# BARASAT GOVERNMENT COLLEGE

## STUDY MATERIAL OF VAC (EVIRONMENTAL STUDIES) OF SEMESTER-1

## (UNDER NATIONAL EDUCATIONAL POLICY)

### INDEX

Syllabus: Ecology; environmental science; pøpulation ecology; habitat; major ecosystems of the world; deep ecology; new environmental paradigm

## CONCEPT OF ECOLOGY AND ECOSYSTEM

The term Ecology was coined by Earnst Haeckel in 1869. It is derived from the Greek words *Oikos*- home + *logos*- study. So **ecology deals with the study of organisms in their natural home interacting with their surroundings.** The surroundings or environment consists of other living organisms (biotic) and physical (abiotic) components. Modern ecologists believe that an adequate definition of ecology must specify some unit of study and one such basic unit described by Tansley (1935) was ecosystem. **An ecosystem is a self-regulating group of biotic communities of species interacting with one another and with their non-living environment exchanging energy and matter.** Now **ecology** is often defined as **''the study of ecosystems''.**

The ecosystem is a unit or a system which is composed of a number of sub-units, that are all directly or indirectly linked with each other. They may be freely exchanging energy and matter from outside—an *open ecosystem* or may be isolated from outside in term of exchange of matter—a *closed ecosystem.*

## BIOTIC AND ABIOTIC COMPONENTS

Ecosystems have basically two types of components, the biotic and abiotic, as described below:

(*a*) **BIOTIC COMPONENTS:** Different living organisms constitute the biotic component of an ecosystem and belong to the following categories:

(*i*) **Producers:** These are mainly producing food themselves *e.g.*, Green plants produce food by photosynthesis in the presence of sunlight from raw materials like water and carbon dioxide.
They are known as *photo-autotrophs* (auto = self, photo = light, troph = food). There are some *chemo-autotrophs*, which are a group of bacteria, producing their food from oxidation of certain chemicals. *e.g.* sulphur bacteria.
(*ii*) **Consumers:** These organisms get their food by feeding on other organisms. They are of the following types:

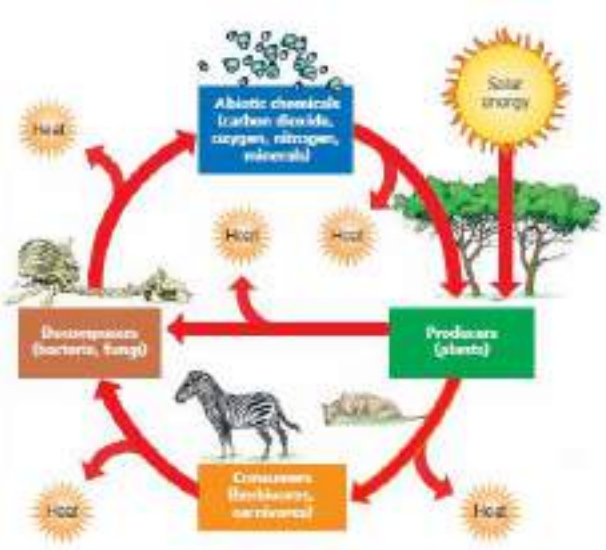
- Herbivores—which feed on plants *e.g.* rabbit, insect.
- Carnivores—which feed on herbivores as secondary carnivores (*e.g.*, frog, small fish) or tertiary carnivores (*e.g.*, snake, big fish), which feed on other consumers.
- Omnivores—which feed on both plants and animals *e.g.*, humans, rats, many birds.
- Detritivores—which feed on dead organisms *e.g.*, earth worm, crab, ants.

(*iii*) **Decomposers:** These are micro-organisms which break down organic matter into inorganic compounds and in this process they derive their nutrition. They play a very important role in converting the essential nutrients from unavailable organic form to free inorganic form that is available for use by plants *e.g.*, bacteria, fungi.

(*b*) **ABIOTIC COMPONENTS:** Various physico-chemical components of the ecosystem constitute the abiotic structure:

(*i*) Physical components include sunlight, solar intensity, rainfall, temperature, wind speed and direction, water availability, soil texture etc.
(*ii*) Chemical components include major essential nutrients like C, N, P, K, H2, O2, S etc. and micronutrients like Fe, Mo, Zn, Cu etc., salts and toxic substances like pesticides.

These physico-chemical factors of water, air and soil play an important role in ecosystem functioning.




Every ecosystem performs the following important functions:

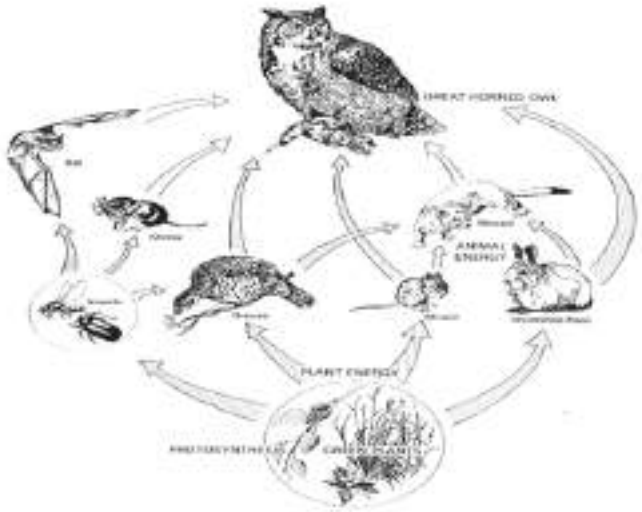
- **There is uni-directional flow of energy in an ecosystem.** It flows from sun and then after being captured by primary producers (green plants), flows through the food chain or food web, following the laws of thermodynamics. At every successive step in the food-chain, there is huge loss of about 90% of the energy in different processes (respiration, excretion, locomotion etc.) and only 10% moves to next level (**Lindemann's Ten per cent law of energy flow**).

- **Nutrients (Materials) in an ecosystem move in a cyclic manner.** The cycling of nutrients takes place between the biotic and abiotic components, hence known as biogeochemical cycles (bio = living, geo = earth, chemical = nutrients).

- **Every ecosystem functions to produce and sustain some primary production (plant biomass) and secondary production (animal biomass).**

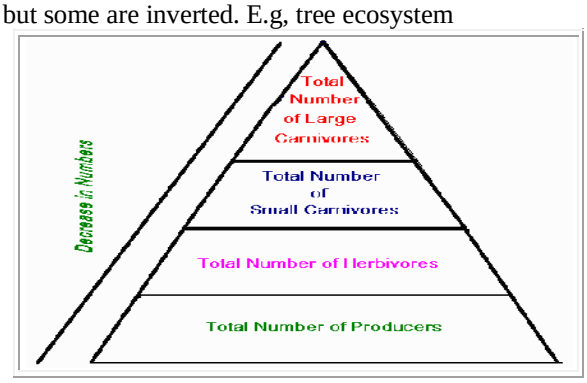
**Every ecosystem regulates and maintains itself and resists any stresses or disturbances up to a certain limit.** This self regulation or control system is known as **cybernetic system**.

1. **FOOD CHAIN**: A food chain is a sequence of populations or organisms of an ecosystem through which food and its contained energy passes.
   **Most food chains have no more than four or five links.** There cannot be too many links in a single food chain because the animals at the end of the chain would not get enough food (and hence energy) to stay alive.
2. **FOOD WEB**: It is a network of food chain which becomes interconnected at various trophic levels.



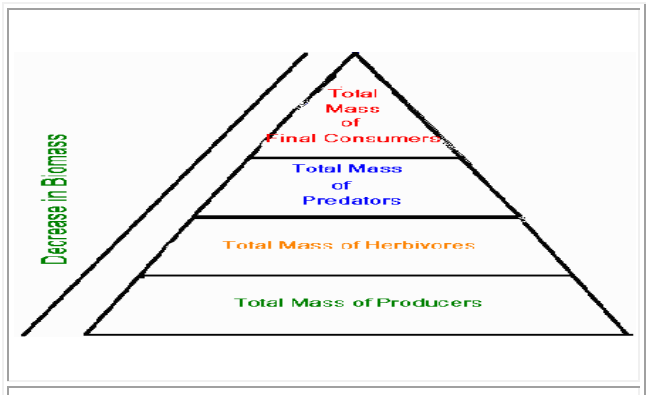
3. **ECOLOGICAL PYRAMIDS** : Trophic levels and the energy flow from one level to the next, can be graphically depicted using an ecological pyramid. Three types of ecological pyramids can usually be distinguished namely:

1. **Number pyramid -** Ecological pyramids are graphical representations of the number of individuals in different nutritional levels . The Number pyramid shows the number of organisms in each trophic level and does not take into consideration the size of the organisms and over-emphasizes the importance of small organisms. In a pyramid of numbers the higher up one moves, so each consecutive layer or level contains fewer organisms than the level below it.
It is mostly upright but some are inverted. E.g, tree ecosystem



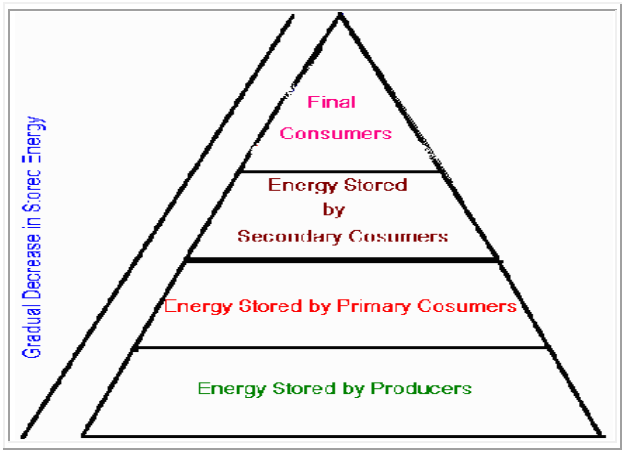

2. **Biomass pyramid.** This pyramid indicates the total mass of the organisms in each trophic level. Thus an enormous mass of grass is required to support a smaller mass of buck, which in turn would support a smaller mass of lions.

