Silent Valley (Darryl, 1985).

The report viewed that "Forest as a natural reserve can yield wood and water on a renewable and sustainable basis, therefore any form of intervention that adversely affects the generation of such resources on a long term basis cannot be termed as development." The Task Force report became a platform for the environmentalists to generate large scale disagreement against the project. The International Unions for conservation of Nature and Natural Resources (IUCN) made a resolution in 1978 for the presentation of the silent valley. The Kerala Forest Research Institute also made an on the spot, assessment and recommended the declaration of the silent valley as a bio-sphere reserve.

Kerala Shastra Sahitya Parishad (KSSP) created mass awareness against the project. KSSP based on certain ideology was identified in popularizing Science to the people (Guha, 1988). Later on KSSP formed a registered Society named as the "Protection of Silent Valley" at Calicut (Prasad, 1987) and later with their logical study based on techno-economic feasibility and socio-economic assessment of the project turned down most of the arguments given by the prodam forces. Since KSSP had a close network with people in north Kerala, they were able to convince the people that the project will not be beneficial to them in the long run due to its destructive affects over natural resources. Finally, the Kerala Government made Silent Valley a national Park considering the importance of valuable rich flora and fauna which needs conservation and proper management. It also recognized that this precious reserve of the life forms and the gene pool is the only undisturbed tropical rain forest in true sense in Kerala, which needs to be preserved permanently (Darryl, Ibid)

Significance of the Silent Valley Movement

Like other social movements in India, Silent Valley movement was also spontaneous, natural, initially went through unorganized processes but later on became more organized. In initial phase the local level groups protesting against the project neither could nor tried to contact the larger platforms because of their apprehensions and lack of clarity on the issue. In initial period the movement at local level had the experiment with the outside forces before co-opting them into their fold. The movement also established the fact that civil society reflects or offers the true concept of development. From the experiences one can say that if the philosophy of the movement gets supports by the higher level platform then it became easy to establish the facts of the concept of people's development as a part of the development process. This movement contributed certain path ways to the other movements in India. It also established the fact that development should not bring destitution to the people and destruction to the natural resources base. Proper awareness is required among people on ecology and environment, for making a movement of this magnitude successful. In later period this movement forced the State to go for small hydro-power projects which became more environment friendly, less destructive to the natural base of the State (Khosoo, 1988).

10.5.2 Chipko Movement, Uttar Pradesh

Chipko Movement started in April, 24 1973 at Mandal of Chamoli district of Gharwal division of Utter Pradesh. The Organiser of the movement had a belief on the ideology of non-violence as propagated by Mahatma Gandhi and Vinoba Bhave. The movement was raised out of ecological destabilization in the hills. The fall in the productivity in forest produces forced the hill dwellers to depend on the market which became a central concern for the inhabitants. The continuous natural distress like flood, and land slide due to Alakananda (1970) river and other catashophes like

Tawaghat tragedy (1977) and Bhagirathi blockade (1978) Branch Rivers of river Ganga caused massive flood in the Gangetic plains. These floods brought a marked change in the ecological history of the region. A look into the forest policies and forest resources exploitation data show that due to over mining of forest resources in different time periods such natural calamities have occurred.

In 1973 the State Forest Department gave a lease of forest trees to Simon Company, a manufacturer of sporting goods from far off Allahabad (Mishra and Tripathy, 1975) the relationship between the erosion and floods on the one hand, and mass scale falling of trees on the other was recognized. On March 27 decision was taken to 'Chipko" that is 'to hug' the trees that were threatened by axe and thus the chipko Andolan (movement) was born. This movement has multifaceted conflicts over forest resources, at the scientific, technical, economic, and, especially, the ecological levels (Shiva, 1986). Major demands of the Chipko movement were not merely to protect timber, fuel, fodder and small slumber but the preservation of soil and water.

Public meetings were held in the region and the felling of trees by the Company was postponed. In initial days villagers were lured by the Company from the forest for other entertainment but later on failed to attract them. In 1974 Sunderlal Bahuguna the "Chipko Messenger" visited the entire region taking the Chipko message from village to village. In subsequent period the local people did not allow any one from cutting trees even for home industries. Thus, one finds a change in the Chipko movement, from economic to ecological. The Chipko movement has been successful in forcing a fifteen year ban on commercial green felling in the hills of Uttar Pradesh and generated pressure for a national forest policy that is ecologically more sensitive. Women were very active and came out of their homes to take lead in the Chipko movement.

Lessons learned

The Chipko movement experimented and established certain original approaches, like marginality, action research and social investigation. Few social workers integrated the Chipko movement for preservation of forest in the sub-Himalayan region of Gharwal. The movement made people conscious of the value of forest, its preservation and the need for maintaining ecological balance. The movement has established the importance of need oriented programmes, indigenous strategies, self-reliance, ecological balance and structural changes that resulted in high degree of people's participation with the help of appropriate small scale technologies. It was experienced that the Western model of development reflected in the form of large scale infrastructure which have marginalised the women to the level of labour delivering products, the Chipko movement proved that women who produce all subsistence goods can maintain the status quo by retaining the traditional eco-system. They saw that conservation of forest seems to be their only source of living and survival. Chipko movement offered women a platform to realise command over

Public power and authority. New ecological concepts were built through this movement that made women to realise these issues which were earlier controlled by their male counterparts. This has resulted in various changes in the gender relations in rural Gharwal region in performing the household and social responsibility. The top down approach long adopted by the State in development of women could not bring much change in the power structure of the rural people. The new concept of ecological challenges became more concerned for the women (Jain, 1984). The experiment could make people believe that participation of women in the development process can be achieved by a mere ideological commitment and a few organisational devices (ibid). Belief in non-violence, cooperation and self-help are the basic axioms of the Sarvodaya Philosophy helped the Chipko movement moving forward. Further, it was a fact that women who were away from the intricacies of public power and political activities genuinely believed in the ideas of cooperation and self-help. The principle like non-violence as a natural and more effective weapon imposed on people as a moral pressure helped considerably to make the Chipko movement a grand success.

The ecological crisis in the Himalayas is not an isolated event. It has its roots in the modern materialistic civilisation which makes men the butcher of Earth (Bahuguna, 1980). Other arguments that forest officials and commercial forestry are merely agents of a development process biased in favor of the urban industrial complex and against local needs. The framings of development schemes by urban centered technocrats have little relevance to the realities of rural India (Bhatt, 1984). Another perspective of the Chipko movement is based on Marxian ideology. It viewed that human nature relationship must not be viewed in isolation from existing relationship of humans.

Chipko still survives and the philosophies of the movement has spread beyond Uttarakhand hills and linked to social activists, humanitarian scientists and people in need in Jammu & Kashmir, Rajasthan, Himachal Pradesh and West Medinipur district of West Bengal, while in Karnataka Chipko has reformulated as Appiko (Hedge, 1994 and Alvares, 1984). The Chipko movement became a psyche of India and the World.

10.5.3 Narmada Banchao Andolan Gujarat

Narmada is one of the major rivers of Indian Peninsula. The scope of the Sardar Sarovar project a terminal reservoir on Narmada in Gujarat in fact is the main issue in the Narmada Water dispute. The Narmada basin covers 94,500 sq. kilometres between the Bindhya and Stapura ranges in Central India. The 1300 kilometres long Narmada valley contains large alluvial plains in Madhya Pradesh. Narmada River on the west is sacred to the Hindus, widening into a 25 kilometres long estuary as it flows into the Gulf of Cambay. It is one of the World's largest multipurpose water projects. The Narmada River Development Project involves the construction of 30

large Dams and many small ones on the river and its 51 main tributaries. The project basically aims to increase food production and hydropower generations in Gujarat, Madhya Pradesh and Maharashtra.

The construction of dams and reservoirs will displace estimated one million people and will submerge 350,000 hectares of forest land and 200,000 hectares of agricultural land (India Today, 1992). The Sardar Sarovar Dam in Gujarat is being strongly opposed by the tribal people due to the fact that it will submerge almost 40,000 hectares of land and 250 villages. Similarly, the reservoir behind Narmada Sarovar Dam will be the largest manmade lake in India submerging 91,348 hectares and displacing 120,000 people from 255 villages, which includes 13 forest villages (Shiva, 1991). Of the total affected persons by submergence of around 80% are agriculturists (Doria, 1990). Around 30% amongst to be submerged belongs to SCs and STs and about 75% are marginal farmers or labourers. Over 90 per cent are illiterate and vulnerable to exploitation.

With respect to the funding of the project, the World Bank supported with an approved loans in 1985. For various reasons the Central and State Government could not meet the resettlement and rehabilitation guidelines and social and environmental issues went unaddressed (Kothari and Singh, 1988). Finally, in 1997 the World Bank decided to cease funding the project but the Indian Government pledged to complete it (Miller and Karunar, 1993).

The Narmada Basin extends over an area of 98796 sq. km and is divided into five well defined physiographical zones. The area has a tropical climate with high variations in rainfall, temperature, and humidity. The average annual rainfall in the catchment area is 12.89. The total cultivable command area of the Narmada Sagar Project is 174967 ha. The cropping pattern to be benefited out of the projectincludes Khariff, Rabi and summer crops. In addition, the project also aims to generate 212 MW power in the initial stage and 147 MW in final stage. The Narmada basin is one of the richest areas of the country for valuable forests and variety of wildlife. The Narmada basin has two world famous national parks like Kanha and Satpura; and five Sanctuaries, Kheoni, Panchamukhi, Bori, Ratapani and Sidhore. Narmada basin also falls on route to several migratory birds flying to South from North.

It was conceived that the massive deforestation due to the project will affect the feeding and breeding of the wild life. The compensatory forestry will not be able to compensate the eco system to the normal situation. Ecological pressure and micro climatic changes caused by deforestation will inevitably threaten the wild life.

Save the Narmada movement began in the 1980s as a struggle for just resettlement and rehabilitation of people being displaced by the Sardar Sarovar Dam, but subsequently the focus was shifted to preserve the environmental integrity and natural

eco systems of the valley. The withdrawal of World Bank funding was a moral victory for the movement. Anti-project movement was very high among the residents of basin area in Madhya Pradesh, while in Gujarat dissatisfaction was observed among people whose lands have been encroached without adequate compensation and inequitable compensation by the Government (Appa and Sridharan, 1992). By linking the problems of environmental changes and degradation of the Valley with issues of economic equity and social justice, the movement forced the bank to withdraw from the project (Estana and Prakash, 1992).

Narmada Movement justifies the fact that an environmental movement can go beyond social and cultural cleavages since it touched the human survival. Therefore, this platform unites people above age, sex, religious, and ethnicity, caste and class identities. Women became the prominent leaders and participants. The encroachment of rights of people in case of Narmada project was strongly protested by the people who protected their age old livelihood resources.

10.6 ENVIRONMENTAL MOVEMENTS IN ODISHA

The state of Odisha, particularly the southern belt, i.e., undivided Koraput, Bolangir and Kalahandi districts, is endowed with 1733 million tonnes (70%) of the total bauxite resources of the country. In the post-liberalisation period this mineral resource has attracted foreign investment, which brought the State into the international arena. Since 1986 several attempts have been made in western Odisha to explore bauxite ore (Government of Odisha, 2000). The major companies which have tried to explore bauxite mining in Odisha at different times include BALCO Ltd., Utkal Alumina, INDAL, TATA, Hydro (Norway), ALCAN (Canada) and HINDALCO. Any such mining projects will have an adverse impact on the life and livelihood of the local and the environment of the region. Therefore, in the local organisation of the agitations women's groups took an active part through picketing, processions and public hearings. The emergence of an indigenous leadership made all these movements more widespread. In fact, in this process of micro movements, the forest-dependent communities are trying to re-establish the functional importance of their indigenous institutions in the environmental protection and to determine the forest based regional needs of the people.

10.6.1 Gandhamardan Environment Protection in Odisha

The People and the Area

Gandhamardan, one of the bauxite rich hill ranges, is situated in Sambalpur and Bolangir region of western Odisha. This region is regarded by tribals and peasants as their mother who provides them with food, firewood, fodder and also water for cultivation and drinking purposes. Gandhamardan hill carries 22 streams and 150

perennial springs. The stream water and plants are the integral part of the local ecological pattern. In the ethnic composition of the region tribal communities like Gonds, Binjhals, Kandhas are the majority one, while Kulta a caste group are the numerical preponderant. The socio-cultural life processes of the local people are inter-twined with the Gandhamardan hill and Nrusingha Nath and Hari Shankar temples. Gandhamardan hill is a cultural territory for the locals of the region (Panigrahi, 1985).

BALCO Intervention

Gandhamardan hills carry an estimated bauxite deposit of 213 million tons covering an area of 9.6 sq.km. BALCO had a plan for mining the Gandhamardan hills with an original investment of Rs. 31.20 crores and creation of an estimated employment of 500 persons on regular basis and 3000 persons as contract labourers. In addition, BALCO had also promised 25 kms railway line, hospital, schools for the local people, plantation under social forestry and a royalty of one crore to the State. The first blasting of BALCO in July 1985 damaged the much revered Nrushingha Nath, the 800 years old temple, which developed physical cracks in the temple and it's Garuda Stambha. In the initial days BALCO butchered around 60,000 trees for the construction of road and ropeway. The tribal people of the region had preserved the forest plants as divine symbols and preserved them as totem of their clans. The destruction of trees by BALCO, therefore, is considered as a threat to their culture and society.

The adverse effects of BALCO on the local agriculture have contributed towards the environmental consciousness of the people. The Durgei stream irrigating 200 acres of land in Manabhanga village was affected due to the construction of a minor irrigation project on the stream to supply drinking water to BALCO Township. In addition, the irrigation project sub merged a big Mango orchard and private irrigated plots. The blasting of hills brought cracks in Khandei Jharan canal and silted the agriculture land that made the land very hard to plough. Gradually the villagers became conscious about the environment and feared that their agro-forestry based livelihood will be jeopardised with the BALCO project. As a result of which, local leadership started with the tribals and peasants and it went from the religion base to a secular base. The costs to maintain the agitation by the locals was collected in the form of rice, and mobilised people to different places of agitation and spread the anti-BALCO message in the region. Gandhamardan Surakhya Parishads (GSYP) were formed in villages, Gram Panchayat and region level which facilitated the grass root movement by involving all sections, both at micro level and macro level. The villagers realised that BALCO management has not merely betrayed the local inhabitants' faith in the modernization process, but also planned to take away the natural resources of their Gandhamardan hills.

Inference

We have learned that the modernisation process launched by BALCO could not build faith among the local. It could not even establish a dialogue process with the common people centring to the benefits of BALCO mining activities to their economy and ecology. As a result, the interests of the common people were ignored and hoodwinked by the interest groups.

On the other hand, the Gandhamardan mining made people believe on their abilities and made them conscious of the environmental issues. The potentiality of the youths and the women have been reflected and recognised in building construction activities. The movement has shown the path that people if united can built and rebuilt environment friendly development through their collective endeavour.

10.6.2 Environmental Movement Against Bauxite Mining in Kashipur

Kashipur is one of the tribal-dominated blocks of Rayagada district. There are 412 villages distributed over 20 Gram Panchayats, accommodating a total population of 101,995. The Poraja and the Kondhs are the two major tribal communities of the region. Of the total geographical area of 15,059 square miles the block has forest coverage of 59,000 acres and reserve forests of 33,000 acres. Around 36.3% of villages are electrified and only 19% of the total population is literate (Census of India, 2001). The total labour force in the block is 43.12% of which agriculture labour comprises of 24.95% while household industry accounts for 0.99%. The agro-products of the region include ragi, paddy, millet, grams (chickpeas), maize and Niger seed. Hill broom is the most important forest product of the region. The block was once full of natural forests and perennial springs. The tribal people living therein terraced the land and made the region habitable. They maintain a symbiotic relationship with nature and natural resources. They enjoy natural rights over the resources surrounding them. Intervention in the region started with various state laws basically designed to exploit the natural resources available in the region. The influx of non-tribal people suppressed the tribals. This has been reflected in the form of massive land alienation, resulting landlessness and severe impoverishment. People's poverty has become chronic as a result of money lending, bonded labour practices, the geographical inaccessibility of the region, exploitation by middlemen, contractors and petty traders, and the low bargaining power and lack of organisation of the people.