Pyramid of biomass is upright for terrestrial habitats. Inverted pyramids are obtained in aquatic habitats.




The Biomass Pyramid

3. **Energy pyramid.** The Energy pyramid indicates the total amount of energy present in each trophic level. It also shows the loss of energy from one trophic level to the next. **The pyramid of energy is always upright.**




**Biological diversity,** or **biodiversity,** is the variety of the earth's species, the genes they contain, the ecosystems in which they live, and the ecosystem processes such as energy flow and nutrient cycling that sustain all life.

**International Union for Conservation of Nature and Natural Resources (IUCN) and Red Data List:**

- IUCN Red list Categories and Criteria for classifying species at high risk of global extinction
- Red list focus attention on taxa at the highest risk setting priorities for conservation measures for their protection
- Provide a global index of the state of degeneration of biodiversity
- Identify and document those species most in need of conservation attention if global extinction rate are to be reduced

OBJECTIVES OF IUCN REDLIST

- To assess in the long term the status of a selected set of species
- To establish a baseline from which to monitor the status of species
- To provide a global context for the establishment of conservation priorities at the local level

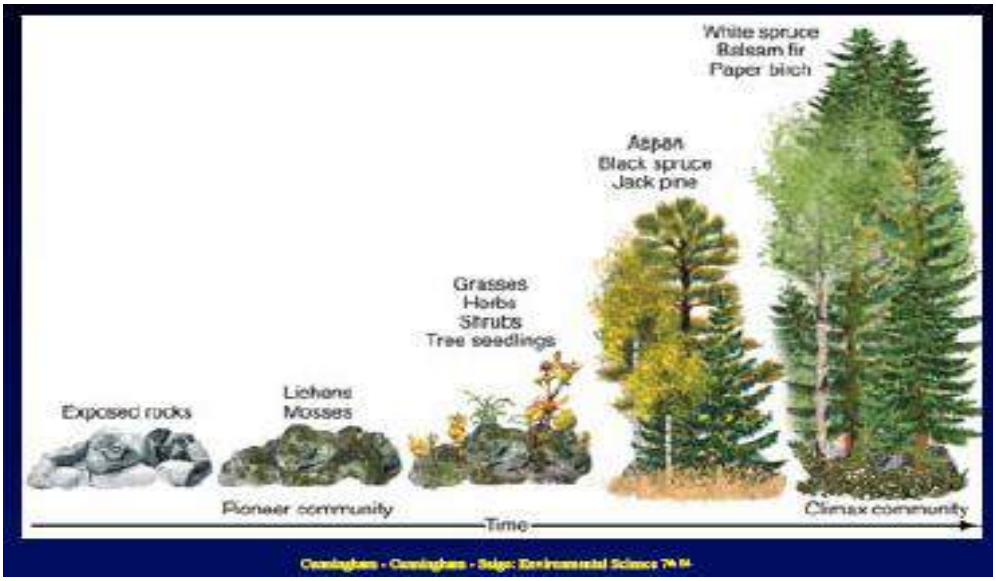
To monitor on a continuing basis, the status of a representative selection of species (as biodiversity indicators) that cover all the major ecosystems of the world

**ECOLOGICAL SUCCESSION :**

Ecological succession is the changing sequence of communities that live in an ecosystem during a given time period.

**PRIMARY SUCCESSION** Primary ecological succession is the changing sequence of communities from the first biological occupation of a place where previously there were no living beings. For example, the colonization and the following succession of communities on a bare rock.

- Change in community composition on a site which previously has had no living organisms



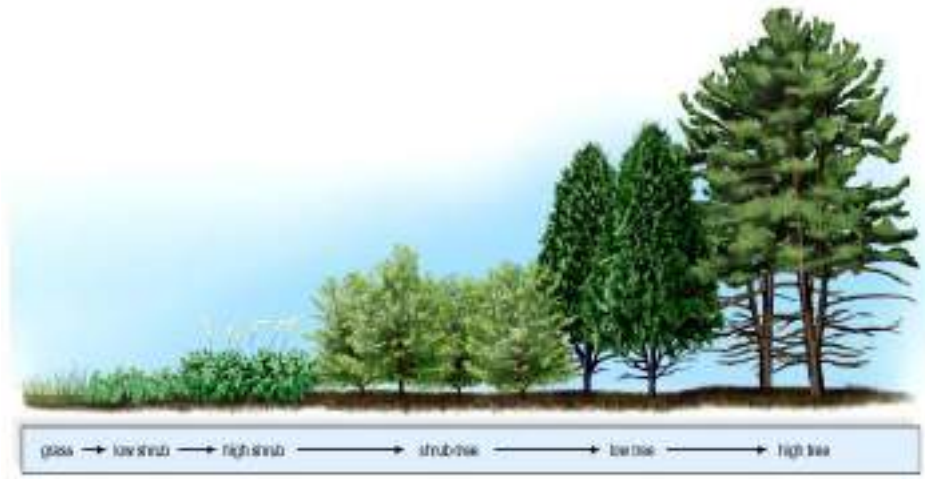

**Pioneer Species** - First plants to colonize: mosses, lichens & herbs

- Rapid dispersal & colonizers
- Rapid growth (opportunistic)
- Relatively poor competitors in stable environments
- Generalists (r-selected species)

**Climax Community**

- May take 100's or 1000's of years to reach this stage
- Stage at which system has reached steady-state equilibrium
- Most permanent of all the stages
- Determined by climatic or edaphic (soil) factors unless intervened
- Humans maintain an equilibrium at sub-climax (e.g. poor soil quality, grazing, preventing forest fires, selective logging)

**Secondary Succession** Secondary ecological succession is the changing sequence of communities from the substitution of a community by a new one in a given place. For example, the ecologicalsuccession of the invasion of plants and animals in an abandoned crop or land.



# DEEP ECOLOGY: FROM DUTY TO ECOLOGICAL CONSCIOUSNESS

**Mouchang Yu**
*Institute of Philosophical Studies, Chinese Academy of Social Sciences (CASS), China*

**Yi Lei**
*Institute of Science, Technology and Society, Tsinghua University, China*

**Keywords:** Arne Naess, biocentric equality, biodiversity, deep ecological consciousness, deep ecology, environment right, George Sessions, life style, platform, responsibility, self-realization, shallow consciousness, sustainable development, ultimate norm

**Contents**



**Summary**

Deep ecology is an important vision in environmental philosophy. It criticizes and rethinks many aspects and deep connections of modern technocratic-industrial societies between humans and nature. It probes the true values of human life and the rational reconstruction of contemporary societies. After the mid-1980s, deep ecology swiftly became a leading force of radical environments in the environmental movements.

Identification is a core concept that makes deep ecology a version. The ultimate norm of "self-realization" is a process of widening and deepening identification with other individuals or beings. The idea is based on modern ecological science and largely absorbs Eastern and Western cultural thoughts. Therefore, the idea has more rationality than others.

The appearance of deep ecology is an important turn from reformist environmental thinking to the radical. It is a turning point from anthropocentric mechanisms to ecocentric holism. As an important part of the postmodern worldview, deep ecology provides a new approach for the theory of sustainable development. This article provides views on "self-realization," values between individuals and wholeness, the scientific basis, and the ecological strategies in different countries and regions.

## 1. Deep Ecology: The Philosophical Foundation of Deep Environmental Ethics

### 1.1. What Is Deep Ecology?

Deep ecology is a philosophy, and a postmodern philosophical worldview. The term deep ecology was coined by Arne Naess in his 1973 article "The shallow and the deep, long-range ecology movement." The essence of deep ecology is to keep asking further questions about human life, society, and nature. Naess points out "the subjective 'deep' stresses that we ask why and how, where others do not. For instance, ecology, as a science, does not ask what kind of a society would be the best for maintaining a particular ecosystem—that is considered a question for value theory, for politics, for ethics." issues, such as natural view and value view; political and ethical issues.

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**Biographical Sketches**

**Mouchang Yu**, born in 1935, got his bachelor's degree from Wuhan University in 1962 and his master's degree from the Chinese Academy of Social Sciences (CASS). Since then, he has worked on natural dialectics in the Institute of Philosophy. Professor Yu is currently a professor, doctoral supervisor, and president of the Chinese Society for Environmental Ethics.

**Yi Lei**, born in 1962, gained his Ph.D. in ecophilosophy. Dr. Lei is a director of the Chinese Society for Environmental Ethics and he works in the Institute of Science, Technology and Society at Tsinghua University, Beijing.

CHAPTER

# 1 Environmental Science : Definition, Scope and Importance

## INTRODUCTION

The science of Environment studies is a multi-disciplinary science because it comprises various branches of studies like chemistry, physics, medical science, life science, agriculture, public health, sanitary engineering etc. It is the science of physical phenomena in the environment. It studies of the sources, reactions, transport, effect and fate of physical a biological species in the air, water and soil and the effect of from human activity upon these.

### Environment Explained

Literary environment means the surrounding external conditions influencing development or growth of people, animal or plants; living or working conditions etc. This involves three questions:

*1. What is Surrounded*

The answer to this question is living objects in general and man in particular.

*2. By what Surrounded*

The physical attributes are the answer to this question, which become environment. In fact, the concern of all education is the environment of man. However, man cannot exist or be understood in isolation from the other forms of life and from plant life. Hence, environment refers to the sum total of condition, which surround point in space and time. The scope of the term Environment has been changing and widening by the passage of time. In the primitive age, the environment consisted of only physical aspects of the planted earth' land, air and water as biological communities. As the time passed on man extended his environment through his social, economic and political functions.

*3. Where Surrounded*

The answer to this question. It is in nature that physical component of the plant earth, viz land, air, water etc., support and affect life in the biosphere. According to a Goudie

environment is the representative of physical components of the earth where in man is an important factor affecting the environment.

(*i*) **Definitions of Environment :** Some important definitions of environment are as under:

1. **Boring:** 'A person's environment consists of the sum total of the stimulation which he receives from his conception until his death.'

   It can be concluded from the above definition that Environment comprises various types of forces such as physical, intellectual, economic, political, cultural, social, moral and emotional. Environment is the sum total of all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms.

2. **Douglas and Holland:** 'The term environment is used to describe, in the aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturity of living organisms.'

(*ii*) **Scope of Environment:** The environment consists of four segments as under:

1. **Atmosphere:** The atmosphere implies the protective blanket of gases, surrounding the earth:

(*a*) It sustains life on the earth.

(*b*) It saves it from the hostile environment of outer space.

(*c*) It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.

(*d*) It transmits only here ultraviolet, visible, near infrared radiation (300 to 2500 nm) and radio waves. (0.14 to 40 m) while filtering out tissue-damaging ultra-violate waves below about 300 nm.

The atmosphere is composed of nitrogen and oxygen. Besides, argon, carbon dioxide, and trace gases.

2. **Hydrosphere:** The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reserviour, polar icecaps, glaciers, and ground water.

(*i*) Nature 97% of the earth's water supply is in the oceans,

(*ii*) About 2% of the water resources is locked in the polar icecaps and glaciers.

(*iii*) Only about 1% is available as fresh surface water-rivers, lakes streams, and ground water fit to be used for human consumption and other uses.

3. **Lithosphere:** Lithosphere is the outer mantle of the solid earth. It consists of minerals occurring in the earth's crusts and the soil *e.g.* minerals, organic matter, air and water.

4. **Biosphere:** Biosphere indicates the realm of living organisms and their interactions with environment, viz atmosphere, hydrosphere and lithosphere.

### Element of Environment

Environment is constituted by the interacting systems of physical, biological and cultural elements inter-related in various ways, individually as well as collectively. These elements may be explained as under:

*(1) Physical elements*

Physical elements are as space, landforms, water bodies, climate soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations.

*(2) Biological elements*

Biological elements such as plants, animals, microorganisms and men constitute the biosphere.

*(3) Cultural elements*

Cultural elements such as economic, social and political elements are essentially man-made features, which make cultural milieu.

## ENVIRONMENT STUDIES: IMPORTANCE

Importance of Environment Studies: The environment studies enlighten us, about the importance of protection and conservation of our indiscriminate release of pollution into the environment.

At present a great number of environment issues, have grown in size and complexity day by day, threatening the survival of mankind on earth. We study about these issues besides and effective suggestions in the Environment Studies. Environment studies have become significant for the following reasons:

### 1. Environment Issues Being of International Importance

It has been well recognised that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence must be tackled with international efforts and cooperation.

### 2. Problems Cropped in The Wake of Development

Development, in its wake gave birth to Urbanization, Industrial Growth, Transportation Systems, Agriculture and Housing etc. However, it has become phased out in the developed world. The North, to cleanse their own environment has, fact fully, managed to move 'dirty' factories of South. When the West developed, it did so perhaps in ignorance of the environmental impact of its activities. Evidently such a path is neither practicable nor desirable, even if developing world follows that.

### 3. Explosively Increase in Pollution

World census reflects that one in every seven persons in this planted lives in India. Evidently with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land. Agricultural experts have recognized soils health problems like deficiency of micronutrients and organic matter, soil salinity and damage of soil structure.

### 4. Need for An Alternative Solution

It is essential, specially for developing countries to find alternative paths to an alternative goal. We need a goal as under:

(1) A goal, which ultimately is the true goal of development an environmentally sound and sustainable development.

(2) A goal common to all citizens of our earth.

(3) A goal distant from the developing world in the manner it is from the over-consuming wasteful societies of the "developed" world.

### 5. Need To Save Humanity From Extinction

It is incumbent upon us to save the humanity from exinction. Consequent to our activities constricting the environment and depleting the biosphere, in the name of development.

### 6. Need For Wise Planning of Development

Our survival and sustenance depend. Resources withdraw, processing and use of the product have all to by synchronised with the ecological cycles in any plan of development our actions should be planned ecologically for the sustenance of the environment and development.

### 7. Misra's Report

Misra (1991) recognized four basic principles of ecology, as under:

(*i*) Holism

(*ii*) Ecosystem

(*iii*) Succession

(*iv*) Conversation.

Holism has been considered as the real base of ecology. In hierarchical levels at which interacting units of ecology are discussed, are as under:

Individual<population<community<ecosystem<biome<biosphere.

Misra (1991) has recognised four basic requirements of environmental management as under:

(*i*) Impact of human activities on the environment,

(*ii*) Value system,

(*iii*) Plan and design for sustainable development,

(*iv*) Environment education.

Keeping in view the of goal of planning for environmentally sustainable development India contributed to the United Nations Conference on Environment and Development (UNCED), also referred to as "Earth Summit" held at Rio de Janciro, the Capital of Brazil, 3rd-14th June, 1992.

## NEED FOR PUBLIC AWARENESS

It is essential to make the public aware of the formidable consequences of the Environmental Degradation, if not retorted and reformative measures undertaken, would

result in the extinction of life. We are facing various environmental challenges. It is essential to get the country acquainted with these challenges so that their acts may be eco-friendly. Some of these challenges are as under:

### 1. Growing Population

A population of over thousands of millions is growing at 2.11 per cent every year. Over 17 million people are added each year. It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although population control does automatically lead to development, yet the development leads to a decrease in population growth rates. For this development of the women is essential.

### 2. Poverty

India has often been described a rich land with poor people. The poverty and environmental degradation have a nexus between them. The vast majority of our people are directly dependent on the nature resources of the country for their basic needs of food, fuel shelter and fodder. About 40% of our people are still below the poverty line. Environment degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge environment degradation are two facets of the same challenge. The population growth is essentially a function of poverty. Because, to the very poor, every child is an earner and helper and global concerns have little relevance for him.

### 3. Agricultural Growth

The people must be acquainted with the methods to sustain and increase agricultural growth with damaging the environment. High yielding varities have caused soil salinity and damage to physical structure of soil.

### 4. Need to Ground water

It is essential of rationalizing the use of groundwater. Factors like community wastes, industrial effluents and chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater. It is essential to restore the water quality of our rivers and other water bodies as lakes is an important challenge. It so finding our suitable strategies for consecration of water, provision of safe drinking water and keeping water bodies clean which are difficult challenges is essential.

### 5. Development And Forests

Forests serve catchments for the rivers. With increasing demand of water, plan to harness the mighty river through large irrigation projects were made. Certainly, these would submerge forests; displace local people, damage flora and fauna. As such, the dams on the river Narmada, Bhagirathi and elsewhere have become areas of political and scientific debate.

Forests in India have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas that were once green, stand today as wastelands. These areas are to be brought back under vegetative cover. The tribal communities inhabiting forests respects the trees and birds and animal that gives them sustenance. We must recognise

the role of these people in restoring and conserving forests. The modern knowledge and skills of the forest deptt. should be integrated with the traditional knowledge and experience of the local communities. The strategies for the joint management of forests should be evolved in a well planned way.