The systematic exploitation of the forest resources was started, in the name of national development, by J. K. Paper Mill of Rayagada, which destroyed the ecological balance of the region and the people. Utkal Aluminum International Ltd UAIL and other companies have entered the region to mine its hills in the guise of developing the area. This has led the people from the situation of food security to food scarcity. Deaths from starvation in Kashipur in 1987 were brought to the

attention of the then Prime Minister Rajiv Gandhi. After reviewing the situation, he evolved a new vision of development, following which IFAD funding worth Rs 400 million was invested in this region.

In 1993 the State proposed a bauxite alumina plant owned by Utkal Aluminum International Ltd (UAIL), a joint venture of Hindal, Tata, Hydro Alumina (aNorwegian company) and Alcan (A Canadian Company), with technical support from Alusuisse, a Swiss company. UAIL is a 100% export-oriented project, costing around Rs 24 billion, to source bauxite and transport it along a 25-km ropeway. People also learned of a second alumina project at the beginning of 1995, under a joint venture of L&T and Alcoan (a US company) with a 100% export-oriented project at a cost of Rs15 billion.

The plant at Kashipur (Doraguda) was to directly affect 2500 people in 24 villages of Kucheipadar, Hadiguda and Tikiri Gram Panchayat (required for the plant site, red mud and ash pond). However, the company claimed that only 147 families from three villages would be affected. In addition, 42 villages in Chandragiri, Maikanch and Kodipari panchayat would be directly affected by open cast mining at Baphlimali, while the company claimed that not a single village would be affected. The UAIL project required 2865 acres of land in Kashipur block in 1995, which includes 1000 hectares of land which has been in use for years for cultivation, forestry and shifting cultivation.

As a form of protest against the mining, 18 tribal people met the Chief Minister of Odisha, the late Biju Patnaik, for the first time in 1993 and demanded cancellation of the project. In 1994 the villagers of Kuchipadar snatched away the survey team's instruments and set fire to their camps. In 1995 the protest took a violent turn, destroying the survey team's camp, and as a result 15 tribal people were arrested. In 1996 the local organisation, PSSP was formed. In 1997 Utkal Alumina created an NGO - Utkal Rural Development Society (URDS) - to try to win people undertaking socioeconomic development works. PSSP opposed URDS and destroyed the company's resettlement colony. In 1998 local people built a barricade at Kucheipadar to stop the entry of project personnel. The police injured nearly 50 people. In 2000 police gunned down three tribal people and injured eight others. In 2001 a protest against the shootings in Maikanch was organised and around 10,000 people participated. Demands were made for mobile health services and irrigation facilities. Since 2002 the people of Kashipur region have been demanding the cancellation of all bauxite projects in KBK districts. On 29 December each of six Gram Sabhas in all the project villages rejected the proposal and suggested scrapping the treaty for the proposed mining.

10.6.3 Ecological and Bio-Diversity Protection Movement in Niyamgiri Hills of Odisha

Niyamgiri, a range of hills stretched over 250 sq. km, is popularly known as Dongaria Kondha land. Socio-culturally Niyamgiri hills are a single hill country, but from administrative point of view this land is divided under three districts of Kalahandi, Rayagada and Koraput. Anthropologists consider Niyamgiri as the original abode of the Dongaria kandhas, which is one of the original sub-groups of the Kandhas, who consider themselves as the descendants of Niyam Raja (Patnaik and Das Patnaik, 1982). The Dongarias have a distinguished heritage, dress style, mode of living, indigenous skills, cultural pattern, and social system interlinked with nature. The major river systems having origin in the hills include Vansadhara, Nagavali, and 36 streams which are culturally and ecologically very rich and maintain their identities till today. Niyamgiri carries most pristine forests of Odisha, vulnerable wildlife species, and proposed south Odisha Elephant Reserve and Wild life sanctuary of the State.

Niyamgiri, a part of the Eastern Ghats, is the natural reserve of metallurgical grade bauxite which rose to very high commercial importance in the era of globalisation. Vedanta Alumina Limited of M/s Sterilite Industries (India) Limited jointly with Odisha Mining Corporation (OMC) has signed agreement on 4th June, 2004 to set up an Alumina Complex of 1.0 MTPA Alumina Refinery Plant, 3.0 MTPA of bauxite mining for a period of 23 years and 75 MW Captive Power Plant at Lanjigarh in Kalahandi with an approximate investment of Rs.4000/crore. These projects will affect a total forest area of 672.018 hectares out of which 660.749 hectares (98.32%) will be diverted for mining and other ancillary activities of the project. The proposed area is situated in Niyamgiri Reserve Forest of Kalahandi (South) Forest Division, and Niyamgiri PRF (Proposed Reserve Forest) of Kalahandi (South) Forest Division, and Niyamgiri PRF (Proposed Reserve Forest) and Jungle Block (Protected Forest) of Rayagada FD. In addition, another 755.5 acres of land consists of village forests from six villages leased by Orissa Industrial Infrastructure Development Corporation Ltd to lease to Vedanta Alumina Ltd for setting up of an Alumina Refinery Plant at Lanjigarh.

Taxonomists who assessed the flora of Niyamgiri hills viewed that the flora of the hill range exhibits a very rich and varied assemblage of plant species owing to its diversified topography with High Mountain peaks and enumerable deep valleys and gorges, abundant springs and diverse vegetation resources. The hill also includes around 50 species of important medicinal plants, 20 species of wild ornamental plants and more than 10 species of crop plants. The secondary data identifies a variety of faunal species under categories like endangered and vulnerable as per the zoological survey of India's Red Data Book.

Dongaria Kandhas fought against Vedanta Company establishing the linkages between the natural environment and their rights. When one looks from the perspective of rights given by the Indian Constitution one finds the violation of natural rights and livelihood of the Dongaria people by the State. Through struggle, the local communities and the like minded forces appealed to the Supreme Court of India to restore the rights of the tribal people and to preserve the forest resources of Niyamgiri Hills. Again Fifth Schedule of the Indian Constitution provides protection to the Adivasi people living in the area. It is provisioned that no land in this area can be transferred to non-tribals (CEC Report, 2005). However, the local people in order to protect their own rights are determined to stop the mining in Niyamgiri Hills.

10.7 ENVIRONMENTAL LEGISLATION

Environmental Provisions in Indian Constitution

Provisions relating to environment were incorporated into Indian constitution through 42nd Amendment in 1976. For the first time "Environmental Protection" got importance.

As per the Directive Principles of State Policy, Article 48 (A), "the State shall endeavour to protest and improve the natural environment and safeguard the forest and wild life in the country.

According to Article 51 A (g), "it shall be the duty of every citizen of India to protect and improve the natural environment, including forests, lakes, rivers and wild life and to have compassion for living creatures". Besides this, the entire

dealing with forests and wildlife were dropped from the State list and inserted in "Concurrent List".

Distribution of Environmental Legislation

The Central Government under Central List has the power to legislate on industry, mines and minerals, oil fields, fishing, inter-state rivers and river-villages. In addition, the Central Government is authorized to make social planning under concurrent list of schedule VII of the Indian Constitution. Since India is a federal system of Government, the State Government can also legislate on industry, mines and minerals, fisheries, which is objected to as per the provision of the Central Government, Some of the major areas of Central enactments formulated by the Central Government include water, air, radiation, pesticides, and forest and wildlife. Some of the specific environment related legislations passed by Central Government in different time periods in different sectors are as follows (Meheta, 1994, Trivedi et al 1995):

Water Pollution
The River Boards Act, 1956
The Merchant Shipping (Amendment) Act, 1970
The Water (Prevention and Control of Pollution) Cess Act, 1974 and 1977

Air Pollution
The Indian Boilers Act, 1923
The Factories Act, 1948
The Mines and Minerals (Regulation and Development) Act, 1947
The Industries (Development and Regulation) Act, 1961
The Air (Preservation and Control of) Pollution Act, 1981

Radiation
The Atomic Energy Act, 1962
Radiation Protection Rules, 1971

Pesticides
The poison Act, 1919
The Factories Act, 1948
The Insecticides Act, 1968

Forest & Wild life
The Indian Fisheries Act, 1897
The Indian Forest Act, 1927
The Prevention of Food Adulteration Act, 1954
The Ancient Monuments and Archaeological sites and Remains Act, 1958
The Wildlife (Protection) Act, 1972
The Urban Land Ceiling and Regulation Act, 1976
The Forest Conservation Act, 1980
The Prevention of Cruelty to Animals Act

General
The Indian Penal Code, 1860
The Environment (Protection) Act, 1986
In addition to these, there are many state enactments passed with respect to water pollution, smoke control, pest control, land utilization and land improvement by different states in different time periods (Meheta, ibid)

The Recommendations of Tiwari Committee 1980
Based on the Tiwari Committee 1980 a separate Department of Environment, Forest and Wildlife were created in 1985. Subsequently the material National Wasteland Development Board (NWDB) and the Central Ganga authority (CGA) were created to manage specific environmental problems. In spite of the measures, there was a

significant fall in the quality and management of environmental problem (Koli, 2005) One such is the Bhopal Gas Tragedy which killed 2700 persons and injured around 20,000 people which forced the National Government to go for a new Act called the Environment (Protection) Act, 1986, passed in response to the resolution passed in 1972 at Stockholm at the World Conference in Human Environment. Environment Assessment of both physical and social aspects of any development project is made compulsory before any project starts. The establishments of Eco-mark scheme, Zoo Authority of India and Central and State Pollution Control Boards ensured the implementation of the Water Act 1974. The Water Cess Act, 1977, The Air Act, 1990 and the Environment Protection Act, 1986. The Pollution control authorities are ill-equipped to monitor and regulate the small and medium industries. As a result, many of the impactions are far from the reality.

10.8 IMPACT OF THE ENVIRONMENTAL MOVEMENTS

We have observed that in India the environmental movements could go beyond the social and cultural cleavages. They could unite people belonging to different caste, ethnic and economic categories, political ideologies, gender and age groups. In many such movements, women who are normally considered as the weaker sections of the society took the lead, both as leader and the participants, in these movements. Like independence movement of India, people of all status groups, viz., children, youth, adults, old and students, all sacrificed ambitions of their life and took part in taking ahead the concepts and the processes of these movements. It was commonly observed that in all the movements the people adopted the Gandhian Concept of non-violence and Satyagraha. These movements have established the fact that common property regimes of the people plays crucial roles in the daily subsistence activities of poor peasants in India. All these issue are being debated at local, national and international levels, where social scientists are playing central role in debates at various levels, including national and international levels.

Couple of new methods have been developed and used in data collection by different anthropologists while studying ecological anthropology. Satellite imagery data, both synchronically and diachronically, are used to identify ecological hot spots, and studied by multi-disciplinary teams (Green and Sussman, 1990; Kottak et al 1994). Secondly, the Geographical Information System (GIS) studies micro situations relating to human and environmental features. Survey data across space and time may be used along with the ethnographic studies to study the environmental situations. The distinct anthropological perspective must be adopted to study the local specificity with respect to the ecological and cultural diversities.

10.9 WOMEN AS NURTURERS OF NATURE

The stories of women for their valour as well as capacity are manifold. Throughout history, their deeds have been glorified in innumerable words. Their struggles, sacrifices and saga of achievements are diverse. Women have been worshipped as Goddesses of wealth, knowledge, wisdom, for creation and sustenance of this whole creation. They have been hailed as the form of 'Shakti' (divine power) that would care for this humanity, destroy the evil and nurture the good on this earth. Therefore, their reverence and care for nature has been duly recognised all through the ages and history. "Women hold up half of the sky, make up one half of the world's task force, and fulfil one half of the planet's potential. In women lie nature's best qualities of motherhood, compassion, humanity and love. Because they have been blessed with the capacity for giving and nurturing life, women also have the capacity for a deep commitment for preserving and nourishing not only their own offspring, but of the entire planet as well" (The Times of India, 9th March, 2003). As Uzma observes, women are in direct and daily contact with environment through their use of resource (food, fuel and water) and through their efforts to maintain secure and healthy environment for their families. They have a major role in managing natural resources-soil, water, forests and energy. Their tasks in agriculture and animal husbandry as well as in the household make them daily managers of the family living environments (Songsore, J and McGranahan, G, 1996. Cit in Parveen, Uzma, pp.26-27). Women are said to have more capacity than men in meeting environmental challenges, the crisis that emanates during natural calamities or other forms of environmental degradation like pollution of all sorts. They work harder than men in keeping the entire household and surroundings clean and maintain hygiene. In the urban settings, the task is all the more arduous because in lower income groups, the families often end up living in slums and unhygienic conditions, making the task of women all the more difficult. The task of fetching water is more or less similar in the roles of urban and rural women. While in rural areas, women go as far as seven or ten kilometers to fetch water, in urban areas, it varies from 20-100 meters distance. In both the cases, by spending so much time on these activities, women give an extra time to fulfil these household duties. Water is one natural resource that has become scarce in nature and over which many conflicts have arisen. Fuel is another resource for which women struggle to meet their ends. While in urban areas, the liquid petroleum gas (LPG) cylinder is used widely, its scarce availability often puts the women in difficult positions. In rural areas, women walk long distances trying to find wood that could be used for cooking purposes. The energy from solar and bio-fuels are yet to be tapped. The use of wood, dung and coal often prove to be harmful but women undergo these troubles in the long-term interests of their household sustenance. This, in a way, reduces their average life expectancy and mortality levels. Noted academic Bina Agarwal observes that, "the gathering of food alone demands an elaborate knowledge of the nutritional and medicinal properties of plants, roots and trees, including a wide

reserve knowledge of edible plants not normally used but critical for coping with prolonged shortages during climatic disasters". It is women who have kept alive these traditional resource management and knowledge and have greatly contributed to devising coping up mechanisms during any kind of disasters. The caring of nature has thus a gender-specific dimension, wherein women are often taken as surviving any calamity and responsible for restoration of nature to its originality. Women, as Guha says, are more likely to perceive scarcity and shortage and are thus more keen to combat or overcome it. Their energetic participation in protest movements has been something of a surprise in this traditional, convention-bound society (Guha, 2006, p.59).

The role of women in various environmental movements is highly recognised and lauded. They have been at the forefront preventing the destruction of environment and saving the surrounding ecology and as well as inhabitants. Two prime examples in our country include The Chipko Movement (literally meaning Hug the Trees Movement) and Narmada Bachao Movement (Save Narmada Movement). While the former prevented the felling of trees in the Himalayan region for commercial purposes, the latter sought to rehabilitate and provide adequate compensation to those displaced due to flooding of the villages because of dam construction. In both the cases, women have taken lead to protect and preserve the natural environment. A striking feature of environmental movements in modern India, as Ramachandra Guha says, has been the crucial role played by women. They have taken to the streets to protest forest felling, unregulated mining, displacement, and overfishing. They have also taken the lead in programs of environmental restoration; in the planting up of bare hillsides, in the conservation of local sources of water supply, and in the promotion of energy-efficient technologies (Guha, 2006, p.58).

10.10 GENDER AND ENVIRONMENT DEBATE

The debate on gender and environment has two dimensions: (1) that gender mediates human/environment interactions and all environmental use, knowledge, and assessment; and (2) that gender roles, responsibilities, expectations, norms and the division of labour shape all forms of human relationships to the environment. "The ancient identity of nature as a nurturing mother links women's history with the history of the environment and ecological change….In investigating the roots of our current environmental dilemma and its connections to science, technology, and the economy, we must re-examine the formation of a world view and a science that, by reconceptualizing reality as a machine rather than a living organism, sanctioned the domination of both nature and women" (Carolyn Merchant). Since ages, it has been categorised that men are more attached to culture while women are attached to nature. Since nature is considered as inferior to culture, women got dominated over by men. This is the traditional perspective over which many perspectives and thoughts

emerged over a period of time. As Sherry Ortner argued, the connection between women and nature was clearly rooted in the biological processes of reproduction. Many others did not subscribe to the nature-culture dichotomy but would agree that biologically and ideologically, women are more attached to nature. To quote Merchant further, "between sixteenth and seventeenth centuries, the scientific revolution and the growth of a market-oriented culture in Europe undermined the image of an organic cosmos with a living female, earth at its centre. This image gave way to a mechanistic world-view in which nature was reconceived as something to be mastered and controlled by humans. The twin ideas of mechanism and of dominance over nature supported both the denudation of nature and male domination over women". The concept of male domination over women and its equating with control over nature has gained wide acceptance. Men are usually seen as materialistic in their outlook and women as nurturers. As for example, in the case of the Chipko Movement, the male members of the region did concede to the demand from the commercial companies and gave a go-ahead for the felling of the trees. But the women, sensing the presence of the commercial companies' efforts to cut down the forests, gathered together to save the trees from felling by making a human chain around the trees. The role of women in various environmental movements have come to gain more prominence thereby making the environmental movements synonymous with women's inclination towards nature's protection and their role as caretakers of natural environment. Furthermore, women were involved in bringing the issue of environmental degradation and the necessity to take care of nature; this further strengthens the view of women being more sympathetic to nature. Even the policy-making, under women, was more pro-environment. For example, Mrs. Indira Gandhi was the first prime minister who recognised the importance of environmental conservation and represented India at the Stockholm Convention in 1972. She also brought a halt to the tree-felling activities in the Himalayan region that came under threat for commercial use. The policy of development that is more oriented towards expanding the urban areas and which has come to be identified as against the tenets of natural environment is associated with the policy-making process by male members. As Vandana Shiva observed, "Modern reductionist science, like development, turns out to be a patriarchal project, which has excluded women as experts, and has simultaneously excluded ecology and holistic ways of knowing which understand and respect nature's processes and interconnectedness as science". She opines that the traditional knowledge systems with which women are well versed have been affected and continue to do so under the impact of modern science. The reasons for understanding man's and woman's relationship with nature is said to have been rooted in "material reality". Men are viewed as materialistic in nature and giving into the demands of modern civilisation and it's so called progress; on the other hand, women are taken as the first victims of whatsoever damage is done to the society in any form. It is even more so in the case of environmental degradation. Since they are the gatherers of the household necessities, their problems become manifold. With more and more parts of the world reeling under the impact of environmental

degradation, problems like natural resource depletion, deforestation, deteriorating soil conditions and perennial water problems apart from pollutions of all kinds have multiplied. The trend is towards taking away the rights of local communities with regard to the environment. Many a system have been affected in the process and there is a gradual erosion of traditional resource management system, knowledge and wisdom that once greatly contributed to the sustenance of the communities on the whole. Increasing urbanization, settlements, advances in science and technology and the materialistic and consumerist culture are gradually eroding the value systems towards sustaining the natural environment. In this context, the debates have centred on issues relating to man's and woman's relationship with nature. The perception has widely been that men are at the forefront of policy-making that is not conducive to environmental conservation and which is tilted more towards development that compromises environmental conservation. Women are perceived, because of their strong ideological leanings towards nature, as being the caretakers and nurturers of nature and as opposing 'development that is destructive'. The contemporary catchword is 'development without destruction' in this context. The world over, more so in the developing world, women are participating in more and more ecological movements as the regional conditions prompt them to do so. The challenges of development in the developing world are manifold wherein, to catch up with the developed West, the nations are pursuing the policies of liberalisation and privatization that are capital-oriented. In this scheme of development, the tilt is obviously towards compromising the environmental standards that one ought to follow. In the name of development, numerous projects are being undertaken that are greatly destroying the environment and depleting natural resources. Therefore, the development vs environment is seen more in gender interactive terms and has marked the beginnings of gender environment debates.

10.11 ECO-FEMINISM

The reasons for the emergence of eco-feminism are manifold. The reasons are enumerated as follows. Firstly, the nature is viewed in terms of feminine principle. Through ancient ages, women in general are considered as an inseparable part of nature. At one level, nature is symbolised as the embodiment of the feminine principle, and at another, she is nurtured by the feminine to produce life and provide sustenance (Vandana Shiva, 1988, p.38). This is a manifestation of Shakti or energy, from which all existence arises. This energy is called nature (Prakriti). Nature, both animate and inanimate is thus an expression of Shakti, the feminine and creative principle of the cosmos; in conjunction with the masculine principle (Purusha), Prakriti creates the world. Nature is inherently active, a powerful, productive force in the dialect of creation, renewal and sustenance of all life (Ibid). The world derives its activity and diversity manifest in the form of life on Earth Mountains, trees, rivers, animals etc. The human being is to live in consonance with nature. Unfortunately,

man's attitude towards nature has turned into that of a dominant force, who can subjugate nature to the maximum extent. This symbolises man's eternal urge to demonstrate domination over woman. Vandana Shiva identifies women as traditional natural scientists, whose knowledge is ecological and plural, reflecting both the diversity of natural ecosystems and the diversity in cultures that nature based living gives rise to (p.41). She credits women with producing and reproducing life not merely biologically but also in terms of providing sustenance, more so a social role. Mie's, who worked on 'Ecofeminism', describes woman's special relationship with nature. The relationship is based on mutual reciprocal process, mutual cooperation and as producers of new life. With the disharmony between both created by the affluent and consumerist culture, the natural relationship finds enormous strains. Shiva observes that the disharmony is triggered 'by the arrival of masculinist, reductionist, industrial, colonising forces of Western culture'. The large number of women participating in the ecological movements, and even defying their men, demonstrates their innate power or Shakti. In India, in spite of women's suppression, there is a universal agreement, even if grudgingly, that women are nurturers of nature. The ancient civilisation and texts have often put women on a higher pedestal in the context of ecological/ environmental concerns. This view finds a wide spread critique among the Western scholars, thus bringing to the fore the cultural differences and the perception of nature as a sacred force to be restored and not exploited. The active participation of women in environmental movements has been widely recognised all over the world. As Guha says, 'some writers have interpreted this ''feminization'' of the environmental movements in terms of culture. Hindu women, they suggest, are intrinsically closer to nature than their Christian or pagan sisters. Other scholars have more plausibly in my view- argued that the participation of women in environmental movements is better explained in terms of the division of labor within the farm household, which mandates that women and girls, and not men, forage for fuel, fodder, and water' (Guha, 2006, pp.58-59). He cites Anil Agarwal's view wherein he says that 'the destruction of the environment clearly poses the biggest threat to marginal cultures and occupations like that of tribals, nomads, fisher folk and artisans, which have always been heavily dependent on their immediate environment for their survival. But the maximum impact of the destruction of biomass sources is on women. Women in all rural cultures are affected, especially women from poor landless, marginal and small farming families. 'Seen from the point of view of these women, it can be argued that all development is ignorant of women's needs, and often anti-women, literally designed to increase their work burden' (Ibid, p.59). Susan Buckingham-Hatfield explains at length about eco-feminism. Eco-feminism was coined as a term in 1974 when Frenchwoman Francoise d' Eubonne called for an ecological revolution to be led by women in order to save planet Earth. Eco-feminism has evolved both as an analysis of society-nature relations and as a prescription for how these relations can be transformed. Broadly, these analyses fall within two areas: cultural eco-feminism and social eco-feminism. Cultural eco-feminism indentifies a powerful and positive link between women and nature, particularly through such

female reproductive functions as childbirth and menstruation. This connection between women and nature is used to argue that women are better placed than men as advocates of nature. Social eco-feminism argues that because women and nature have both been subjugated by a society dominated by men, women, through the roles they play, are in a better position than men to speak for nature, because of this shared experience of domination. Social eco-feminists contest that there is anything more natural in a woman's body than in man's and disagree with cultural eco-feminists' belief that there is something which constitutes a woman's essence (Susan Buckingham-Hatfield, 2000, p.35). The cultural eco-feminists basically attempt to reverse the traditional hierarchy of male domination over women demonstrating the positive side of those characteristics previously held to be inferior and stressing the importance of women-nature links to the survival of nature. On the other hand, social eco-feminist perspective argues that it is the social role ascribed to women which identifies women more closely with nature. Women's closeness to nature, they argue, is more out of the social construction through generations. It is because of this that the women find themselves unable to distance themselves from nature and experience subjugation and discrimination based on their socially ascribed caring role. These two perspectives are often incorporated in the eco-feminist arguments with ecological and social analysis.

Eco-Feminism as a broad, diverse, world-wide movement unique eco-feminist approaches

- Liberal eco-feminists who seek reform from within existing political and economic structures.
- Radical eco-feminists who wish to dismantle those very structures through direct action.
- Cultural eco-feminists who focus on the cultural manifestations of the women-nature connection, earth-based spirituality, goddess religions and witchcraft.
- Social eco-feminists who would build on the social ecology movement of the American anarchist philosopher Murray Book chin in an attempt to restructure hierarchical society into egalitarian, decentralized bioregional communities.
- Socialist eco-feminists who draw on neo-Marxist philosophies to focus on the relationship between production and reproduction and on women's work in the continued biological and social reproduction of life on Earth.
- Ecological eco-feminists who strive to show the respects in which eco-feminism and the science of ecology (specifically eco-system ecology) share vital similarities.
- Deep ecological eco-feminists who draw on the work of the Norwegian philosopher, Arne Naess, and strive to dismantle both anthropocentrism (human-centeredness) and androcentrism (male-centeredness).

- Critical or transformative eco-feminists who wish to transform the very categories of masculine and feminine and the divisive nature of dualistic rationality.
- Aboriginal or native eco-feminists who live close to nature, nurturing sacred lands and re-consecrating degraded spaces.
- Eco-feminism of the Third world who criticise maldevelopment in the First World and show us how women of colour may be in a privileged position because their minds are not yet colonized and because they do not profit from the oppression of others. Source: Hallen (1994: 207).

There are also varied opinions regarding the subject of eco-feminism. For example, Val Plumwood is apprehensive about the focus on women's proximity to nature, which is rather a burdensome perspective and can lead to women's role in cleaning up the environment by appealing to their feelings of guilt and motherly duty. Janet Biehl expressed the view that women are being asked to take the fall to save the planet. Carolyn Merchant proposes a partnership ethic in which men and women enjoy a non-hierarchical partnership with nature. Karen Warren too shares this view by advocating the interpersonal relationships of mutuality, care, reciprocity, friendship, appropriate trust and love. Plumwood specifically propounds that the feminine traits of caring, naturalness and embodiedness are the result of domination and this led to the dualistic thinking, which she proposes to do away with. Cecile Jackson criticises eco-feminism for too much of idealising women and for obscuring the differences and conflicts between them. She particularly identifies the tension between women in the North and South, where the former tend to construct the latter as 'victims'. In South, she argues, women's relationship to each other and to the environment is heavily influenced by their class, age and position in the family and that any of these factors might result in treating the environment less favorably than eco-feminists would expect (cited in Susan Buckingham, pp.38-41). Biehl specifically denounces the role of women as special custodians of nature and advocates more of a society in which men and women aspire to an ethic of humanity. In spite of the differing views, most of them agree to the fact that eco-feminism should be more inclusive and pluralistic and should give space to many of the voiceless people.

10.12 WOMEN'S WORKS ON ENVIRONMENT

Some of the most illuminating works on nature/ environment have been written by women who held pioneering positions in their respective fields. In the following paragraphs, we enumerate the works of six prominent women who contributed extensively to the subject of nature/ environment. Anna Botsford Comstock (1854-1930) was one such distinguished women who greatly contributed to the nature study. Around 1893, a serious agricultural depression in the north-eastern part of the United States of America drove many a people to migrate to the cities. This led to a natural

concern for the rural life and led her to work extensively on the American nature-study movement. Born into a Quaker family, her higher education consisted of her inquiry into the peripheries of science in art, popularization, and children's education. As Pamela Henson states, Comstock found it more comfortable to incorporate her aesthetic appreciation of nature into scientific interpretation for children and a popular audience. This appreciation was part of her overall sense of subjective connectedness to the world around her. Anna Comstock experienced the natural world in emotional terms and felt a sense of personal relationship and responsibility to living things around her. She was able to channel her own feeling for nature and her progressive social ideals into an educational and environmental philosophy much needed in her cultural period in America. Her philosophy was that at the heart of a fully human existence is the cultivated imagination and insight for truth and beauty, as found in nature (Peter Blaze Corcoran, p.139). She opined that nature was a nurse for human health and she reiterated these opinions through her writings. In 1911, she published her famous work 'Handbook of Nature-Study'. She actively advocated educational reform and nature conservation and saw the love for nature as the best motivator. Rachel Carson (1907-1964) was also a distinguished writer and thinker on the subject of nature. A renowned biologist, she wrote extensively in three volumes on the subject of sea and came to be known as the biographer of the sea. She raised certain fundamental questions about the human knowledge of the nature and how science can reveal such knowledge to the human beings. Rachel Carson's philosophy of environmental education speaks of sensory creatures in a sensory world, humble citizens of a mysterious universe, and people free to place themselves under the influences of earth, sea, and sky and their amazing life'. In 1958, she decided to write a brief article on the impact of DDT spraying upon bird life that led to one of the most extensive researches and one that became a path breaking work Silent Spring. Translated into every possible language, 'it crystallized an ethic of the environment which inspired grassroots environmentalism, the deep ecology movement and the creation of the Environmental Protection Agency (EPA) and its state counterparts; it influenced the eco-feminist movement and feminist scientists'. Carson's environmental philosophy raises questions about the nature of nature and human knowledge of it; it invites the reader to stand in wonder at the depth of nature's influence upon values and attitudes; and it calls a people to their responsibility to halt its destruction. Indeed, the recent intellectual history of environmental thought owes much to the wisdom of this remarkable scientist, writer, educator, elder and lover of nature (Joy Palmer, p.199). Dr.Gro Harlem Brundtland (born 1939), Norwegian by birth, is known for her great interest in the field of public health issues and environmental concerns and these concerns that reflected in her writings, catapulted her to international repute. It brought to the fore the global environmental thinking that is the hallmark of every nation's policy on environment. She was also an active public figure who worked for the Norwegian Labour Movement and became the Minister of the Environment in 1974. She became the Prime Minister of Norway at a young age of 41 years and continued to hold the post for more than a decade. It was

during this time that she gained international recognition for championing and promoting the principle of sustainable development. In 1983, she was invited by the then United Nations Secretary General to establish and chair the World Commission of Environment and Development. The Commission published its seminal report Our Common Future or what is also called as The Brundtland Report. This Report also led to the holding of the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. The Report highlights the points that the basic needs of humanity should be given over-riding priority and that there are limits to development as the capacity of the earth is limited to absorb human activities. It calls for ensuring a sustainable level of population, conserving the resource base and merging of the environment and economics in policy decision-making processes. Touching upon the common concerns, challenges and endeavours, the Report brought to the fore the necessity of reformulating the policies on environment and development and bring about a positive amalgamation of both. Indeed Dr.Brundtland's contribution is remarkable and would continue to inspire future generations too. Val Plumwood (born 1939) began her work on environmental philosophy along with her husband Richard Routley in the early 1970s. Much known as an eco-feminist, she articulated her views in her work Feminism and the Mastery of Nature (1993); she opines that dualism has deeply marked the concepts of nature and reason. The environmental crisis, according to her, is a crisis of this dualistic reason, a form of rationality expressed especially in the contemporary global market, which conceives rationality as self-interest in opposition both to the emotions and to the ecologically situated body. Plumwood argues from an eco-socialist perspective against the treatment of animals and nature as property under capitalism and for the ecological virtues of more egalitarian and democratic social systems. Another eminent thinker and contemporary feminist poet, Susan Griffin (born 1943) reflected her concerns on nature although her works, especially in her prose-poem, Woman and Nature: The Roaring inside Her (1978). It stands out as a key text of environmental thought and a germinative work of eco-feminism. In her works, she diagnosed the ills of the Western mind and also constantly focused on the ill-treatment meted out to the nature and women in the patriarchal culture. She writes that 'we belong to a civilization which is bent upon suicide, which is secretly committed to destroying nature and destroying the self that is Nature'. In the context of environmental thought, Griffin's profound insight that gender issues and ecological issues are interconnected has been responsible for transforming both feminism and environmental thought' (Joy Palmer, p.301). Vandana Shiva (born 1952) is one of the most articulate environmentalists of India and has gained international repute with many of her seminal works in the field of environment. She devoted her time to take up environmental activism and founded the Research Foundation for Science Technology and Ecology to articulate the emerging social and ecological issues. She is a prolific author, encompassing multi-disciplinary scholarship, on the subject's biodiversity, bio piracy, eco-feminism, food security and so on. Her work Staying Alive gives an insight into the plight of women in the developing world; she called for a turn-around in the development mindset, and

for the feminine principle to be applied to substitute the sanctity of life for the sanctified development concept rooted in patriarchy. She brought to the fore agricultural ills through her work The Violence of the Green Revolution. She took up an untiring crusade against Monsanto's agenda to monopolise the global water supplies. For her outstanding contribution to the field of environment, she continues to receive worldwide recognition and numerous awards. As Lynne Dumble says, Vandana Shiva's presence is one of the authority, carrying weight within government and non-government, academic and non-academic, feminist and non-feminist, rural and urban, and national and international circles. She stands as a beacon of hope for the global Green movement and the world's expanding underclass of poverty-stricken farmers, most found in developing regions, and the majority of women, prey for transnational corporations carrying the global order's imprimatur to turn life resources into money-making commodities in the third millennium' (Joy Palmer, p.320).