### 6. Degradation of Land

At present out of the total 329 mha of land, only 266 mha possess any potential for production. Of this, 143 mha is agricultural land nearly and 85 suffers from varying degrees of soil degradation. Of the remaining 123 mha, 40 are completely unproductive. The remaining 83 mha is classified as forest land, of which over half is denuded to various degrees. Nearly 406 million head of livestock have to be supported on 13 mha, or less than 4 per cent of the land classified as pasture land, most of which is overgrazed. Thus, our of 226 mha, about 175 mha or 66 per cent is degraded to varying degrees. Water and wind erosion causes further degradation of almost 150 mha This degradation is to be avoided.

### 7. Reorientation of Institutions

The people should be roused to orient institutions, attitudes and infrastructures, to suit conditions and needs today. The change has to be brought in keeping in view India's traditions for resources use managements and education etc. Change should be brought in education, in attitudes, in administrative procedures and in institutions. Because it affects way people view technology resources and development.

### 8. Reduction of Genetic Diversity

Proper measures to conserve genetic diversity need to be taken. At present most wild genetic stocks have been disappearing from nature. Wilding including the Asiatic Lion are facing problem of loss of genetic diversity. The protected areas network like sanctuaries, national parks, biosphere reserves are isolating populations. So, they are decreasing changes of one group breeding with another. Remedial steps are to be taken to check decreasing genetic diversity.

### 9. Evil Consequences of Urbanisation

Nearly 27 per cent Indians live in urban areas. Urbanisation and industrialisation has given birth to a great number of environmental problem that need urgent attention. Over 30 percent of urban Indians live in slums. Out of India's 3,245 towns and cities, only 21 have partial or full sewerage and treatment facilities. Hence, coping with rapid urbanization is a major challenge.

### 10. Air and water Population

Majority of our industrial plants are using outdated and population technologies and makeshift facilities devoid of any provision of treating their wastes. A great number of cities and industrial areas that have been identified as the worst in terms of air and water pollution. Acts are enforced in the country, but their implement is not so easy. The reason is their implementation needs great resources, technical expertise, political and social will. Again the people are to be made aware of these rules. Their support is indispensable to implement these rules.

## VARIOUS TYPES OF ENVIRONMENT

According to Kurt Lewin, environment is of three types which influence the personality of an individual as under:

(*a*) Physical Environment,

(*b*) Social and Cultural Environment, and

(*c*) Psychological Environment.

These may be explained as under:

### 1. Physical Environment

Physical environment, refers to geographical climate and weather or physical conditions wherein and individual lives. The human races are greatly influenced by the climate. Some examples are as under:

(*a*) In the cold countries i.e. European countries the people are of white colour. Likewise, in Asian and African countries, that is, in hot countries people are of dark complexion.

(*b*) The physique of an individual depends on climate conditions as the individual tries to adjust in his physical environment.

(*d*) The human working efficiency also depends on the climatic conditions.

### 2. Social Environment

Social Environment includes an individual's social, economic and political condition wherein he lives. The moral, cultural and emotional forces influence the life and nature of individual behaviour. Society may be classified into two categories as under:

(*i*) An open society is very conductive for the individual developement.

(*ii*) A closed society is not very conductive for the developenment.

### 3. Psychological Environment

Although physical and social environment are common to the individual in a specific situation. Yet every individual has his own psychological environment, in which he lives. Kurt Lewin has used the term 'life space' for explaining psychological environment. The Psychological environment enables us to understand the personality of an individual. Both-the person and his goal form psychological environment.

If a person is unable to overcome the barriers, he can either get frustrated or completed to change his goal for a new psychological environment. But adopting this mechanism, the individual is helped in his adjustment to the environment.

## STRUCTURE OF ENVIRONMENT

Environment is both physical and biological. It includes both living and non-living components.

### (i) Physical Environment

The Physical Environment is classified into three broad categories viz.

(*i*) Solid,

(*ii*) Liquid

(*iii*) Gas.

These represent the following spheres:

(*i*) The lithosphere (solid earth)

(*ii*) The hydrosphere (water component) and

(*iii*) The atmosphere

As such, the three basic of physical environment may be termed as under:

(*i*) Lithospheric Environment

(*ii*) Hydrospheric Environment

(*iii*) Atmospheric Environment

The scientists have classified them into smaller units based on different spatial scales, *e.g.*

(*i*) Mountain Environment

(*ii*) Glacier Environment

(*iii*) Plateau Environment

(*iv*) Coastal Environment

### (ii) Biological Environment

The biological of the environment consists of:

(*i*) Plants (flora)

(*ii*) Animals (fauna).

Thus, the biotic environment further be divided into floral environment and faunal environment. All the organisms work to form their social groups and organizations at several levels. Thus, the social environment is formed. In this social environment the organisms work to derive matter from the physical environment for their sustenance and development. This process gives birth to economic environment. Man claims to be most skilled and civilized of all the organisms. This is the reason why his social organisation is most systematic. The three aspects of man, *e.g.* physical, social and economic, function in the biotic environment as under:

### (i) The Physical Man

The 'Physical Man' is one of the organisms populations or biological community. He is in need of basic elements of the physical environment like habitat (space), air, water and food. Besides, like other biological populations, he releases wastes into the ecosystem.

### (ii) The Social Man

The 'Social Man' performs the following functions:

(*a*) Establishing social institutions,

(*b*) Forming social organisations,

(*c*) Formulating laws, principles and policies,

(*d*) Taking steps to safeguard his existence, interest and social welfare.

### (iii) The Economic Man

The economic man derives and utilises resources from the physical and biotic environment with his skills and technologies. The economic function makes the man an environment/ geomorphic process as he transports matter and energy from one component of the ecosystem to the other. There may be any following two situations:

(*a*) His exploitative functions may be in harmony with the natural environment. Such, functions do not necessarily involve change in the working of the ecosystem.

(*b*) These functions may exceed the critical limit. Consequently, the equilibrium of the environment/ecosystem is disturbed and a great number of environment and ecological problems crop up. These are determental to man him besides to whole population of human species in a given ecosystem.

## QUESTIONS

1. What is Environment? Discuss the scope of Environment.
2. Describe the importance of environment studies.
3. "The need for public awareness about environment is of vital importance." Discuss.
4. Discuss the various types of environment.

### Short Answer Type Questions

1. Define environments.
2. Discuss the scope of environment.
3. Write a note on the importance of environment studies.
4. Write a note on the need of public awareness about environment.
5. Write a note on physical environment.
6. Write a note on biological environment.

# Habitat and Ecological niche

The **habitat** of an organism is the place where it lives, or the place where one would go to find it. The **ecological niche**, however, includes not only the physical space occupied by an organism but also its functional role in the community (its trophic position, for instance) and its position in environmental gradients of temperature, moisture, pH, soil, and other conditions of existence. These three aspects of the ecological niche can be conveniently designated as the spatial or habitat niche, the trophic niche, and the multidimensional or hyper-volume niche.

Consequently, the ecological niche of an organism not only depends on where it lives but also includes the sum total of its environmental requirements. The concept of niche is most useful, and quantitatively most applicable, in terms of differences between species (or the same species at two or more locations or times) in one or a few major (operationally significant) features.

The dimensions most often quantified are **niche breadth and niche overlap** with neighbors. Groups of species with comparable roles and niche dimensions within a community are termed guilds. Species that occupy the same niche in different geographical regions (continents and major oceans) are termed ecological equivalents.

The term habitat is used widely, not only in ecology but elsewhere. Thus, the habitat of the water backswimmer (*Notonecta*) and the water boatman (*Corixa*) is the shallow, vegetation-choked area (littoral region) of ponds and lakes; one would go there to collect these particular water bugs. However, the two species occupy very different trophic niches, as the backswimmer is an active predator, whereas the water boatman feeds largely on decaying vegetation. The ecological literature is replete with examples of coexisting species that use different energy sources.

If the **habitat** is the "address" of the organism, **niche** is its "profession," its trophic position in food webs, how it lives and interacts with the physical environment and with other organisms in its community. Habitat may also refer to the place occupied by an entire community. For example, the habitat of the sand sage grassland community is the series of ridges of sandy soil occurring along the north sides of rivers in the southern Great Plains of the United States.

Habitat in this case consists mostly of physical or abiotic complexes, whereas habitat for the water bugs includes living and non-living objects. Thus, the habitat of an organism or group of organisms (population) includes other organisms and the abiotic environment.

The concept of ecological niche is not so generally understood outside the field of ecology. Terms such as niche are difficult to define and quantify; the best approach is to consider the component concepts historically. **Joseph Grinnell** (1917, 1928) used the word niche "to stand for the concept of the ultimate distributional unit, within which each species is held by its structural and instinctive limitations … no two species in the same general territory can occupy for long identically the same ecological niche."

Thus, Grinnell thought of the niche mostly in terms of the **microhabitat**, or what is now called the **spatial niche**. **Charles Elton** (1927) was one of the first to begin using the term niche in the sense of the "**functional status of an organism in its community.**" Because of Elton's great influence on ecological thinking, it has become generally accepted that niche is by no means a synonym for habitat. Because Elton emphasized the importance of energy relations, his version of the concept is designated the trophic niche.