10.13 LET US SUM UP

We have observed that environmental movements have been a productive zone of inquiry. Environmental movements in India have established the fact that these are the series of transformative discourses. In some cases the environmental debates have reflected the rights of the people over their natural resource basket, the source of livelihood for them. The denial of traditional structure of control over these natural resources has been questioned by the communities, the major participants of such environmental movements. Often they have questioned the exploitation methods and development models of the State. In anthropology the combination of ecological and ethnographic approaches has expanded the scope of environmental research. This has brought in a paradigm shift in the content and focus of ecological anthropology from applied perspective. When we map out the new approaches in the study of environmentalism we find the cases of resistance from people across space and time. The Subaltern voices crop up through such environmental movements has been established and anthropologists have taken such voices for ethnographic analysis. When we look at the social structure, degradation of natural resources and related environmental changes, one finds the complimentary and symbiotic relationship between society and environment, which is difficult to ignore.

In this Unit, you have learnt about the women's contribution to the field of environment and how traditionally as well as in modern times, they have come to be identified as nurturers of nature. The debates on gender and environment have been given an insight in this Unit. The Unit also highlights the eco-feminism debate, its support and critique base. It also highlights the outstanding contribution of some of the women throughout history and in the contemporary times by citing the case studies of six eminent women. In final, we need to understand the role of women in

multi-dimensional approach, taking into view the feminist and non-feminist approaches.

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10.16 POSSIBLE QUESTIONS

1) What is environmental anthropology? Describe its growth and development in India.

2) Describe how globalisation has impacted the environment and human life and the living conditions of rural people in India.

3) What is environmental movement? Do you think that socio-cultural factors play crucial role in the movement processes which are taking place in rural India?

4) Do you think globalisation has contributed in changing the nature of environmental movement in India? Explain with the help of few cases of environmental movement from Eastern India.

5) What is environmental movement? Do you think that India has enough laws to protect the natural environment of the country?

6) Discuss briefly the role of women as nurturers of nature.

7) Discuss at length, in your own words, the gender-environment debate.

8) What do you understand by eco-feminism? Examine the various aspects associated with it.

9) Discuss in detail the outstanding contribution of women in the field of environment. Cite case studies as examples.

UNIT-11 NATURAL DISASTERS & MANAGEMENT

Unit Structure

11.1 LEARNING OBJECTIVES

After going through this unit you will be able to —

- Define the concept of disasters and classify them
- Risk and vulnerability
- Learn about the causes of some major natural disasters and the
- Measures to mitigate them
- Learn about manmade disasters.
- Define disaster management
- Know about the precautionary measures to be taken for disasters
- Know about the measures to be taken during disaster.
- Define the role of NGOs and the civil society in disaster management
- Know about regional disaster and its management.

11.2 INTRODUCTION

In this unit we are going to discuss the concept of disasters and the difference that lies between disaster and some synonymous terms. You will get to know from this unit about these extreme calamities, their causes, their characteristic effects to be adopted. You may already have a fair experience of these natural or manmade hazards that commonly occur in N.E. India.

So, this unit will present to you a brief account of all these disasters and the measures to cope with them.

11.3 DEFINING DISASTER

"Disaster" is a sudden adverse and unexpected natural or manmade event which causes significant physical damage, loss of lives or property, sometimes permanent change of the natural environment. Disasters occur very rapidly, instantaneously and indiscriminately. It is an unforeseen event which may cause great loss of lives and property and damage to the whole environment.

11.4 TYPES OF DISASTERS

It can be broadly divided into two types - Natural and Manmade or Anthropogenic.

- **Natural Disasters:** These are the results or responses to some extreme physical events which cause a significant loss of life, damage to property, and affect the whole environment.
- **Manmade Disasters**: These are the results of some extreme anthropogenic events which cause great loss or damage to life, property as well as the environment.

11.5 CAUSES AND EFFECTS OF SOME NATURAL DISASTERS

- **Flood Disaster:**
  - Definition of Flood: Flood simply means "inundation of extensive land area with water for several days in continuation. "In other words, it is that condition of a river when the amount of water it carries is much larger than its carrying capacity and as a result the water cannot remain confined to the river and inundates the nearby low areas. It may be noted that flood is a natural phenomenon. It is caused by heavy rainfall but it causes loss to human lives and property.
  - Causes of Flood:

- Heavy Rainfall: Continuous heavy rainfall for a long period is the main cause of flood. During heavy rainfall there is a larger accumulation of water in the upper catchment areas of the concerned river and it flows into the downstream areas, thereby causing flood in the plains below. Similarly, lower catchments areas are also affected by heavy rainfall. Assam experiences frequent flood caused by the Brahmaputra River.
- River System Blockage: Blockage of river drainage system due to landslide or encroachment also creates severe inundation inthe low catchments areas.
- Meandering River Course: Sinuous and meandering river courses obstruct the normal flow system and reduces the velocity resulting in stagnation of water for prolonged periods which ultimately leads to the overflow of the surrounding areas.
- Low Rainfall Areas: Sudden heavy rainfall in the arid and semiarid areas where rainfall is scanty and infrequent also causes flash floods as such areas have very poor drainage system.
- Deforestation: Injudicious and indiscriminate destruction of forest resources in the upper catchment areas decreases the infiltration capacity of the soil and consequently increases the surface runoff resulting in severe flood.
- Urbanization: Increasing urbanization increases the intensity and magnitude of floods. Construction of buildings, roads etc. Reduces infiltration of water and considerably increases the surface runoff of water. This causes floods in the urban areas.
- Decay of Dams/Embankments: Due to natural and man-made causes sometime breach of embankment takes place and the resultant flow of water through the broken points of the embankment, causes severe flood leading to severe damage to human lives, animals and properties.
- Reservoirs: Heavy rainfall causes increase of water volume in the reservoirs and the quick rise in the water level causes floods in the nearby areas.

- **Earthquake Disaster**: The earthquake is a vibration of the surface of the earth with rocking energy of wave motion capable of shaking buildings apart and causing gaping fissures to open up in the ground. The magnitude or intensity of energy released by the earthquake is measured by the Richter scale.
    - Causes of Earthquake: A number of factors are thought to be responsible for causing disequilibrium or isotactic imbalance in the earth's crust. Mainly natural factors and occasionally manmade factors

are responsible for this disequilibrium. Natural causes like volcanic activity, Plate tectonic movements, Faulting and Elasticity cause the occurrence of earthquake. Anthropogenic causes like high explosions, breaching of dams also induce earthquake disaster.

- Impact of Earthquakes: The effects of earthquakes are divided as primary, secondary and transient effects depending upon the intensity, magnitude and severity of the occurrence.

- Primary Effects

a. Regional geological changes,
b. Displacement of and cracks in any matter
c. Fissures and cracks in buildings, roads etc.
d. Elevation and depression of land.

Figure.11.1: World Distribution of Earthquakes

e. Accumulation of water.
f. Change in the direction of river current.
g. Formation of stream tremors in ponds and water bodies.
h. Displacement of well and spring.

- Secondary Effects

a. Landslide b. Minor slippage
c. Uprooting of poles and posts
d. Death of fishes
e. Common damage to buildings
f. Effects on glaciers
g. Stopping of pendulum clocks
h. Snapping of cables.

- Transient Effects

a. Perceptible tremors
b. Sliche in rivers and ponds
c. Tsunami d. swaying of bridges
e. Shaking of buildings
f. Birds/animals disturbed

g. Fright and panic among human beings
h. Hearing of sounds.

- **Drought Disaster:** A drought can be defined as an extended period of months or years which a region experiences. This condition is usually experienced due to the insufficiency in rainfall, lack of irrigation facilities, under exploitation of the available water sources and non-availability of adequate amount of water for meeting the normal crop requirement for agriculture.
  - Causes: Drought is related to the failure of the normal rains at a particular time. All those natural and human activities which affect rainfall and water resources are the causes of drought. Some of these causes are—
    - Less amount of water vapor in the air due to the occurrence of hailstorms may result in drought.
    - Wind is another natural factor which helps in the shifting of air masses
    - EI-Nino which increases the temperature of the water in oceans also influences the climate of the different parts of the world.
    - Injudicious destruction of trees for agriculture or constructional activities combined with the resultant erosion causes the loss of moisture from the land areas and ultimately results in drought.
  - Impacts: The problems associated with drought can have economic, environmental, and social impacts. Because nature and human society depend on water. Lack of water results in the migration of people. It is a very common occurrence. The agricultural sector is particularly affected by drought. The lack of water can often cause a decline in crop yields, leading to the reduction in income for farmers and an increase in the market price of products. A prolonged drought, may cause unemployment of farmers and problems for the retailers of agricultural products, having a significant impact on the economy of the area. Health problems like malnutrition, dehydration and spread of various diseases become a common sight in a drought-hit area. Drought can also result in insect infestations and plant diseases, increasing erosion, habitat and landscape degradation, forest fire, wild fire etc. Prolonged drought like condition leads to desertification.
- **Tsunami Disaster**: Tsunami is a giant, vast, rare and deadly series of sea waves produced by submarine earthquake or volcanic eruption or slides under water. Tsunami is a Japanese word meaning tsu (harbor) and nami (wave). The term is pronounced soo-NAA-mee. It is a natural phenomenon consisting of a series of waves generated when water in a lake or a sea is rapidly displaced on a massive scale. The effects of a tsunami can sometimes be quite insignificant but sometimes these are highly devastating.

- Causes: The tsunami is caused by earthquakes, volcanic eruptions, explosions under the sea.
- Impact of Tsunami: Tsunami has a devastating and catastrophic effect when it becomes a hazard. Tsunami affects the coastal areas very harshly. The records of the tsunamis that have already taken place point to the destruction of huge number of coconut trees in the coastal areas besides causing a devastating impact on human lives and properties. The hazards of tsunami have taken a heavy toll of human lives. Many people had left their home and hearth in the tsunami affected areas and being homeless came to live in refugee camps.

11.6 MANMADE DISASTERS

- **Industrial (Chernobyl Disaster):** Chernobyl is a city in Northern Ukraine, Soviet Union which was evacuated on 25th April,1986 due to the nuclear disaster at the Chernobyl power plant located 14.5 kilometer north-west. The power plant is within Chernobyl Raion. It was a sad day for all the people of Ukraine. The explosion took place at around one in the morning while the neighboring town of Pripyat was asleep. Four workers were killed instantly. The Chernobyl Nuclear Power Plant near the town of Pripyat, Ukraine, exploded at around 1.23 A.M .A nuclear reactor burst through a 4000 ton steel concrete cover and the reactor's core temperature was 20000C. The accident spread all kinds of toxic substances in the nearby areas causing severe impact in the whole environment including plants and animals. The accident triggered the release of substantial amounts of radiation into the atmosphere in the form of both particle and gaseous radio isotopes which were 400 times more radioactive.

- **Fires:** Though fires sometimes occur due to some natural causes yet most of the time human activities are primarily responsible for the incidence of fire. Many human activities like camp fires, explosions, careless handling of machines in industries, chemical laboratories, wars and social conflicts, atomic researches cause fire. This is a very frequent and common problem in the highly industrial metropolitan areas. Fire accidents cause severe economic loss as well as environmental degradation. The forest fires used in connection with agricultural activities inflict great loss to the wild life habitats. Hundreds of trees are destroyed and animals lose their habitat. In fact, some species of animals and trees may totally get extinct leading to a huge biodiversity loss. Fire accidents in some industries take hundreds of lives, cause loss of properties and affect the whole environment. Therefore, some steps need to be taken to cope up with this disaster. People should be very careful while

handling machines, using chemicals and lighting fire in camps. Emergency services should always be kept ready to face such eventualities.

- **Accidents:** An accident is an instantaneous, unexpected and unplanned sequence of events that cause ruinous effect on property, lives and the environment. Accidents are caused due to both natural and manmade activities. Natural causes include mainly natural geological processes like earthquake, landslides, erosion etc. On the other hand, accidents due to manmade causes include sudden explosions in the industries, head on collision of motor vehicles etc. These sudden accidental events can be mitigated through the emergency services provided by the government and NGOs, proper planning of the cities and awareness of the people.

  - **Oil Spills**:
    - The release of liquid petroleum hydrocarbon into the water bodies due to anthropogenic activities is referred to as oil spills which cause severe pollution of the water body and the whole environment as well. This type of incident is very common in the marine environment only.
      Oil spill is mostly caused by sudden accidents or leakage of oil tankers, cleaning of the tankers in shore areas, leakage of oil from the refinery and other fuel industries.
  - Effects:
    - Effects on Birds: This oil penetrates through the feathers to the body of a bird and impairs the bird's flight abilities, making it difficult or impossible for it to defend itself against predators. This oil also damages. Kidneys and the liver function, poisoning the digestive tract. Seals and Dolphins are also affected while feeding on the contaminated species. The reproductive function of the animals is also affected by the oil spill.
    - Effects on Fishes: Fish species are badly affected by this kind of pollution. Oil enters into their bodies through gills, affects the eggs and the larval survival. Reduced growth, enlarged livers, changes in heart and respiration rates, fin erosion, and reproductive impairment are the other adverse effects of oil spills on fishes noticed. Oil has the potential to impact the spawning success, as eggs and larvae of many fish species, including Salmon, are highly sensitive to this toxic substance.
    - Effects on Invertebrates: Oil can directly affect the invertebrates by altering their metabolic activities. Effects on Plants: Some small plants, algae, and other aquatic plants are also affected badly.

The pollution caused by oil spills can be reduced by some bioremediation and photo remediation techniques using some bacteria to remove the oils from the water body. Some chemical methods are also used to reduce this pollution.

11.7 DISASTER MANAGEMENT

A disaster, whether it is a manmade or due to natural causes, may have devastating effects. We cannot stop the loss or damage caused by disaster. But it can be reduced to some extent. This is called disaster management. Disaster is a sudden occurrence and it does not give any kind of warning before its occurrence. Earthquakes, floods, soil erosion, big industrial accident, deforestation caused by fire, volcanic eruption, cyclical storm ,cyclical sea waves, hail storm, Tsunami Tides, thunderstorm, drought, terrorist attack, natural or manmade accidents are all different forms of disaster. Men's various activities are to some extent responsible for the occurrence of a disaster that causes loss or damage to lives and property but precautions/preventions if taken in advance can reduce the impact of disaster to some extent. For this we should take methodical and pre-planned steps. Skilled planning can also prevent in reducing the impact of disaster. Different kinds of disaster need different measures or precautions to prevent or reduce their impact. The U.N.O in1987 took a very important proposal in this regard. According to this proposal, the 1990-2000 decade was declared as the International Natural Disaster Prevention decade. This proposal consists of the following:

- Every state should increase its capability of predicting a disaster and organizing its management.
- The loss or damage caused by Natural disaster should be minimized. The present and future scientific measures for prediction of such disasters should be expanded.
- Analysis of natural disaster, its solution and future prediction should be given the priority.
- There should be a provision of possible guidelines and planning regarding disaster management.

11.8 SAFETY MEASURES IMMEDIATELY BEFORE A DISASTER

When we talk about the forewarning of a disaster we are expected to say that " there is a possibility of occurring earthquake of 7.5 Richter scale at such place with such year of time or a disaster to happen – the possibility of occurring an earthquake cannot be ruled out " . There must be some definite quantitative value. The basic aim / purpose of these forewarnings is to minimize the amount of loss and damage to be caused by such earthquakes. It can be seen that the impact of natural disasters is felt most in the developing and underdeveloped countries. The main reason behind this is

that these countries lack both the essential infrastructure and an integrated planning for disaster management. At the same time the population increase is another reason for the greater loss and damage on account of a disaster.

- **Pre Alertness:** For remaining alert in advance before a disaster occurs there should be scientific planning and so that we can face a disaster. Every country should have the capability to organize the warning system before a disaster. Besides, different organizations should be given responsibility to create an awareness about disasters among the people. The following disaster management organizations are mentioned stage wise :

Stage	Organization
1) National -	Home Ministry, Central aid and re-employment department
2. State -	Disaster Management Department
3) District -	Office of the District and Magistrate
4) Sub-division -	Office of Civil S.D.O.
5) Block development -	Block development office
6) Panchayat -	Panchayat Samity Office

Apart from these, there are various Govt. and non-governmental organizations which are associated with disaster management. They are Police department, Para-military forces, Civil defence, Home guard, Fire service, National Cadet Corps. National services, Nehru Yuvak Kendra ,international agencies like FAO , ILO , UNDP , UNFPA , UNICEF , WEP ,WHO , Red Cross Society , various national and international NGOs, private and public voluntary organizations . Data collected from satellites (Digital Data) help to analyze it. With the use of these systematic data, wiccan make use of the information, theory and technology of various geographical and scientific collection, analysis classification, simplification, transformation etc.

- **Fore Warning of Disaster on the Basis of Systematic Data Collection:** It is very difficult to predict a disaster and studies need to be conducted regarding various disasters .Nowadays excepting earthquakes, other kinds of disaster can be predicted. According to an international research journal “Nature” the earthquake can also be predicted. Nowadays, extensive studies have been undertaken and considerable amount of information technology is being used for prediction of disasters. It is possible to make timely use of this information technology to scientifically collect different geographical data, analyse, classify, simplify, transform and present them and as per requirement use them. Information gathered from satellites has played an important role in predicting a national disaster. For example, Indian Weather report institution through the medium of Television (T.V.) has telecast weather report. In India, through the help of satellite (digital data), information regarding drought, flood, cyclone etc. is disseminated among the public. Indian satellites like

IRS-IC, IRS-ID, IRS-P3 satellites, are used to examine the status of flood and its management and through its help even the maps of flood affected areas are being prepared.

- **Decision Based on Informative System:** It has now become easier to prepare forewarnings of disaster on the basis of the present informative system. In this respect WMO has taken steps with the help of information, collection and research to find out the main reasons of disasters. The possibility of disaster taking place can also be predicted on the basis of statistical theory and historical information. It is very difficult to give precise advance warning but the probability can be referred to. For example, an advance warning can be such that there is a 70% to 80% possibility of the occurrence of an earthquake at such place (within coming year). This advance warning does not indicate that this possible earthquake cannot happen within some days or within the coming 20 years. It is a very complex matter to prepare advance warning on the occurrence of earthquake on the basis of such information. Information system has played a significant role in evaluating disaster and its management. For, these purposive modes of analysis enriched with information contribute to the adoption of effective practical decisions by the administrators and the voluntary and welfare institutions. In recent times, it has been possible to arrive at better decisions by applying the techniques of GIS and remote sensing. The technique of presenting, analyzing or unifying the physical, social, economic or political characteristics collectively or separately through the medium of maps with geographical significance is called GIS (Geographical Informative System). If a model can be prepared using satellite based maps by collecting information on any zone or region their planning for disaster management and the implementation can be more effectively done.
- **Preparation/Guidelines for Disaster Management:** Natural disasters are the sudden unexpected natural processes or events that cause significant damage or loss of life and property and affect the environment.

Although we cannot stop a disaster yet we can at least prevent or reduce the damage to some extent. For this, we need a methodical planning and management strategy. We have to identify the areas or the zones which are vulnerable to a disaster or a calamity. Public awareness is necessary for taking precautionary measures before and after a disaster. Earth quake zones and the structures which are vulnerable to earthquakes should be identified. Proper roads and open areas and infrastructures are to be identified for the rescue operations at the time of disasters. The chief aim of preparing the plans should be to effect proper coordination among the various organizations, to train them up, to create awareness among the different sections of the people and to ensure the active cooperation of the govt. administration, non Govt. and voluntary organizations and the people.

Another important task is to keep the concerned departments ready for disaster management. Some of the media to be used during a disaster are Wireless Telephone, mobile phone, satellite phone, computer network etc.

- **Creating Awareness Among School Going Children:** One of the important steps to create an awareness about disaster management is to sensitize the school children. We can recall that at the dawn on 26th Dec. 2004, Tsunami devastated the Indian Coastal areas of Kerala, Tamilnadu, Andhra Pradesh, Andaman and Nicobar Island taking a toll of one thousand lives. Following this event in the year 2005, Indian govt. introduced in the CBSE curriculum lessons for creating awareness about Tsunami at all India level. As a result, the school children are being taught the do's and don'ts of facing the situation when a disaster takes place and when it passes over . A survey was conducted by Asian Disaster Reduction Centre (ADRC) in 2005 in Sri Lanka, Maldives and Indonesia in which school children, faculties and the general public were included. Its main aim was to give training in disaster management and to show how the loss and damage caused by disaster could be reduced to some extent. The study revealed that through proper training a disaster could be mitigated to a considerable extent. Another revelation from the research was that more than 90.4%school students liked to read about disaster. Through school children their family member's would also become aware about the precautionary measures connected with disaster. In order to popularize the measures for mitigating disasters among the general public , it is essential to include it as a compulsory subject for the school children and the necessary syllabus has to be prepared for the purpose . About34 million school children in the world are expected to fall victim to a disaster. So it is likely that the school buildings may collapse during an earth quake in earthquake prone areas if these are not constructed as resistant to earthquakes.
- **Safety Measures/Actions**: Planning the safety measures is highly essential for inculcating awareness among the school children. Under the auspices of LOL UNDP Disaster Risk Management Programmes safety instructions/ guidelines have been prepared for schools by the Govt. of India. The main aim of this is to give training about the precautionary measures to be taken before a disaster. The items that are included under safety guidelines are the following– Inclusion of the subject of disaster management in the curriculum, to increase awareness , provide education and training in different stages to the public and the government employees, mock drill, formation of disaster management committee in school , safety measures to be taken in the construction of buildings, to develop technology to mitigate disaster, conducting workshops with the help of electronic network, newsletter etc. Keeping in view these safety guidelines the security advisory councils involving every class should be formed in schools.

11.9 STEPS TO BE TAKEN DURING DISASTER

There should be proper planning for the post disaster measures so that the loss can be minimized. Some of the steps that are to be taken after disaster are–

- To rescue people from the calamity as fast as possible
- To identify the living, injured and the dead people and to keep their records.
- To keep the communication network from getting disrupted.
- To guard against the possible theft of essential articles.
- To arrange temporary relief camps and to provide drinking water, medicine and electricity.
- To ensure the supply of essential things like food, woolen/warm clothes, bedding, utensils etc.
- To ensure adequate transport facilities in the affected areas
- To check the loss of lives and damage.
- To arrange the rehabilitation of the affected people and to take steps to bring back normally.
- To prepare a detailed report of loss and damage.

- **Relief Camps:** Establishing and organizing relief camps after a disaster takes place is very important. The affected people need special help for rehabilitation after a disaster. For instance, after a disaster, first aid, drinking water, food, seeds for cultivation etc. are some of the important items needed by the disaster affected people. Under these circumstances the government and NGOs should act together in organizing the relief camps and the government should provide the necessary first aid , relief materials , rescue materials , food and medicines to the organizations managing the relief camps .
  - Resources: During the disaster period the flow of required funds to deal with the loss and destruction will depend on the supply of the funds by the public and private organizations . To ensure the flow of funds in the post disaster periods the following steps need to be taken:
  - Every government should have some special funds to be spent for relief measures for disaster.
  - It should be strictly monitored so that the funds are utilized only for the disaster affected areas and for the specific purpose. The amount of fund needed for pre- disaster and post disaster periods will be determined by proper guidelines
  - Special insurance schemes should be made for disaster prone areas. Special funds are to be allotted for relief measures

- The various industrial and commercial organizations, educational institutions, private companies etc. are to be encouraged for forming relief funds.
- The financial institutions disbursing loans for constructing houses should ensure that necessary precautions are taken in constructing house.

- **Things that are needed during a Disaster**: During the post disaster period certain essential things are required and providing these essential things is one of the major tasks. Some of the essential things are – food, water bottles, warm cloths, radio, paper, pen, old newspapers, soap, tooth paste, tooth brush , things that are used by small kids, heavy shoes, candle, knife, etc. To provide, the above mentioned things, disaster management committees should appoint some organizations and trained workers who can act and distribute the relief materials as per requirement to the victims.
- **Providing Relief after a Disaster:** To provide relief after a disaster is the primary responsibility of the National Crisis Management Committee under the central Government. Apart from that, various social groups and organizations have been playing an important role. It is essential to have co-ordination among all these groups to mitigate a disaster. Particular attention is to be given to the following in the post disaster period :

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  - Improvement in transport and communication.
  - Providing safe drinking water
  - Maintaining proper electricity, telephone and sanitation
  - Managing the required food, shelter and clothes.
  - To keep accurate account of loss and damage
  - To ensure the supply of seeds for cultivation and other facilities.

- **Planning for the Required Action in Post Disaster Period**: The required guidelines have already been prepared at the national level. But it is essential to prepare the guidelines for actions to be undertaken by concerned departments. High level committees at the central, state and district levels are needed to tackle the problems during disasters. Committees are also to be set up at the gaon Panchayat level. At the district level some special groups are to be formed such as rapid action force, rescuers, first aids, primary health care, management of relief camps, drinking water etc. Besides, there should be groups to look after sanitation, survey for payment of compensation, and relief works.
- **Psychology of the Affected People during Disaster:** The mindset of the disaster victims is gravely affected by natural disasters and their adverse effects. Many people attribute such disasters to fate. Disaster affected people usually suffer from a sense of insecurity as a result of which they are inflicted with fear, mental tension, depression, irritation and loss of sleep. The department of disaster management should take up special measures to change this mindset of the affected people. Flood is an unavoidable natural disaster in Assam. Some special measures need to be taken to make people live with the disaster of floods.
- **Providing Assistance for Rehabilitation:** During the post disaster period special assistance is needed for the rehabilitation of the victims. For example, it is necessary to provide seeds to the cultivator's after floods. For this, the agriculture department should arrange for sowing of paddy seeds at higher plains. Reconstruction of the damaged infrastructure is another important task in the post disaster period. Besides, professional suggestions need to be sought from the concerned professionals to deal with the devastation caused by disasters.

11.10 PARTICIPATION OF NGOs AND SOCIETY

In order to survive at the time of disasters it is important for the various communities in the society to remain alert. In this case, the NGOs are expected to take important steps those who are engaged in disaster management are to be properly trained and well prepared. In this respect the participation of voluntary organizations, NGOs and sections of the society may make positive impact. The voluntary organizations and the different communities need to share mutual cooperation for this. For its effective implementation the concerned people are to be particularly responsible for and aware about the immediate rescue operations,

Rehabilitation and improvement of the environment. For this is needed a yearlong plan of action as well as the competence to tackle the situation immediately. The voluntary organizations should remain ever ready to create an awareness among the different sections of the society. For example, during the monsoons advance

warning about floods about to occur, relief steps to recover the losses etc. Can be imparted to the people besides ensuring the distribution of relief materials, medicines, seeds and other things. The poor people have to suffer untold miseries during a disaster, caused by destruction of houses and land becoming unfit for cultivation. The voluntary organizations are to extend both long term and short term help in this situation.

11.11 REGIONAL DISASTER MANAGEMENT AND PLANNING

Disaster management in general is a united effort of different departments through effective coordination. National Disaster management involves the planning for preparedness, prediction, warning for disaster, relief and rehabilitation, repair and reconstruction. For this different departments are to be involved at different levels and made ready through proper training for disaster management. The administrators, scientists, planning officers and various sections of the society have to play a vital role in this. Organizations and various social institutions should be engaged in coordinated work before and after a disaster. For this in different levels, Training is to be conducted for readiness for a disaster. In this regard, administration, science, planning commission, NGO and various communities play a very important role. Already Natural Hazard Management Authority (NHMA) has identified probable hazards and have informed public. This organization of govt. of India has adopted various schemes and works in association with NGOs in this regard. It includes maps of hazardous/risk zones, etc. In urban areas, guidelines of hazard proof houses and bridges are to be prepared.

11.12 LET US SUM UP

- After going through this unit you must have learnt to define disaster, how it differs from hazard, risk and vulnerability, and the types of disasters. This unit has also discussed the major disasters, the causes, effects and the mitigation measures in the event of a major disaster. Disaster is the result of the hazardous events causing economic loss, loss of lives and environmental degradation.
- Basically there are two types of disasters – natural and manmade. Both natural causes and manmade activities are behind the incidence of major disasters like floods, earthquake, landslides, and volcanoes. They cause severe damage to the environment.
- Finally, the unit acquaint the learners with the Chernobyl disaster with its devastating oil spills impact occurring due to manmade activities. People should be made aware about the effects of these hazards and their mitigation measures. We have also given some questions and examples to enable you to have a better understanding of the concept of disasters.

- Whether it is manmade or due to natural causes, a disaster causes grave impact on the human society. We cannot stop a disaster and its devastating effect but we can reduce the damage or loss caused by it to some extent. This is called disaster management.
- The first and foremost aim of early prediction of disaster is to see that the loss and damage caused by a disaster can be reduced. The impact of disaster is more severe in the developing countries because there are lacunae in disaster management. In these countries, increasing population and high poverty levels are other important factors responsible for greater incidence of hazards.
- To survive in disaster it is important for various communities in society to remain alert. Specially, NGO's should take important steps in this regard.
- The Natural Hazard Management Authority (NHMA) have identified areas of possible hazard.

11.13 FURTHER READING

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11.14 POSSIBLE QUESTIONS

VERY SHORT ANSWER QUESTIONS

Q 1. What are the primary, secondary and transient effects of earthquake?

Q 2. What do you mean by disaster management?

SHORT ANSWER QUESTIONS

Q 1. Elaborate on flood disaster.

Q 2. How does oil spill affect the wild life?

Q 1. Write a short note on the measures to be taken during a disaster.

Q 2. Write a short note on Regional Disaster Management and Planning Commission.

LONG ANSWER QUESTIONS

Q 1. What are the environmental impacts of drought?

Q 2. Describe the causes and effects of Tsunami.

Q 3. Explain with examples the role of voluntary organizations and the Society in general in disaster management?

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UNIT-12 ENVIRONMENTAL PROTECTION ACT

Unit Structure

12.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- Understanding the Water Act, 1974
- Implementation Mechanism of the Water Act
- Understanding the Air Act, 1981
- Implementation Mechanism of the Air Act, 1981
- Understanding the Importance of Wild Life Act

- In-Depth Study of the need for Wild Life Protection and the Laws for the Same
- Understanding the need for Environment Protection Act
- In-Depth Study of the Provisions of the Environment Act, 1986

12.2 INTRODUCTION

There are various laws enacted in India time to time to protect environment and prevent various types of pollution. Our constitution also in Article 48 A and 51A (g) has provided enough safeguards to protect environment. In 48 A, Directive principle of state policy it stated that "the state shall endeavor to protect and improve the environment and to safeguard the forests and wild life of the country". Article 51 A (g) (Fundamental duties of citizens) states "it shall be the duty of citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for loving creatures.

12.3 WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974: AN INTRODUCTION

Water (Prevention and Control of Pollution) Act, 1974 (hereinafter referred to as Water Act) was enacted in pursuance of resolutions passed by State legislatures under Article 252 of the Constitution of India. The Act was first in the series of laws dealing with pollution in India. The Act was passed with the following main objectives:

- to make provisions for prevention and control of Water Pollution
- for providing legal regime aimed at maintaining or restoring wholesomeness of water
- for establishment of Central and State Pollution Control Boards to regulate and curb water pollution

The Water Act contains 64 sections and is divided into eight chapters. Chapter I deals with the preliminary part i.e. date of enforcement, application of the Act and definitions. As stated earlier, originally the Act was passed in pursuance of resolutions passed by 12 State legislatures and it was made applicable in those States and in Union Territories immediately. As of date, the Act is applicable throughout the territory of India. The Union government has enacted Water (Prevention and Control of Pollution) Rules, 1975 under the Water Act.

Section 2 of the Act defines the words and expressions used in the Act. Of these, it is necessary to examine the following for proper understanding of the subject.

The Act lays down a comprehensive definition of the word “Pollution” in the context of water pollution. The definition reads as under:

"pollution means such contamination of water or such alteration of the physical, chemical or biological properties of water or such discharge of any sewage or trade effluent or of any other liquid, gaseous or solid substance into water (whether directly or indirectly) as may, or is likely to, create a nuisance or render such water harmful or injurious to public health or safety, or to domestic, commercial, industrial, agricultural or other legitimate uses, or to the life and health of animals or plants or of aquatic organisms.”