**G. E. Hutchinson** (1957) suggested that the niche could be visualized as a **multidimensional space or hyper-volume within which the environment permits an individual or species to survive indefinitely. Hutchinson's niche, which can be designated the multidimensional or hyper-volume niche, can be measured and mathematically manipulated**. For example, two-dimensional climographs, which depict x- and y-axes of a particular species of bird and a fruit fly, could be expanded as a series of coordinates (x-, y-, and z-axes) to include other environmental dimensions.

Hutchinson (1965) also distinguished between the fundamental niche—the maximum "abstractly inhabited hyper-volume" when the species is not constrained by competition or other limiting biotic interactions—and the realized niche—a smaller hyper-volume occupied under particular biotic constraints. The **concepts of niche breadth and niche overlap are illustrated in two dimensions in Figures 7-13A and B.**

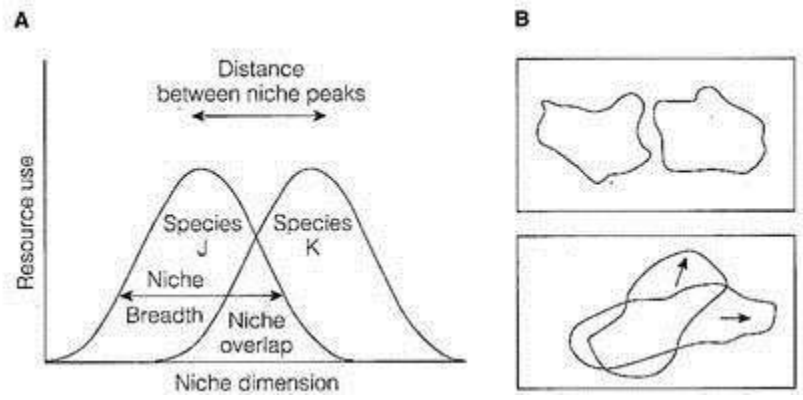


**Figure 7-13.** Schematic representations of the niche concept. (A) Activity curves for two species along a single resource dimension illustrate the concepts of niche breadth and niche overlap. (B) In the upper diagram, two species occupy nonoverlapping niches, whereas in the lower diagram, niches overlap so much that severe competition results in divergence, as indicated by the arrows.

Perhaps a simple analogy from everyday human affairs will help to clarify these overlapping and sometimes confusing ecological uses of the term niche. To become acquainted with a person in the human community, one would need to know, first of all, his or her address, (where she or he could be found). “Address” would represent habitat. To “know” the person, however, one would want to know something about his or her occupation, interests, associates, and role in community life.

All this information would be analogous to that person’s niche. Thus, in the study of organisms, learning the habitat is just the beginning. To determine the status of the organism within the natural community, one would need to know something of its activities, especially its nutrition; energy sources and resource partitioning; relevant population attributes, such as intrinsic rate of increase and fitness; and finally, the organism’s effect on other organisms with which it comes into contact, and the extent to which it modifies or can modify important operations in the ecosystem.

In a classic investigation in the history of ecology, Mac Arthur (1958) compared the niches of four species of American warblers (Parulidae) that all breed in the same macrohabitat (a spruce forest) and all feed on insects but forage and nest in different parts of the spruce tree. MacArthur constructed a mathematical model, which consisted of a set of competition equations in a matrix from which competition coefficients were calculated for the interaction between each species and any of the other three.

Thus, niches of similar species associated together in the same habitat can be precisely compared when only a few operationally significant measurements are involved. Two species proved especially competitive, so that if either were absent, the other might be expected to move into the vacated niche space.

## Difference Between Habitat and Niche

| BASIS FOR COMPARISON | HABITAT | NICHE |
|---|---|---|
| Meaning | A habitat is an area, where a species lives and interact with | A niche is an ideology, of how an organisms lives or survive in the |

| BASIS FOR COMPARISON | HABITAT | NICHE |
|---|---|---|
| | the other factors. | provided environmental conditions. |
| Consist of | Habitat consist of numerous niches. | Niches does not contains such components. |
| It includes | Affect of temperature, rainfall and other abiotic factors. | Flow of energy from one organisms to other through ecosystem. |
| Examples | Desrets, oceans, forest, rivers, mountains, etc. are examples of habitat. | It is a part of habitat only, where shelter for living being can be furnished. |
| Supports | Habitat supports numerous species at a time. | Niche supports a single species at a time. |
| What it is | Superset | Subset |
| Nature | Habitat is a physical place. | Niche is an activity performed by organisms. |
| Specificity | Habitat is not species specific. | Niche is species specific. |

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## Types of Ecological Niches

Ecologist Charles Elton's definition of niche focused on the role of a species, such as its trophic role. His tenets emphasized more on community similarity and less on competition.

In 1957, Zoologist G. Evelyn Hutchinson provided a sort of compromise of these trains of thought. Hutchinson described two forms of niche. The **fundamental niche** focused on the conditions in

which a species could exist with no ecological interactions. The **realized niche**, in contrast, considered the population's existence in the presence of interactions, or competition.

The adoption of the ecological niche concept has allowed ecologists to understand the roles of species in ecosystems.

## Importance of Ecological Niches

Ecologists use the concept of the ecological niche to help understand how communities relate to environmental conditions, fitness, trait evolution and predator-prey interactions in communities. This becomes ever more important as climate change affects community ecology.

Ecological niches allow species to exist in their environment. Under the right conditions, the species will thrive and play a unique role. Without the ecological niches, there would be less biodiversity, and the ecosystem would not be in balance.

**Interspecies competition:** Ecologists refer to *coexistence* when describing ecological niches. Two competing species cannot exist in one ecological niche. This is due to limited resources.

*Competition* affects the fitness of species, and can lead to evolutionary changes. An example of interspecies competition is an animal that forages for pollen or nectar from a specific plant species, competing with other such animals.

In the case of some species of ants, the insects will compete for nests and prey as well as water and food.

**Competitive exclusion principle:** Ecologists use the competitive exclusion principle to help understand how species coexist. The competitive exclusion principle dictates that two species cannot exist in the same ecological niche. This is due to competition for resources in a habitat.

Early champions of the competitive exclusion principle were Joseph Grinnell, T. I. Storer, Georgy Gause and Garrett Hardin in the early and mid 20th century.

Competition in a niche either leads each species to specialize in a different way, so as not to use the same resources, or leads one of the competing species to become extinct. This is another way of looking at natural selection. There are two theories used to address competitive exclusion.

In ***R**** **Theory**, multiple species cannot exist with the same resources unless they differentiate their niches. When resource density is at its lowest, those species populations most limited by the resource will be competitively excluded.

In ***P**** **Theory**, consumers can exist at high density due to having shared enemies.

Competition plays out even at the microbial level. For example, if *Paramecium aurelia* and *Paramecium caudatum* are grown together, they will compete for resources. *P. aurelia* will eventually overtake *P. caudatum* and cause it to go extinct.

UNIT 3

# MAJOR ECOSYSTEMS

## Structure



## 3.1 INTRODUCTION

In the previous units you have studied about ecosystem and its structure. As you know the world itself is very vast, and it represents a big ecosystem called biosphere. The word ecosystem is made up of “eco” and “system”. Eco means the habitat, and system means a complex set of interconnected components, both living and non-living. Here system also indicates a functional property and hence an ecosystem can be considered as a functional unit of nature.

Ecosystems can be broadly divided into two main categories: terrestrial and aquatic. Major terrestrial ecosystems include forests, grasslands and deserts while lakes, rivers, oceans, estuaries and wetlands are collectively known as aquatic ecosystems. In this unit we will discuss various types of terrestrial and aquatic ecosystems. Besides, you will also study about the importance of the forests, grasslands and aquatic ecosystems.

## Expected Learning Outcomes

After completing the study of this unit, you should be able to:

- differentiate between the major types of terrestrial ecosystems such as grasslands, forests and deserts;
- describe general features and biota of grasslands, forests and deserts;
- describe importance of forests to human welfare;
- describe aquatic ecosystems and distinguish between freshwater ecosystems, marine ecosystems and estuaries; and
- explain the difference between the biota of lakes, rivers and marine ecosystem.

## 3.2 FOREST ECOSYSTEM

Now let us see as to what a forest is. The word forest is derived from the Latin word 'foris' meaning outside, the reference being to village boundary fence that must have included all uncultivated and uninhabited land. Today a forest is any land managed for the diverse purpose of forestry, whether covered with trees, shrubs and climbers or not. The forest ecosystem includes a complex assemblage of different kinds of biotic communities. The nature of soil, climate and local topography determine the distribution of trees and their abundance in the forest vegetation. Characteristics of different types of forests (Fig. 3.1) are described below:

The term taiga is applied to the northern range of coniferous forests.