Thus water pollution includes the following

- Contamination of Water;
- Alteration of Physical, Chemical or Biological properties of Water;
- Discharge of sewage, trade effluent or any other liquid, gaseous of solid substance into water

Which creates or is likely to create nuisance or which renders it unfit or less fit for the purpose for which it is to be used or which makes it harmful for human beings, animals, plants and aquatic organisms.

"Sewage effluent" means affluent from any sewerage system or sewage disposal works and includes sullage from open drains.

"Sewer" means any conduit pipe or channel, open or closed, carrying sewage or trade effluent.

"Trade effluent" includes any liquid, gaseous or solid substance which is discharged from any premises used for carrying on any Industry, operation or process, or treatment and disposal system, other than domestic sewage.

In relation to any factory or premises word “occupier” has been defined to mean the person who has the control over the affairs of the factory or premises. In relation to a substance, word “occupier” has been defined to mean a person in possession of the substance.

12.4 IMPLEMENTATION MECHANISM

Water Act provides for the establishment of Central Pollution Control Board at the National Level and for establishment of State Pollution Control Boards in States to regulate, prevent and control water pollution and lay down standards for emission in streams and matters connected therewith. The Water Act lay down the provisions for the establishment and Composition of Central, State and Joint Boards whereas it provides the powers, duties and functions of Boards.

12.4.1 Central Pollution Control Board

The Water Act cast a duty on the Union government to constitute Central Pollution Control Board (CPCB). The Board has the features of a body corporate with perpetual succession, common seal, capacity to sue and be sued, power to acquire, hold and dispose of property, capacity to contract etc. The CPCB is designed to consist of the following members.

(i) The Chairman of the Board who shall be full time Chairman to be nominated by the Union government. To be eligible to be appointed as Chairman, the person shall possess special knowledge or practical experience in matters relating to environmental protection. A person having knowledge and experience in managing and administering institutions dealing with environmental pollution is also eligible to be appointed as a Chairman of CPCB.

(ii) Not more than five Government officials as representative of the Union government. These officials are required to be nominated by the Union government.

(iii) Not more than five persons from amongst the State Pollution Control Boards. Of these five, not more than two shall be from the local authorities functioning with the States. These members are also required to be nominated by the Union government.

(iv) Union government is required to nominate non-officials (not more than three) to represent the interests of Agriculture, fishery, industry or trade or any other interest which the Union government believes that it should also be represented in the Board.

(v) Two persons representing Companies or Corporations owned or controlled by the Union government. These persons are also to be nominated by the Central government.

(vi) Central government is required to nominate one Full time member-secretary. Member Secretary is required to possess knowledge and experience of scientific, engineering or management aspects of pollution control.

The tenure of members of the Board is three years. However, the tenure official members shall come to an end as soon as they cease to hold the office under the government by virtue of which they were appointed. Similarly, members appointed to represent State Boards shall cease to be members of CPCB as soon as they cease to be members of State Boards. Members are eligible for re-nomination. If any member is absent from three consecutive meetings without sufficient reason, he shall be deemed to have vacated the office of CPCB. A member may be removed from office after giving him a reasonable opportunity of being heard. Member may also resign from office before the expiry of his tenure. Salaries, Allowances and other conditions of

service of Chairman, Member-Secretary and other members are provided in Water (Prevention and Control of Pollution) Rules, 1975.

- **Functions and Duties of CPCB**

The primary function of CPCB is to promote cleanliness of streams and wells across the country. This apart, the Board has been mandated to perform the following functions.

i) CPCB is to advise the Union government regarding matters concerning prevention and control of water pollution

ii) CPCB is required to co-ordinate the activities of State Boards and to resolve any disputes arising among them.

iii) CPCB is to provide technical assistance and guidance to State Boards and to sponsor investigation and research relating to problems concerning water pollution.

iv) To plan and organize training of persons associated or likely to associated with programmes for prevention, control and eradication of water pollution

v) To organize programmes through mass media campaigns for prevention and control of water pollution

vi) If the State Boards defaults in complying with the directions of the CPCB and consequently there arises grave emergency, then in public interest, CPCB can discharge the functions of State Boards.

vii) To collect, compile and publish technical and statistical data relating to water pollution, measures for preventing the same.

viii) To prepare material regarding treatment and disposal of sewage and trade effluents and to disseminate information regarding the same.

ix) To lay down standards for a stream or well and to modify or annul the same in consultation with State government.

x) To plan and organise a national programme for the prevention, control and abatement of water pollution and cause the same to executed.

xi) To establish or recognise laboratories for analysis of samples of water, sewage or trade effluents.

xii) To perform such other functions as may be prescribed from time to time.

Thus, CPCB is entrusted with multifarious tasks concerning prevention, control and mitigation of water pollution and to co-ordinate the functioning of State Boards.

- **12.4.2 State Pollution Control Boards**

Water Act casts important and multifarious functions and duties upon State Pollution Control Boards. These State Pollution Control Boards are required to be constituted by State Governments. Like its National counterpart, these Boards have the attributes of a Body Corporate, capacity to sue and be sued, capacity to hold, acquire and dispose of property, perpetual succession, common seal etc. Composition of State Pollution Control Boards is as under:

(i) The Chairman of the Board who shall be either full time or Part-time Chairman to be nominated by the State government. To be eligible to be appointed as Chairman, the person shall possess special knowledge or practical experience in matters relating to environmental protection. A person having knowledge and experience in managing and administering Institutions dealing with environmental pollution is also eligible to be appointed as a Chairman of CPCB.

(ii) Not more than five Government officials as representative of the State government. These officials are required to be nominated by the State government.

(iii) Not more than five persons from amongst the local authorities functioning with the States. These members are also required to be nominated by the State government.

(iv) State government is required to nominate non-officials (not more than three) to represent the interests of Agriculture, fishery, industry or trade or any other interest which the State government believes that it should also be represented in the Board.

(v) Two persons representing Companies or Corporations owned or controlled by the State government. These persons are also to be nominated by the State government.

(vi) State government is required to nominate one Full time member-secretary. Member Secretary is required to possess knowledge and experience of scientific, engineering or management aspects of pollution control.

From the above, it can be seen that the composition of State Boards is similar to CPCB with the difference that requisite members in case of a State Board are to be nominated by the respective State governments. Further, the tenure of members of State Boards, their service conditions and other matters connected therewith are also the same as in case of CPCB.

- **Functions and Duties of State Boards**

State Pollution Control Boards are entrusted with variety of functions mainly with the implementation of the provisions of the Water Act and rules framed thereunder. Section 17 of the Water Act lays down the functions of State Boards.

i. State Boards are to advise the State governments regarding matters concerning prevention, control and abatement of water pollution

ii. State boards are to chalk out detailed and comprehensive plans for prevention and control of pollution in streams and wells within the State and to secure their execution.

iii. State Boards are required to collect the information pertaining to water pollution, prevention and control mechanism and to disseminate the same at all levels within the State.

iv. State Boards are mandated to encourage, conduct and participate in research regarding water pollution, prevention and control.

v. State Boards are to co-ordinate and collaborate with CPCB regarding training of personnel and to organize mass education programmes relating to water pollution, prevention and control.

vi. One of the most important functions of State Boards is to inspect sewage and trade effluents being discharged in the State and to inspect the works plants established for the treatment, purification and disposal of the same. State Boards are also to review and reformulate the plans for the same.

vii. Under the Water Act, the establishments discharging sewage and trade effluents are required to obtain requisite permission or consent before establishment. The State Boards are vested with powers to inspect those establishments and grant necessary sanction subject to terms and conditions for the achievement of the objects of the Water Act.

viii. To collect, compile and publish technical and statistical data relating to water pollution, measures for preventing the same.

ix. To prepare material regarding treatment and disposal of sewage and trade effluents and to disseminate information regarding the same.

x. To lay down standards and norms for the quality of receiving water within the State and to modify or annul the same.

xi. On the basis of quality of water, the Boards are required to classify the streams or wells and their suitability for different purposes.

xii. State Boards are required to find out the economical and reliable methods for treatment of sewage and trade effluents keeping in view various factors like soil conditions, climate and flow characteristics of streams or wells.

xiii. To advise the State governments regarding the location of industries which are likely to pollute streams or wells.

xiv. State Boards are required to set standards for treatment of sewage and trade effluents to be discharged into a particular stream keeping in view the fair weather dilution available in that stream and also the tolerance limits of pollution permissible in the water of the stream.

xv. The State Boards are required to pass necessary orders for prevention, control or abatement of discharge of waste into streams or wells. The State Boards are empowered to amend, vary or revoke these orders from time to time.

xvi. The State Boards are also empowered to direct any concerned person to construct, modify, extend or adapt system for systems for disposal of sewage and trade effluents as may be necessary for the prevention and control of water pollution.

xvii. To plan and organise a national programme for the prevention, control and abatement of water pollution and cause the same to executed.

xviii. To establish or recognise laboratories for analysis of samples of water, sewage or trade effluents.

xix. To devise methods for utilization of sewage and suitable trade effluents in agriculture.

xx. To devise methods for disposal of sewage and trade effluents on land keeping in view various factors and prevalent conditions.

xxi. To lay down effluent standards to be complied with by persons while causing discharge of sewage or sullage or both and to lay down, modify or annul effluent standards for the sewage and trade effluents;

xxii. To establish or recognise laboratories for analysis of samples of water, sewage or trade effluents.

xxiii. To person such other functions as may be prescribed from time to time.

Unlike CPCB whose main functions are either advisory in nature or to lay down the standards and norms, the functions of State Boards are wider and more in the nature of execution of national and state plans. The State Boards are required to regulate the discharge of waste, sewage, trade effluents in the stream and wells within the State.

It is worth mentioning here that the State Boards are required to be constituted for States only. So far as Union Territories are concerned, even though Union Territories with legislature, the CPCB is empowered to exercise all the functions of State Boards. However, the CPCB has been empowered to delegate these functions with respect to Union Territories to a person or body of persons as may be specified by Union government.

12.4.3 Joint Boards

Water Act empowers two or more states to enter into agreement for constitution of Joint Boards to discharge the functions of State Boards. Agreement for constitution of Joint Boards can be entered into between

i. Two or more adjoining states or
ii. Union government in respect of one or more Union Territories on one side and one or more states adjoining such UTs on the other side.

Agreement for constitution of Joint Boards to perform the functions of State Boards may be renewed from time to time. Such agreement may also contain the following:

i. Provisions for division/apportionment of expenditure between participating governments.
ii. Provisions for distribution of powers and functions between participating governments.
iii. Provisions for consultation on general or particular matters between participating governments and
iv. Other incidental and ancillary matters.

- **Composition of Joint Boards**

Composition of Joint Boards is on similar lines as the Central and State Boards are constituted. In case of Joint Board constituted in pursuance of agreement between two or more contiguous states, the Joint Boards shall consist of the following members.

i. The Chairman of the Board who shall be full time Chairman to be nominated by the Central government. To be eligible to be appointed as Chairman, the person shall possess special knowledge or practical experience in matters relating to environmental protection. A person having knowledge and experience in managing and administering institutions dealing with environmental pollution is also eligible to be appointed as the Chairman of Joint Board.
ii. Two officials each of the participating states to act as representative of the respective State government. These officials are required to be nominated by the concerned State governments.
iii. One person from each participating State who shall be from the local authorities functioning within that State. These members are also required to be nominated by the respective participating State governments.
iv. Each participating State government is required to nominate one non-official member to represent the interests of Agriculture, fishery, industry or trade or any other interest which the State government believes that it should also be represented in the Board.

v. Two persons representing Companies or Corporations owned or controlled by the participating State government. These persons are to be nominated by the Central government.
vi. Like Chairman of the Joint Board, Full-time member Secretary is also required to be nominated by the Central government. Member Secretary is required to possess knowledge and experience of scientific, engineering or management aspects of pollution control.

In case of Joint Board constituted in pursuance of agreement between Central government in respect of one or more Union territories and one more adjoining State governments, the Joint Boards shall consist of the following members.

i. Full time Chairman to be nominated by the Central government. To be eligible to be appointed as Chairman, the person shall possess special knowledge or practical experience in matters relating to environmental protection. A person having knowledge and experience in managing and administering institutions dealing with environmental pollution is also eligible to be appointed as the Chairman of Joint Board
ii. Two officials each of the participating UT/UTs. These officials are required to be nominated by the Central government. In addition, there shall be two officials each to represent participating State government/governments to be nominated by the participating States.
iii. One person from each participating UT or one each from participating UTs who shall be from the local authorities functioning within that UT. These members are required to be nominated by the respective Union government. In addition one person each from participating States from amongst the members of local authorities functioning within the State to be nominated by the participating state government.
iv. One non-official member to be nominated by Central government and one by State government/governments to represent the interests of Agriculture, fishery, industry or trade or any other interest.
v. Two persons representing Companies or Corporations owned or controlled by the Central government situate within the UT/participating UTs. These persons are to be nominated by the Central government. Similarly two persons representing Companies or Corporations owned or controlled by the participating State government. These persons are also to be nominated by the Central government.
vi. Like Chairman of the Joint Board, Full-time member Secretary is also required to be nominated by the Central government. Member Secretary is required to possess knowledge and experience of scientific, engineering or management aspects of pollution control.

As stated earlier, these Joint Boards are required to perform the functions of State Pollution Control Boards subject to such bifurcation as may be provided for in the

agreement. These Joint Boards shall be subject to the direction and control of the Central government when the matter pertains to UT or when the matter is within the territorial jurisdiction of more than one State. So far as participating States are concerned they can also issue directions to Joint Board subject to the condition that matter is within the territorial jurisdiction of that particular State.

12.5 AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

Constitution of India, as originally enacted did not contain any specific provision pertaining to environment protection, in general and prevention and control of air pollution, in particular. The United Nations Conference on Human Environment held at Stockholm in June 1972 decided to take appropriate steps for preservation and protection of natural resources of the earth including Air. India participated in this conference. Stockholm conference is watershed in International Environmental law and it affected Indian nation also. The Constitution (Forty Second Amendment) Act, 1976 inserted Article 48A in the Indian Constitution which provides that State shall endeavor to protect and improve the environment and to safeguard the forests and wild life of the country. The amendment also included Fundamental duties in the Constitution.[vi] Once, Indian nation decided to implement the decisions taken at Stockholm conference, it enacted Water Act, 1974 and *Air (Prevention and Control of Pollution) Act*, 1981 (hereinafter referred to as Air Act). Air Act was enacted under Article 253 of the Constitution. The Act came into force on 16th May 1981 and it applies to whole of India

The objectives of the Air Act, as stated in the Preamble, are as follows:

i. To provide for the prevention, control and abatement of air pollution;
ii. To provide for the establishment of Central and State Pollution Boards for carrying out the purposes of the Act;
iii. To confer powers upon Central and State Boards for carrying out the functions assigned by the Act and;
iv. To preserve the quality of air.

The Act defines air pollution as the presence in the atmosphere of air pollutant.[ix] Air pollutant is defined to mean any solid, liquid or gaseous substance including noise present in the air in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.[x] Thus the definition of air pollutant is very wide to include the presence of any substance in the atmosphere which might be injurious to the plants, living creatures, human being or the environment. The Amendment Act of 1987[xi] inserted words 'including noise' in the definition of air pollutant thereby further widening the definition of the term air

pollutant. Thus, if the noise exceeds tolerance limits as to be injurious to human beings, living creatures, plants or environment, it comes within the meaning of air pollution. The Act defines various other terms such as approved fuel, approved appliance, automobile, chimney, emission, control equipment, occupier etc.[xii]

12.6 IMPLEMENTATION MECHANISM

Air Act contemplates establishment of Central and State Pollution Control Boards for carrying out the objectives of the Act.