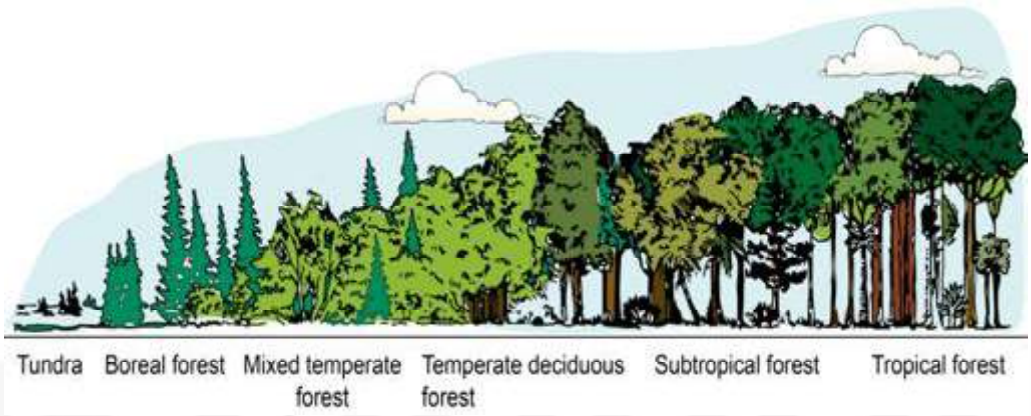


**Fig. 3.1: Types of forests**

i) **Coniferous forest:** Cold regions with high rainfall and strongly seasonal climates with long winters and fairly short summers are characterised by boreal coniferous forest which is transcontinental. These forests are characterised by evergreen plant species such as spruce. (*Picea glauca*), fir (*Abies balsamea*) and pine trees (*Pinus roxburghii / Pinus strobes*) and by animals such as the lynx, wolf, bear, red fox, porcupine, squirrel, and amphibians like tree frogs and pond frogs.

The litter resultant from conifer needles is broken down very slowly and is not particularly rich in nutrients. These soils are acidic and are mineral deficient. The productivity and community stability of boreal forests are lower than those of any other ecosystem.

ii) **Temperate deciduous forest:** The temperate forests are characterised by a moderate climate and broad-leafed deciduous trees, which shed their leaves in winter and grow new foliage in the spring. These forests are characteristic of North America, Europe, Eastern Asia (including China and Japan), Chile and part of Australia with a cold winter and an annual rainfall of 75-150 cm. The precipitation may be fairly uniform throughout year.

Trees are quite tall about 40-50 m in height and their leaves are thin and broad. The predominant genera of this biome are maple (*Acer*), beech (*Fagus*), oak (*Quercus*), hickory (*Carya*), basswood (*Tilia*), chestnut (*Castanea*), and cottonwood (*Populus*). In Himalayas, the temperate vegetation includes pines, cedars (*Cedrus*), fir and juniper trees along with rhododendrons and willow (*Salix*).

The common animals are deers, bears, squirrels, gray foxes, bobcats, wild turkey and woodpeckers. Common invertebrates include earthworms, snails, millipedes, coleoptera and orthoptera. Vertebrates include amphibians such as toad, salamander, cricket and frog, reptiles such as turtle, lizard and snake, mammals such as racoon, opossum, pig and mountain lion, and birds like horned owl and hawks.

The flora of tropical rain forest is highly diversified: a sq. km area may contain 300 different species of trees - a diversity unparallel in any other ecosystem. The extremely dense vegetation of the tropical rain forests is vertically stratified with tall trees often covered with vines, creepers, lianas, epiphytic orchids and bromeliads. Under the tall trees there is a continuous evergreen carpet, the canopy layer, some 25 to 35 metres tall. The lowest layer is an understory of trees, shrubs, herbs, ferns and palms, all of which become dense where there is a break in the canopy.

iii) **Temperate evergreen forest:** Many parts of the world have a mediterranian type of climate which is characterised by warm, dry summers and cool, moist winters. These are commonly inhabited by low evergreen trees having needle-like or broad leaves. These include hemlock, yew and maple .Shrubs may range up to 3-4m in height. The characteristic animals of temperate evergreen woodland chaparral are mule, deer, brush rabbit, wood rat, chipmunk and lizard.

iv) **Temperate rain forest:** The temperate rain forests are colder than any other rainforest and exhibit a marked seasonality with regard to temperature and rainfall. Rainfall is high, but fog may be very heavy which may actually represent a more important source of water than rainfall itself. The diversity of plant and animals is much low as compared to their warmer counterparts.

v) **Tropical rain forest:** Tropical rain forests occur near the equator, and are among the most diverse communities on the earth. Both temperature and humidity remain high and more or less uniform. The annual rainfall exceeds 200 cm and is generally distributed throughout the year.

The common vertebrates of tropical rain forests are the arboreal amphibian *Rhacophorus malabaricus*, aquatic reptiles, chameleons, agamids, geckos, many species of snakes and birds, and a variety of mammal such as leopard, jungle cats, ant-eaters, giant flying squirrels, monkeys and sloths.

vi) **Tropical seasonal forest:** Tropical seasonal forests occur in regions where total annual rainfall is very high but segregated into pronounced wet and dry periods. In exceedingly wet tropical seasonal forests, commonly known as monsoon forests, the annual precipitation may be several times that of the tropical rainforests. Teak is often a major large tree in the best known tropical seasonal forests of India (central India) and South East Asia. Bamboo is also an important climax shrub in these areas.

vii) **Subtropical rain forest:** In regions of fairly high rainfall but less temperature difference between winter and summer, broad-leaved evergreen subtropical forest is found. The vegetation includes mahogany, palms, oaks, magnolias and tamarind, all laden with epiphytes (of Pineapple and orchid families), ferns, vines and strangler fig. (*Ficus aureus*). Animal life of subtropical forest is very similar to that of tropical rainforests.

**Importance of Forest**

For humans, forests have been a source of multiple products, services and recreation, and basis of the development of culture and civilisation. Apart from

the source of fuel wood, they provide raw materials to various wood industries like pulp and paper, composite wood, rayon and other man-made fibres, matches, furnitures, shuttles and sport goods. Indian forests also provide many other minor products such as essential oils, medicinal plants, resins and turpentines , lac and shellac, katha and catechu, bidi wrappers and tasser silk. Forests have great biological importance as reservoirs of genetic diversity apart from playing an important role in regulating earth's climate.

Forests provide habitat, and food as well as protection to wildlife species. Forests enhance local precipitation and improve water holding capacity of soil, regulate water cycle and maintain soil fertility by returning the nutrients to the soil through litter. Forests check soil-erosion, landslides and reduce intensity of flood and droughts. Forests, being home of wildlife are important assets of aesthetic, touristic and cultural value to the society.

**Forest Conservation**

Urbanization, expansion of agriculture and extraction of timber pose serious threats to forest worldwide. Certain forest conservation and management processes have to be employed in the forests to maintain them. To get the desired quality of timber or pulp for paper industry, monoculture forests of fast growing trees such as poplars, certain conifers and eucalyptus have been cultivated by human. Existing forests are strongly manipulated in order to increase their yield of desired benefits. It includes weeding (the elimination of species which might compete with the seedlings of the desired species), thinning (eradication of individuals of the same species) and brashing (removal of leafless lower branches especially in conifers). Forest Management also includes the controlling of forest fire. Silviculture is a branch of forestry which is concerned with the establishment, development, care and reproduction of monocultures of valuable timber trees such as teak, sal, sheesham and kel.

We will discuss in detail about all the above and issues related to forest in Unit 5 titled Forest Resources.

## SAQ 1

a) Fill in the blanks and complete the following statements :

   i) The forest biomes comprise a complex assemblage of different kinds of ……..

   ii) Forests may be evergreen or ……..

   iii) Tropical rain forests occur near the ……..

b) What are the direct and indirect services provided by forest to us?

c) Write the major difference between temperate deciduous forest and temperate evergreen forest.

## 3.3 GRASSLAND ECOSYSTEM

The grassland ecosystem is found where rainfall is about 25-75 cm per year, not enough to support a forest, but more than that of a true desert. Typical grasslands are vegetation formations that are generally found in temperate climates. The grass layer is sparse and consists mainly of annual grass species.

The major difference between steppes and savannas is that all the forage in the steppe is provided only during the brief wet season whereas in the savannas forage is largely from grasses that not only grow during the wet season but also have a smaller amount of regrowth in the dry season.

In arid to semi-arid tracts, active growth of vegetation is triggered each year by the advent of the monsoon during June or early July. The biomass increases to its peak value around September to October. Fruiting is completed by November and subsequently the plants dry up. In subtropical parts of India which receive winter rains, there is usually a second flux of growth in December and January.

In the central and eastern parts of Rajasthan, where the rainfall is about 500 mm per year and the dry season is of six to eight months, dry savanna grazing ecosystems have developed. The light shade cast by the sparse population of trees like *Prosopis cineraria* favours the growth of the grasses which in the best-watered areas can reach up to a height of 100 to 120 cm.

**Economic Importance**

India with just 2.4 per cent of the total land area of the world supports more than half of the buffaloes, 15 per cent of cattle, 15 per cent of goats and 4 percent of sheep. The livestock wealth plays a crucial, role in Indian life. It is a major source of fuel, draught power, nutrition and raw material for village industries

Grassland ecosystems are important to maintain many domesticated and wild herbivores such as horse, mule, ass, cow, pig, sheep, goat, buffalo, camel, deer and zebra which provide food, milk, wool, hide or transportation to humans.