- **12.6.1 Central Pollution Control Board (CPCB)**

The Air Act adopts integrated and comprehensive approach to tackle environmental pollution and accordingly, the Act provides that Central Board constituted under the Water Act, shall have the powers and shall perform the functions assigned to the Central Board under the Air Act also.[xiv] Therefore, the Central Board constituted under the Water Act shall be the Central Board for the purposes of Air Act also and it shall perform functions of State Board in Union Territories apart from performing the functions of Central Board.[xv]

- **Functions of CPCB**

As stated earlier, CPCB established under the Water Act is to perform functions and duties under the Air Act also with a view to have coordinated and integrated approach for the protection and prevention of environment. As such, CPCB, apart from performing functions under the Water Act, will discharge duties under the Air Act also. The functions are almost similar under both the Acts. The primary function of CPCB under the Air Act is to improve the quality of air and to prevent control and abate air pollution throughout the country. CPCB has been mandated to perform the following functions.

i) CPCB is to advise the Union government regarding matters concerning improvement of quality of air and regarding prevention, control and abatement of air pollution;

ii) To plan and execute a national programme for the prevention, control and abatement of air pollution;

iii) CPCB is required to co-ordinate the activities of State Boards and to resolve any disputes arising among them;

iv) CPCB is to provide technical assistance and guidance to State Boards and to sponsor investigation and research relating to problems concerning air pollution;

v) To plan and organize training of persons associated or likely to be

associated with programmes for prevention, control and eradication of air pollution;

vi) To organize programmes through mass media campaigns for prevention and control of air pollution;

vii) To lay down ambient air quality standards;

viii) To collect, compile and publish technical and statistical data relating to air pollution, measures for prevention and abatement of the same;

ix) To collect and disseminate information pertaining to air pollution;

x) To perform such other functions as may be prescribed from time to time;

xi) To issue directions to State Boards;

xii) If the State Boards defaults in complying with the directions of the CPCB and consequently there arises grave emergency, then in public interest, CPCB can discharge the functions of State Boards.

Central government is empowered to issue directions to CPCB and CPCB is bound by such directions.

Therefore, under the Air Act, CPCB is to perform functions similar to functions assigned under the Water Act. CPCB has launched National Air Quality Monitoring Programme at 342 operating stations covering 127 cities in various States and UTs for monitoring four air pollutants i.e. Sulphur Dioxide, Oxides of Nitrogen, Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM/PM10).

- **12.6.2 State Pollution Control Boards**

Air Act provides that State Boards constituted under the Water Act shall be the State Boards for the purposes of Air Act also. It implies that if a State has adopted Water Act and has constituted State Board under the Water Act, it shall not be required to constitute another board for the purpose of implementation of Air Act and all powers and functions shall be carried out by that Board only.

However, if any State has not adopted the Water Act or has not constituted the State Pollution Control Board, then the State government is required to constitute State Pollution Control Board under the Air Act. Like Water Act, Air Act also casts various duties and confers multifarious powers under the State Pollution Control Boards. The State Boards have the task of implementing the provisions of the Air Act. Like Water Act, State Boards under the Air Act also have the attributes of a Body Corporate, capacity to sue and be sued, capacity to hold, acquire and dispose of property, perpetual succession, common seal etc. Composition of State Pollution Control Boards is as under:

i. The Chairman of the Board shall be either full time or Part-time Chairman to be nominated by the State government. To be eligible to be appointed as Chairman, the person shall possess special knowledge or practical experience in matters relating to environmental protection.

ii. Not more than five Government officials as representative of the State government. These officials are required to be nominated by the State government.

iii. NotmorethanfivepersonsfromamongstthelocalauthoritiesfunctioningwiththeStates. These members are also required to be nominated by the State government.

iv. State government is required to nominate non-officials (not more than three) to represent the interests of Agriculture, fishery, industry or trade or any other interest which the State government believes that it should also be represented in the Board.

v. Two persons representing Companies or Corporations owned or controlled by the State government. These persons are also to be nominated by the State government.

vi. State government is required to nominate one Full time member-secretary. Member Secretary is required to possess administrative experience and practical experience in relation to environmental protection.

Of the above members, at least two members must have special knowledge or practical experience relating to improvement of quality of air or matters pertaining to prevention, control and abatement of air pollution.

The perusal of the above makes it clear that the composition of State Board under the Air Act is almost similar to the composition of State Board under the Water Act. It is further clarified that after constitution of the State Board under Air Act, if any State adopts Water Act and constitutes State Board under the Water Act, State Board constituted under Air Act shall be dissolved.

The tenure of members of the Board is three years. However, the tenure of official members shall come to an end as soon as they cease to hold the office under the government by virtue of which they were appointed. Similarly, members appointed to represent Companies/Corporations owned or controlled by the State government or the Local authority, shall cease to be members of the Board as soon as they cease to be the officers of the Company/Corporation or the Local authority. If any member is absent from three consecutive meetings without sufficient reason, he shall be deemed to have vacated the office of the State Board. A member may be removed from office after giving him a reasonable opportunity of being heard. Member may also resign

from office before the expiry of his tenure. Members are eligible for re-nomination.

If any person suffers from the following disqualifications, he shall not be eligible to appointed as the member of State Board and if he is the member, he shall cease to be member of the State Board:

i) Declared as in insolvent;

ii) Declared as person of unsound mind;

iii) Convicted of an offence involving moral turpitude;

iv) Convicted of any offence under the Air Act;

v) Having economic interest

a. Being member/partner/having share in firm or company manufacturing control equipment, industrial plant etc for improvement of quality of air;

b. Being director, secretary, manager or salaried employee of a company or a firm which is having any contract with the government or government instrumentalities regarding improvement of quality of air, prevention, control and abatement of air pollution

c. Abused his position as a member

Any member who becomes subject to any of the above disqualifications shall be removed by the State government after giving him reasonable opportunity of being heard and such member shall not be eligible for re-appointment.

State Boards are required to have at least one meeting in every three months. However, if any urgent business is required to be transacted, Chairman of the Board is authorised to convene meetings for the purpose.

- **Functions of State Boards**

In addition to the functions under the Water Act, State Boards are required to perform the following functions;

To collect and disseminate information pertaining to air pollution;

To plan and execute programme for the prevention, control, abatement and eradication of air pollution;

i) To advise the State government regarding matters pertaining to air pollution;

ii) To inspect air control equipment manufacturing plants and to issue appropriate directions concerning prevention, control and abatement of air pollution;

iii) To co-ordinate and collaborate with CPCB in organizing training of

persons engaged in connection with prevention, control and abatement of air pollution;

iv) To inspect air pollution control areas, assess the quality of air and to take steps for prevention, control and abatement of air pollution;

v) To lay down, in consultation with CPCB and having regard to ambient air quality standards prescribed by CPCB, standards for emission of air pollutants into the atmosphere by industrial plants and vehicles;

vi) To establish or recognize a laboratory in connection with functions under the Air Act;

vii) To advise the government regarding suitability of any premises for the purposes of carrying on of any industry likely to cause air pollution;

viii) To perform such other functions as may be prescribed from time to time

Perusal of the above shows that the State Boards are to perform multifarious functions under the Air Act also. Whenever, State government is of the opinion that the State Board has defaulted persistently in the performance of its functions under the Air Act, State government can supersede the State Board by notification in official gazette for a period of six month. Similarly, State Board can be superseded when State government is of the opinion that in public interest it is required. The period can be further extended by six months by the State government or State Government may reconstitute the State Board. Where CPCB or the State Boards constituted under the Water Act are superseded by the Central or the State government under the Water Act, the functions under the Air Act shall also be performed by the authority or persons so authorised or by the Central or State government.

12.7 THE WILD LIFE (PROTECTION) ACT, 1972

Conservation of living natural resources – plants, animals, and microorganisms and the nonliving elements of the environment on which they depend is crucial for development and progress. Wildlife resources constitute a vital link in the survival of the human species, because every one of us depends on plants and animals for all vital components of our welfare. The whole environment runs in the form of a food chain and survival and dependence of all the species is vital and interdependent.
Hon'ble Markandey Katju J, has also stated that:

Preservation of wildlife is important for maintaining the ecological balance in the environment and sustaining the ecological chain. It must be understood that there is interlinking in nature

In the present society, the challenge that the world faces is not the idea of conservation but can conservation be implemented in national interest and within the means available to each country.

The general impression about the term "wildlife" is that it includes ferocious, terrestrial or aquatic animals living in jungle such as lions, tigers etc. But actually the term includes all living organisms i.e. all plants, animals and micro-organisms living in their natural habitat in wild state other than the cultivated plants and domesticated animals. The Conservation of wildlife is of immense importance to mankind, the extinction of wildlife would ultimately lead to the extinction of the human species itself. The ecological balance of the nature is disrupted if any harm is caused to the wildlife.

- **Legislative History**

In India, the Wildlife laws have a long history.

a) The earliest concern for wildlife could be traced to 3rd Century BC when King Ashoka enacted the law of preservation of wildlife and environment.

b) Under the Indian Penal Code, 1860 the term "animal" is defined and it declares maiming and killing of animals as an offence punishable under various sections.

c) The British Government passed the Elephants Preservation Act, 1879 which prohibited killing, injuring, capturing or any attempt of the same to elephants.

d) The first direct codified law for wildlife protection was enacted by the British Government – The Wild Birds Protection Act, 1887 which prohibited possession or sale of any kind of specified wild birds.

e) In 1912, the Wild Birds and Animal Protection Act was passed to fulfill the inadequacies of the Wild Birds Protection Act 1887.

f) The Indian Forest Act, 1927, thereafter consolidated the law relating to forests and the transit of forest produce.

g) The Forest (Conservation) Act, 1980 was enacted to further check deforestation.

h) The Cruelty to Animals Act, 1960 and The Wildlife Protection act, 1972 were passed to protect, preserve and improve Wild Life.

The Wildlife (Protection) Act, 1972 was passed by the Parliament under Article 252 of the Constitution at the request of eleven states and was intended to provide a

comprehensive National framework for wildlife protection and to adopt a conservation strategy for specified endangered species and provide for protection of all species in specified areas.

The Preamble of the Act Lays down, "An Act to provide for the protection of wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto with a view to ensuring the ecological and environmental security of the country."

The Act serves the Constitutional purpose mentioned under Article 48 A and Article 51 A(g) as it prohibits hunting of wild animals except in certain limited circumstances. The court has declared that the provision of the wildlife Act are salutary and are necessary to be implemented to maintain ecological chain and balance.

12.8 IMPORTANT DEFINITIONS (SECTION 2)

Section 2 of the Act deals with definitions .Some of the important definitions as they exist after the

Amendment Act of 2002 are:

1. “Animal” includes mammals, birds, reptiles, amphibians, fish, other chordates and invertebrates and also includes their young and eggs.
2. “animal article” means an article made from any captive animal or wild animal, other than vermin, and includes an article or object in which the whole or any part of such animal has been used, and ivory imported into India and an article made there from.
3. “Captive animal” means any animal, specified in Schedule I, Schedule II, Schedule III or Schedule IV, which is captured or kept or bred in captivity.
4. “Forest officer” means the Forest officer appointed under clause (2) of section 2 of the Indian Forest Act, 1927 (16 of 1927) or under any other Act for the time being in force in a State “forest produce” shall have the same meaning as in sub-clause (b) of clause (4) of section 2 of the Indian Forest Act, 1927 (16 of 1927)
5. “habitat” includes land, water or vegetation which is the natural home of any wild animal;
6. “hunting”, with its grammatical variations and cognate expressions, includes,—
    a) killing or poisoning of any wild animal or captive animal and every attempt to do so;

b) capturing, coursing, snaring, trapping, driving or baiting any wild or captive animal and every attempt to do so;

c) injuring or destroying or taking any part of the body of any such animal or, in the case of wild birds or reptiles, damaging the eggs of such birds or reptiles, or disturbing the eggs or nests of such birds or reptiles;

7. "National Board" means the National Board for Wild Life constituted under section 5A
8. "National Park" means an area declared, whether under section 35 or section 38, or deemed, under sub-section (3) of section 66, to be declared, as a National Park;
9. "protected area" means a National Park, a sanctuary, a conservation reserve or a community reserve notified under sections 18, 35, 36A and 36C of the Act;
10. "Reserve forest" means the forest declared to be reserved by the State Government under section 20 of the Indian Forest Act, 1927 (16 of 1927), or declared as such under any other State Act.
11. "sanctuary" means an area declared as a sanctuary by notification under the provisions of Chapter IV of this Act and shall also include a deemed sanctuary under sub-section (4) of section 66
12. "weapon" includes ammunition, bows and arrows, explosives, firearms, hooks, knives, nets, poison, snares and traps and any instrument or apparatus capable of anaesthetizing, decoying, destroying, injuring or killing an animal;
13. "wild animal" means any animal specified in Schedules I to IV and found wild in nature;
14. "wild life" includes any animal, aquatic or land vegetation which forms part of any habitat;

- **AUTHORITIES TO BE APPOINTED UNDER THE ACT (SECTION 3 AND SECTION 4)**
  - A Director of Wildlife Preservation and such other officers as necessary are appointed by Central government.
  - A Chief Wildlife Warden, Wildlife Wardens, honorary wild life Wardens and such other officers as necessary are appointed by State Government.

- **POWER TO DELEGATE (SECTION 5)**

i. The Director may, with the previous approval of the Central Government, by order in writing, delegate all or any of his powers and duties under this Act to any officer subordinate to him subject to such conditions, if any, as may be specified in the order.

ii. The Chief Wild Life Warden may, with the previous approval of the State Government by order in writing, delegate all or any of his powers and duties under this Act, except few to any officer subordinate to him subject to such conditions, if any, as may be specified in the order.

iii. Subject to any general or special direction given or condition imposed by the Director or the Chief Wild Life Warden, any person, authorized by the Director or the Chief Wild Life Warden to exercise any powers, may exercise those powers in the same manner and to the same effect as if they had conferred on that person directly by this Act and not by way of delegation.

- **CONSTITUTION OF THE BOARD (SECTION 5 A)**

Section 5 A of the Amendment Act of 2002 provides that the Central Government shall within three months for National Board and within a period of six months for State Boards from the date of commencement of the Amendment Act of 2002 constitute the National and State Board for Wild Life.

National Board for Wild Life consists of the following members, namely:-

a) the Prime Minister as Chairperson;

b) the Minister in-charge of Forests and Wild Life as Vice-Chairperson;

c) three members of Parliament of whom two shall be from the House of the People and one from the Council of States;

d) Member, Planning Commission in-charge of Forests and Wild Life;

e) five persons to represent non-governmental organizations to be nominated by the Central Government;

f) ten persons to be nominated by the Central Government from amongst eminent conservationists, ecologists and environmentalists;

g) the Secretary to the Government of India in-charge of the Ministry or Department of the Central Government dealing with Forests and Wild Life;

h) the Chief of the Army Staff;

i) the Secretary to the Government of India in-charge of the Ministry of Defence;

j) the Secretary to the Government of India in-charge of the Ministry of Information and Broadcasting;

k) the Secretary to the Government of India in-charge of the Department of Expenditure, Ministry of Finance;

l) the Secretary to the Government of India, Ministry of Tribal Welfare;

m) the Director-General of Forests in the Ministry or Department of the Central Government dealing with Forests and Wild Life;

n) the Director-General of Tourism, Government of India;

o) the Director-General, Indian Council for Forestry Research and Education, Dehradun;

p) the Director, Wild Life Institute of India, Dehradun;

q) the Director, Zoological Survey of India;

r) the Director, Botanical Survey of India;

s) the Director, Indian Veterinary Research Institute;

t) the Member-Secretary, Central Zoo Authority;

u) the Director, National Institute of Oceanography;

v) one representative each from ten States and Union territories by rotation, to be nominated by the Central Government;

w) the Director of Wild Life Preservation who shall be the Member-Secretary of the National Board.

- **FUNCTIONS OF THE NATIONAL BOARD (SECTION 5 C)**

1. It shall be the duty of the National Board to promote the conservation and development of wild life and forests by such measures as it thinks fit.
2. Without prejudice to the generality of the foregoing provision, the measures referred to therein may provide for-

    a) framing policies and advising the Central Government and the State Governments on the ways and means of promoting wild life conservation and effectively controlling poaching and illegal trade of wild life and its products;

    b) making recommendations on the setting up of and management of national parks, sanctuaries and other protected areas and on matters relating to restriction of activities in those areas;

    c) carrying out or causing to be carried out impact assessment of various projects and activities on wild life or its habitat;

    d) reviewing from time to time, the progress in the field of wild life conservation in the country and suggesting measures for improvement thereto; and

    e) Preparing and publishing a status report at least once in two years on wild life in the country.

- **CONSTITUTION OF STATE BOARD FOR WILD LIFE (SECTION 6)**

The State Government shall, within a period of six months from the date of commencement of the Wild Life (Protection) Amendment Act, 2002 constitute a State Board for Wild Life consisting of the following members, namely:-

a) the Chief Minister of the State and in case of the Union territory, either Chief Minister or Administrator, as the case may be - Chairperson;

b) the Minister in-charge of Forests and Wild Life - Vice-Chairperson

c) three members of the State Legislature or in the case of a Union territory with Legislature, two members of the Legislative Assembly of that Union territory;

d) three persons to represent non-governmental organisations dealing with wild life to be nominatedby the State Government;

e) ten persons to be nominated by the State Government from amongst eminent conservationists, ecologists and environmentalists including at least two representatives of the Scheduled Tribes;

f) the Secretary to the State Government or the Government of the Union territory, as the case may be, in-charge of Forests and Wild Life;

g) the Officer in-charge of the State Forest Department;

h) the Secretary to the State Government, Department of Tribal Welfare;

i) the Managing Director, State Tourism Development Corporation;

j) an officer of the State Police Department not below the rank of Inspector-General;

k) a representative of the Armed Forces not below the rank of a Brigadier to be nominated by the Central Government;

l) the Director, Department of Animal Husbandry of the State;

m) the Director, Department of Fisheries of the State;

n) an officer to be nominated by the Director, Wild Life Preservation;

o) a representative of the Wild Life Institute of India, Dehradun;

p) a representative of the Botanical Survey of India;

q) a representative of the Zoological Survey of India;

r) The Chief Wild Life Warden, who shall be the Member-Secretary.

- **DUTIES OF STATE BOARD FOR WILD LIFE (SECTION 8)**

It shall be the duty of the State Board for Wild Life to advise the State Government

a) in the selection and management of areas to be declared as protected areas;

b) in formulation of the policy for protection and conservation of the wild life and specified plants;

c) in any matter relating to the amendment of any Schedule;

d) in relation to the measures to be taken for harmonizing the needs of the tribal and other dwellers of the forest with the protection and conservation of wild life; and]

e) in any other matter connected with the protection of wild life which may be referred to it by the State Government.

12.9THE ENVIRONMENTAL (PROTECTION) ACT, 1986

The Act came into force on November 19, 1986, the birth anniversary of our Late Prime Minister Indira Gandhi, who was a pioneer of environmental protection issues in our country. The Act extends to whole of India. The Constitution of India clearly states that it is the duty of the state to 'protect and improve the environment and to safeguard the forests and wildlife of the country'.

As compared to all other previous laws on environment protection, the Environment (Protection) Act, 1986 is a more effective and comprehensive measure to fight the problem of pollution.

Objects:

i. The Environment Protection Act is a means to implement the decisions of the UN Conference on the Human Environment held in Stockholm (June1972).

ii. The Environment Protection Act also seeks to enact a general blanket law on environmental protection, dealing with all aspects of pollution and harm to the nature and not limiting its scope to just one type of pollution or pollutants.

iii. The exhaustive nature of Environment Protection Act also ensures that no ambit of environmental protection is left and all hazards' to the environment are absolutely roofed and addressed under the Act.

iv. The Act also provides punishment (deterrent in nature) to those responsible for causing harm to the environment or endangering it.

v. The Act provides for a scheme and a mechanism of working of various already existing regulatory authorities and also creates more agencies for furtherance of environment protection.

vi. The Act also aims at promoting sustainable development as a means to achieve the end of prosperity and opulence.

In the case of *N D Jayal*v *Union of India,* (2004) 9 SCC 362, it was held that If the Act is not armed with the powers to ensure sustainable development, then it will be a barren shell. Sustainable development is one of the means to obtain the object and purpose of The Act as well as the Protection of Life under "Article 21".Acknowledgment of this principle will breathe new life into our environmental jurisprudence and Constitutional resolve.

12.10 IMPORTANT DEFINITIONS

Section 2 of the Environment (Protection) Act, 1986 deals with definitions. Some of the important definitions are as under:

"**Environment**" includes water, air, and land and the interrelationship which exists among and between water, air and land and human beings, other living creatures, plants, microorganism and property [Section 2(a)].

"Environmental Pollutant" means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be injurious to environment [Section 2(b)].

"Environmental pollution" means presence in the environment of any environment pollutant [Section 2(c)]. It causes imbalance in environment. The materials or substances when after mixing in air, water or land alters their properties in such manner, that the very use of all or any of the air water and land by man and any other living organism becomes lethal and dangerous for health.

"Handling" In relation to any substance, it means the manufacturing, processing, treatment, packaging, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like of such substance [Section 2(d)].

"Hazardous Substance" means any substance or pro-Environment Protection Actration which, by reasons of its chemical or physic-chemical properties, is liable to cause harm to human beings or other living creatures, plants, micro-organism, property or the environment [Section 2(e)].

"Occupier" It means a person who has control over the affairs of the factory or the premises, and includes, in relation to any substance, the person in possession of the substance [Section 2 (f)].

- **POWERS PROVIDED BY THE ACT TO CENTRAL GOVERNMENT:**

The Act provides the Central Government with the power to take measures to protect and improve the environment. It endows the Central government the power to take all measures which it deems necessary to protect, preserve and improve the environment. It can take measures to curb activities causing harm to the environment it can control and bring a halt to activities discharging pollutants. In particular, and without prejudice to the generality of the provision such measures may include measures with

respect to all or any of the following matters, namely:-

i. Co-ordination of Actions by the State Governments, officers and other authorities--

    a. under this Act, or the rules made there under, or

    b. under any other law for the time being in force which is relatable to the objects of this Act;

ii. Planning and execution of a nation-wide program for the prevention, control and abatement of environmental pollution;

iii. Laying down standards for the quality of environment in its various aspects;

iv. Laying down standards for emission or discharge of environmental pollutants from various sources whatsoever: Provided that different standards for emission or discharge may be laid down under this clause from different sources having regard to the quality or composition of the emission or discharge of environmental pollutants from such sources;

v. Restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards;

vi. Laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution and remedial measures for such accidents;

vii. Laying down procedures and safeguards for the handling of hazardous substances;

viii. Examination of such manufacturing processes, materials and substances as are likely to cause environmental pollution;

ix. Carrying out and sponsoring investigations and research relating to problems of environmental pollution;

x. Inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and giving, by order, of such directions to such authorities, officers or persons as it may consider necessary to take steps for the prevention, control and abatement of environmental pollution;

xi. Establishment or recognition of environmental laboratories and institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act;

xii. Collection and dissemination of information in respect of matters relating to environmental pollution;

xiii. Preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution;

xiv. Such other matters as the Central Government deems necessary or expedient for the purpose of securing the effective implementation of the provisions of the Act as per Section 3(2) of the Act.

Section 3(3) gives power to the central government to constitute an "authority" or "authorities" to assist in its functions which is tied with the duty to constitute such an authority so as to provide a better mechanism. This was highlighted in various cases such as *Lafarge Umiam Mining (P) Ltd.* v. *Union of India*, (2011) 7 SCC 338; *T.N. Godavaram Thirumulpad*v.*Union of India and Others*, (2014) 4 SCC 61.

The ambit of powers given to the central government under this Act is very wide and under this section the central government also can implement the suggestions of the Supreme Court. The Supreme Court in various cases such as *F.B. Taraporawala*v. *Bayer India Ltd*., (1996) 6 SCC 58, has directed the Central Government to constitute an authority under Section 3(3) of the Environment (Protection) Act, 1986. The Central government has constituted the **Loss of Ecology (Prevention and Payment of Compensation) Authority** for the state of Tamil Nadu on the instruction of the Supreme Court. In *Vellore Citizens' Welfare Forum* v. *Union of India* also known as T. N. Tanneries case, (1996) 5 SCC 647 where the Supreme Court observed:

"It is thus obvious that the Environment Act contains useful provisions for controlling pollution. The main purpose of the Act is to create an authority or authorities under Section 3(3) of the Act with adequate powers to control pollution and protect the environment. It is a pity that till date no authority has been constituted by the Central Government. The work which is required to be done by an authority in terms of Section 3(3) read with other provisions of the Act is being done by this Court and the other courts in the country. It is high time that the Central Government realises its responsibility and statutory duty to protect the degrading environment in the country. If the conditions in the five districts of Tamil Nadu, where tanneries are operating, are permitted to continue then in the near future all rivers/canals shall be polluted, underground waters contaminated, agricultural lands turned barren and the residents of the area exposed to serious diseases. It is, therefore, necessary for this Court to direct the Central Government to take immediate Action under the provisions of the Environment Act."

12.11 PREVENTION, CONTROL AND ABATEMENT OF ENVIRONMENTAL POLLUTION:

Section 7 of the Act specifically provides that no person carrying on any industry, operation or process shall discharge or emit or permit to be discharged or be emitted any environmental pollution in excess of the prescribed standards. Section 7 of the Environment Protection Act provides that certain standards have to be maintained and no person or an industry can be permitted to cause damage to the environment. If any

person is found guilty of causing damage to the environment then by applying the "polluter pays principle" he can be asked to pay the exemplary damages for polluting the environment. In *D.S. Rana*v. *Ahmedabad Municipal Corporation*, AIR 2000 Guj 45, the imposition of restrictions on the trade or operation of melting gold and silver which was causing public nuisance and a health hazard and damaging the environment was held to be proper.

Section 8 provides that persons handling hazardous substances are required to comply with procedural safeguards where the discharge of any environmental pollution in excess of prescribed standards occurs or is apprehended to occur due to accident or other unforeseen circumstances the people responsible for such discharge and the person in charge of the place where the discharge occurs shall be bound to mitigate or reduce the pollution. He is required to give intimation and render all assistance to the concerned authorities.

Section 9 provides that on receipt of such intimation or otherwise the concerned authorities shall take steps to prevent or mitigate the environmental pollution Section 10 provides that the Central government can give any person powers of entry, inspection of any place for the purpose of examining and testing equipment, industrial plant, record, register or document and make such seizures as is necessary to prevent or mitigate environmental pollution.

12.12 POWER TO TAKE SAMPLES AND PROCEDURE TO BE FOLLOWED THEREAFTER

The Central government or any other officer empowered by it in this behalf has the power to take for the purpose of analysis, samples of –

(i) Air

(ii) Water

(iii) Soil, or

(iv) Other substance.

The Sample can be taken in prescribed manner from any-

(i) Factory

(ii) Premises, or

(iii) Other place.

In order to make the result of any sample admissible in the evidence in any legal proceedings the following procedure must be followed:-

a) Notice must be served on the occupier or his agent or person in charge of the place. The notice must indicate his intention to have the analysis of sample;

b) The Sample must be collected in the presence of the occupier of his agent or his agent;

c) The sample to be placed in a container or containers which shall be marked and sealed and shall also be signed both by the person taking the sample and the occupier or his agent;

d) Send without delay, the container or the containers to the laboratory established or recognized by the Central Government under section 12 [i.e. Environmental Laboratory].

In a case where the occupier, his agent or person willfully absents himself, the person taking the sample shall collect the sample for analysis to be placed in a container or containers which shall be marked and sealed and shall also be signed by the person taking the sample, and in a case where the occupier or his agent or person present at the time of taking the sample refuses to sign the marked and sealed container or containers of the sample as required, the marked and sealed container or containers shall be signed by the person taking the samples, and the container or containers shall be sent without delay by the person taking the sample for analysis to the laboratory established or recognized and such person shall inform the Government Analyst in writing, about the willful absence of the occupier or his agent or person, or, as the case may be, his refusal to sign the container or containers (Section 11).

The Central Government or the officer empowered to take samples under Section 11 shall collect the sample in sufficient quantity to be divided into two uniform parts and effectively seal and suitably mark the same and permit the person from whom the sample is taken to add his own seal or mark to all or any of the portions so sealed and marked. In case where the sample is made up in containers or small volumes and is likely to deteriorate or be otherwise damaged if exposed, the Central Government or the officer empowered shall take two of the said samples without opening the containers and suitably seal and mark the same. The Central Government or the officer empowered shall dispose of the samples so collected as follows:-

i. One portion shall be handed over to the person from whom the sample is taken under acknowledgement; and
ii. The other portion shall be sent forthwith to the environmental laboratory or analysis.

The Act provides that any person who fails to comply or contravenes any of the provisions of the Act, or the rules made or orders or directions issued under the Act or rules, shall be punished with

a) With imprisonment for a term which may extend to 5years,

b) With fine which may extend to one lakh rupees,

c) With both.

In case the failure or contravention continues after the conviction for first failure or contravention, an additional fine which may extend to five thousand for every day can be imposed for a period during which failure or contravention continues. If the failure or contravention continues beyond a period of one year after conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years (Section 15).

12.13 OFFENCES BY COMPANIES AND GOVERNMENT DEPARTMENTS:

The Act incorporates the principle of vicarious liability of the person in-charge, Director, Manager, Secretary or other officer for the offence if committed by the company. When any offence is committed by the company, the company as well as the person directly in-charge of and responsible for the conduct and business of company shall be deemed to be guilty and liable to punishment. However the person in-charge and responsible for the conduct and business of the company is not held liable if he proves

(i) that the offence was committed without his knowledge; or

(ii) that he exercised all due diligence/care to prevent the commission of such

If it is proved that the offence has been committed by a company with the consent, or connivance, or negligence of any director, manager, secretary other officer of the company then such persons are deemed to be guilty of the offence and liable for punishment (Section 16).

When an offence under this Act has been committed by any Government Department, the head of the department shall be deemed to be guilty and liable for punishment. However, there is no liability of the head of the department if he proves (a) that the offence was committed without his knowledge; or (b) that he exercised all due diligence/care to prevent the commission of such offence.

Section 17 states that if it is proved that the offence has been committed by a Government Department with the consent, or connivance or negligence of any officer be that the head of the department, then such a person shall be deemed to guilty and liable for punishment. However, the Act provides protection for Actions taken in good faith (Section 18).

In *U.P. Pollution Control Board* v. *Mohan Meakins Ltd*, (2003) SCC 745, the Supreme Court made it clear that directors and managers who were responsible for

causing the pollution would be liable under section 16 of the Environment Protection Act and there was inordinate delay in taking up the case. The court further observed that it couldn't afford to deal lightly with cases involving pollution of air and water.

In *SuoMotu*v. *Vatva Industries Asson,* AIR 2010 Guj 33, it was held that the pollution control board and its officers are free and competent to take Action against any person on violating any provision of the environmental laws. They need not to wait for the direction of the court for taking Action under the law. In fact such a course of seeking direction from the court would amount to dereliction of duty.

The Act further empowers the Central Government to make rules for the purpose of carrying out the purposes of this Act. The Central Government has enacted various rules in furtherance of section 3, 6, 8 read with section 25. Some of the important rules enacted under the Act are:-

i. The Hazardous Waste (Management and Handling) Rules,198
ii. Manufacture, Storage and Import of hazardous chemical Rules, 1989
iii. Hazardous Micro0organisms Rules,1989
iv. Bio- Medical Waste (Management and Handling)Rules,1998
v. Municipal Solid waste (Management and Handling) Rules ,2000
vi. The Batteries (Management and Handling) Rules,2001

Thus, the Act is a very important piece of legislation which is in the form of an umbrella legislation covering all forms of environmental pollution. However there are still many lacunas in the Act which remain such as no Minimum sentence is prescribed, thus diluting the deterrent effect of the Act. Also the Act emphasis on Criminal Liability rather than Civil Liability. It also lacks any incentive to the general public for taking steps to bring the culprit to books. The awareness towards improving the quality of environment has increased substantially and all efforts are being made at different levels to minimize environmental pollution and thus help in improving the quality of life. All in all it is a positive piece of legislation which is a way forward towards achieving sustainable development.

12.14 LET US SUM UP

- **Parliament** of India has also enacted Water Act, 1974 to Prevent and curb Water pollution in India.
- To achieve the purpose of the Water Act, Central and State pollution control Boards have been constituted so as to ensure the effective implementation of the Act.

- From the foregoing discussion, it is clear that Union Government has not only enacted a Law to cope up with increasing menace of Air pollution but has also set up pollution control Boards to control, regulate and mitigate Air pollution.
- To understand the need of Wild Life Protection.
- To understand the provisions of Environmental protection Act and its various liability.

12.15 POSSIBLE QUESTIONS

Short Questions

1) Name two Articles of Indian constitution that deals with Environment Protection.
2) Enlist four Indian Environmental Laws enacted exclusively for the protection of Environment.

Long questions

1) Explain Water Preventions Act 1974
2) Explain Air Preventions Act 1981
3) Explain Environmental Pollution Act 1986
4) Explain Wild Life Protection Act 1972
5) Explain the objectives of the Water and Air Act.

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