Overgrazing has harmful ecological effects. The mulch cover of the soil is reduced, microclimate becomes drier and the place is readily invaded by xerophytic plants. Due to absence of humus cover, mineral soil surface is heavily trampled when wetness produces puddling of the surface layer, which in turn reduces the infiltration of water into the soil and accelerates its run off.

Thus, you can realise the importance of the grassland and now after having read about this ecosystem you would like to know what desert biome is and where it occurs? But before that you try SAQ.

## SAQ 2

a) Discuss the importance of grassland ecosystem.

b) What are the harmful effects of overgrazing on the area?

## 3.4 DESERT ECOSYSTEM

Deserts are formed in regions with less than 25 cm of annual rainfall, or sometimes in hot regions where there is more rainfall, but unevenly distributed

in the annual cycle (Fig. 3.2). Deserts in temperate regions often lie in “rain shadows”, that is, where high mountains block off moisture from the sea. These areas thus receive meagre rainfall and along with low rainfall there are fluctuations in temperature.

Deserts are found in Australia, Arabia, Turkestan and Argentina. Thar desert in Western India and Pakistan, Gobi desert of Mongolia, and Sinai desert of Egypt are also well known deserts

**Fig. 3.2: Desert Ecosystem**

The perennial plant species like creosote bush (*Larrea*), organ pipe cactus, ferrocactus and spurges (*Euphorbia*) are scattered throughout the desert ecosystem. In shallow depressed areas with salt deposits sarcobatus, geesewood, seepwood and salt grasses are common. The annuals, wherever present, germinate, bloom and reproduce only during the short rainy season, and not in summer and winter. This is an adaption to desert condition.

Animals such as reptiles and some insects are adapted to deserts, because their impervious integuments and dry excretions enable them to get along on the small amount of water. A few species of nocturnal rodents, for example, excrete very concentrated urine and do not use water for temperature regulation, and can live in the desert without drinking water. Other animals such as camel must drink periodically but are physiologically adapted to withstand tissue dehydration for appreciably long periods of time.

Because water is the dominant limiting factor, the productivity of any desert is almost directly dependent on the rainfall. Where soils are suitable, irrigation can convert deserts into some of our most productive agricultural land. Whether productivity is continuous or is only a temporary ‘bloom’ depends on how well human is able to stabilise biogeochemical cycles and energy flow at the increased irrigation rates.

Among reptiles there occur two species of testudines (*Loricata*), 18 species of lizards, and 18 species of snakes. Of the lizards, some species like *Calotes versicolor* and *Uromastyx hardwickii* are predatory on the desert locust inhabiting localised areas in Thar desert. Among predominant predatory birds are two species of vultures,namely, White-rumped vulture (*Gyps bengalensis*) and the White scavenger vulture, *(Neophron percnopterus*).

The mammalian fauna of Indian deserts (Box 3.1) includes many species, some of which are rat-tailed bat, longer hedgehog, Indian hairy-footed gerbil, wild boar, jungle cat and panthers.

**Box 3.1: Case study: Indian Desert**

The Indian desert is one of the most heavily populated desert regions of the world. According to 2011 census, population densities vary from 361 in Jhunjhunu to 17 persons/km$^2$ in Jaisalmer district. The settlement patterns are entirely compact or entirely spread.Villages are both with compact settlements and spread homesteads (dhanis). Rural people live in hamlets, small villages and dhanis or homesteads. The desert society has multitude of caste and sub-castes. By and large villages where some powerful local chieftains resided and constructed fortresses, developed into towns, which became local trade centres. The settled population in villages is mostly agro-pastoral. About three-fourth of total workers in desert are engaged in cultivation and as agricultural labour. Animal husbandry is followed as supplementary occupation.

Total livestock population recorded an increase of 9.8 million during 1956 to 1981. During 1972-1983 livestock population increased by more than 42 per cent. The enormous increase in human and livestock population has been depleting the natural resources at rapid rate.

# SAQ 3

Tick mark the correct answer in the following statements.

a) Which animal drinks water periodically and is physiologically adapted to withstand tissue dehydration for long period?

   i) Lion

   ii) Tiger

   iii) Camel

   iv) Elephant

b) Which biome experiences intense heat and strong wind with a great desiccating action during April to June?

   i) Tundra biome

   ii) Desert biome

   iii) Forest biome

   iv) Grassland biome

c) On which animal *Calotes* and *Uromastyx* are predatory in Thar desert

   i) desert locust

   ii) desert gerbil

   iii) desert dragon flies

   iv) desert snakes

# 3.5 AQUATIC ECOSYSTEM

Global waters cover about three-quarters of the earth's surface, either as fresh water where salt content is less than 0.5 per cent or as saline water where the salt content is more than 3.5 per cent, or as brackish water where salt content is intermediate between fresh water and saline water. Because of their salt content estuaries and oceans bear different kinds of organisms .It is on this basis, that aquatic ecosystems are categorised into: (i) **Fresh water ecosystems**- lakes, ponds, swamps, pools, springs, streams, and rivers;(ii) **Marine ecosystems** - shallow seas and open ocean; (iii) **Brackish water ecosystems-** estuaries, salt marshes, mangrove swamps and forests.

## 3.5.1 Aquatic Organisms

The organisms in the aquatic ecosystem are unevenly distributed but can be classified on the basis of their life form or location into five groups as shown in Fig. 3.3.The five groups are given as under:

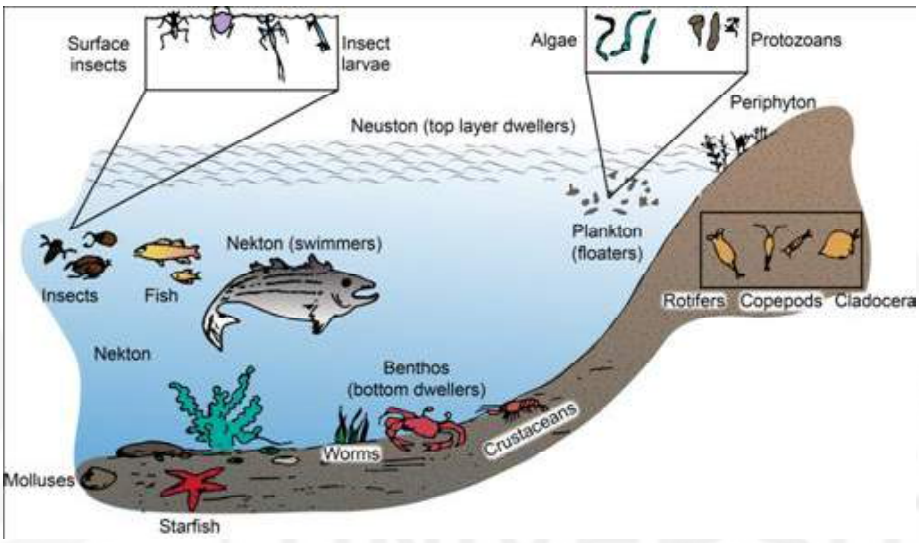


**Fig 3.3: Life Styles of Aquatic Organisms**

i) **Neuston:** These are unattached organisms which live at the air-water interface such as floating plants and several types of animals (see Fig. 3.3). Some spend most of their lives on top of the air-water interface, such as water striders, while other spend most of their time just beneath the air-water interface and obtain most of their food within the water, e.g., beetles and back-swimmers.

ii) **Periphyton:** These are organisms which remain attached or clinging to stems and leaves of rooted plants or substances emerging above the bottom mud (Fig.3.3). Usually sessile algae and their associated group of animals fall in this group.

iii) **Plankton:** This group includes both microscopic plants, chiefly algae (phytoplanktons) and animals, primarily crustaceans and protozoans (zooplanktons) found in all aquatic ecosystems, except certain swift moving water. The locomotory power of the planktons is limited so that their distribution is controlled largely by currents in the aquatic ecosystems. Most phytoplanktons and zooplanktons are capable,

however, of at least some movement.

iv) **Nekton:** This group contains animals which are swimmers. The nektons are relatively large and powerful as they have to overcome the water currents (see Fig. 3.3). The animals range in size from the swimming insects, which may be only about 2 mm long, to the largest animals that have lived on earth, namely the blue whale.

v) **Benthos:** The benthos or the benthic organisms are those found living in or on the bottom or benthic region of the water mass (Fig. 3.3).They exhibit a variety of adaptations to the environment since the bottom is a more heterogeneous habitat than either the open water or the surface. Benthos includes crabs, lobsters and sponges.

## SAQ 4

Match the terms used for defining groups of aquatic organisms given in column A with their definitions given in column B.

| Column A | | Column B | |
|---|---|---|---|
| i) | Neuston | a) | The group of plants and animals which are found living in or on the bottom of an aquatic ecosystem. |
| ii) | Nekton | b) | Plants or animals that cling to rooted water plants above the bottom mud. |
| iii) | Benthos | c) | Animals and plants of minute size which float in the aquatic ecosystems, seas, rivers, ponds and lakes. These organisms are incapable of independent movement and depend on water currents for movement. |
| iv) | Plankton | d) | Aquatic animals that swim strongly and are able to overcome water currents. |
| v) | Periphyton | e) | Organisms associated with the surface film of water. |

### 3.5.2 Freshwater Ecosystem

Fresh water ecosystem depends on the terrestrial ecosystems for large quantities of organic and inorganic matter which are constantly added into them by the communities growing on nearby land.

The fresh water ecosystems can be conveniently divided into two main divisions:

i) Lentic (from 'lenis', calm) or standing or basin series ecosystems. Examples of this division are lakes, pools, ponds, swamps and marshes.

The largest lake in the world, the lake Superior in North America has a surface area of 83,000 $km^2$ and a maximum depth of 307 metres. The deepest lake, in the world, Lake Baikal in Siberia is nearly half the area of Lake Superior, i.e., 31,500 $km^2$. It has, however, more than twice its depth (706 metres).

Some lakes are formed in crater depressions of extinct volcanoes and are called crater lakes. Lakes may also arise by landslides blocking off streams and valley. Lakes are not evenly distributed on the earth but are grouped in certain regions called 'lake districts'

ii) Lotic (from 'lotus', washed) or running or channel series ecosystems. Examples of this division are rivers, streams and springs.

These two fresh water ecosystems have been described in the following sections.

Lakes are inland, depressions containing standing water. They vary considerably in area and depth.

Fresh water lakes of this earth hold $125 \times 10^3 m^3$ of water and have inflow as well as outflow. In addition they have various patterns of circulation within their boundaries and so their water is not totally static. However, they do lack the constant linear or turbulent flow characteristic of the rivers.

**Lakes, Impoundments and Wetlands**

Lentic ecosystems include all those systems which have a static body of water. Lakes (Fig. 3.4) (Box 3.2), impoundments and wetlands are all lentic ecosystems. Let us see how they differ from each other.

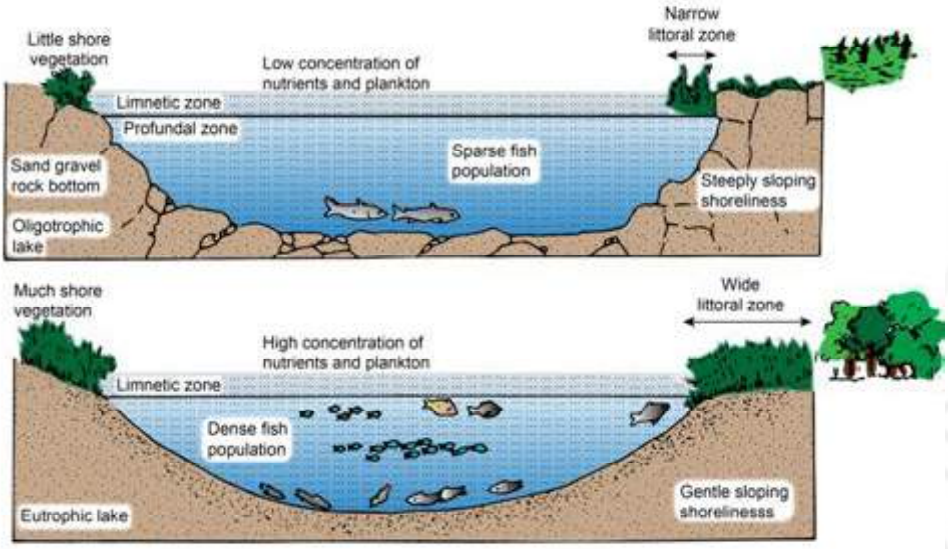


**Fig. 3.4: Lake and its biota.**

**Lakes:** Most lakes occur in regions which have recently been subjected to geological changes, say within the past 20,000 years. However, a few lakes, such as lake Baikal in Russia and Lake Tanganyanitia in Africa are ancient and are estimated to have originated twenty million years ago.

**Box 3.2: Case Study: Loktak Lake**

Loktak Lake (Fig 3.5) is situated 38 km south of Imphal city, the capital of Manipur State. The lake covers an area of about 286 sq. km .Main water body of the lake is surrounded by shallow water, which stagnates over a marsh/swamp land.

The characteristic feature of the Loktak Lake is the presence of floating islands known as Phumdis. These are heterogeneous masses of soil vegetation and organic matter, which occur in all sizes from a few centimeters to about 2.5 m. They occupy about two-third of the surface area of the lake.

Free-floating plants, such as water hyacinth and partly decomposed roots and rhizomes contribute greatly to its development. The largest single mass of phumdis occupying an area of 40 sq. km constitutes Keibul Lamjao National Park.

**Fig.3.5: Loktak Lake with phumdis.**

A number of streams originate from the hill ranges immediately to the west of the lake and these streams flow directly into Loktak Lake. The indirect catchment area covers catchments of five important rivers i.e. Imphal, Iril, Thoubal, Sekmai and Khuga and is spread over an area of 7157 sq. km.The Lake has been the source of water for generation of hydroelectric power, irrigation and water supply. A large population living around the lake depends upon the lake resources for sustenance. The staple food of Manipur is directly linked to Loktak Lake. The lake is rich in biodiversity and was designated as a wetland of international importance under Ramsar Convention in 1990. The Keibul Lamjao National Park, in the southern part of the lake, is home to the endangered Manipur brow, antlered deer (*Cervus eldi eldi*), locally called Sangai. The lake has been also the breeding ground of a number of riverine fishes and continues to be a vital fisheries resource. It supports a significant population of migratory and resident waterfowl.

**Impoundments:** They may be called offstem or onstem depending on how these have been created. Onstem reservoirs – these are located in upland areas and are formed by damming a stretch of river or stream in a suitable river valley. In India only these types of impoundments are found. Offstem reservoirs are built in low land areas by pumping water some distance from a river or from an underground source.

**Fig. 3.6: Wetland.**

**Wetlands:** Wetlands are permanently or periodically water covered areas (Fig. 3.6, Box 3.3). They can be defined as submerged or saturated lands either artificially created or natural, and either periodically or permanently covered up to a depth of six metres by water which may be fresh, brackish or saline.

The wetlands may be classified into two categories:

I. Inland wetlands occur when inland is surrounded by land and contain fresh water, e.g. bogs and swamps.

II. Coastal wetlands occur near the coast and contain saline or brackish waters, e.g. mangrove swamps, mangrove forests.

**Box 3.3: Case Study: Threats to wetlands in Assam**

Almost 40% of all wetlands in Assam are under threat. A survey conducted by the Assam Remote Sensing Application Center (ARSAC), Guwahati, and the Space Applications Centre, Ahmedabad has revealed that 1367 out of 3513 wetlands in Assam are under severe threat due to the invasion of aquatic weeds and several developmental activities. The wetlands of Assam form the greatest potential source of income for the state in terms of fisheries and tourism. Though the wetlands of Assam have the capacity of producing 5,000 t/ha/yr of fish, around 20,000 t of fish has to be imported to meet local demand. This is primarily due to poor wetland management.

### 3.5.3 Lotic Ecosystems – Rivers

The lotic or flowing water habitats include rivers, streams and brooks. The most outstanding features of such habitat is the continuously flowing water which moulds the characteristics of the water bed and influences the distribution of organisms within.

The two most important features are:

1) Rivers are open or heterotrophic systems, whereas lakes are closed or self contained systems except for some gains or losses from inflowing or outflowing streams;

2) Nutrients in a lake may be used several times, whereas in rivers, at any point, plants and animals must avail of temporarily available nutrients.

**Biota of Rivers**

The biota of both the rapidly flowing and the slowly flowing sections of the river are very distinct. Let us study the biota characteristic of river.

a) **Animals:** In the exposed rock surface habitats only those organisms are found which have efficient mechanisms for staying in one place. These include fresh water limpet, larvae or water penny (riffle beetles), fresh water sponges and caddis flies.

The microhabitat formed in the spaces between rock fragments is slightly sheltered. Here stone fly and dragonfly both of which are flattened and have behavioural adaptations to hold them in place (i.e. clinging by instinct to hard surface and orienting themselves along the current) are found

In the microhabitat beneath rocks, where current is a weak, animal such as annelids, flatworms, clams, some snail species and other insect larvae are found.

In the rapidly flowing habitat, nekton occurs only in areas where current is not too strong and include cold water fish species such as trout or salmon. In areas where the current is very strong nekton are absent and in such cases, the benthos may be many and varied and may form the entire community.

b) **Plants:** Among the plants only small, well attached forms, such as sessile algae can survive here. Thus, due to the presence of only a few plants, the nutrient base for animals here is organic detritus washed into the river from the drainage area.

## 3.5.4 Marine Ecosystems

A marine ecosystem is the largest and most stable system on the earth and is of great ecological significance. The sea water is salty with an average 3.5%. Sodium chloride (NaCl) is 27% of the salt while rest other important minerals are calcium, potassium and magnesium. An important factor in limiting the production and distribution of marine life is light. Temperature remains almost constant in ocean ranging from 2°C in polar region to 32°C or more in tropics.

The marine habitat is distinguishable into two different zones:(1) Benthic zone – which forms the basin or floor of the ocean, regardless of depth; (2) Pelagic zone – which represents the free water zone, filling the basin (see Fig. 3.7).

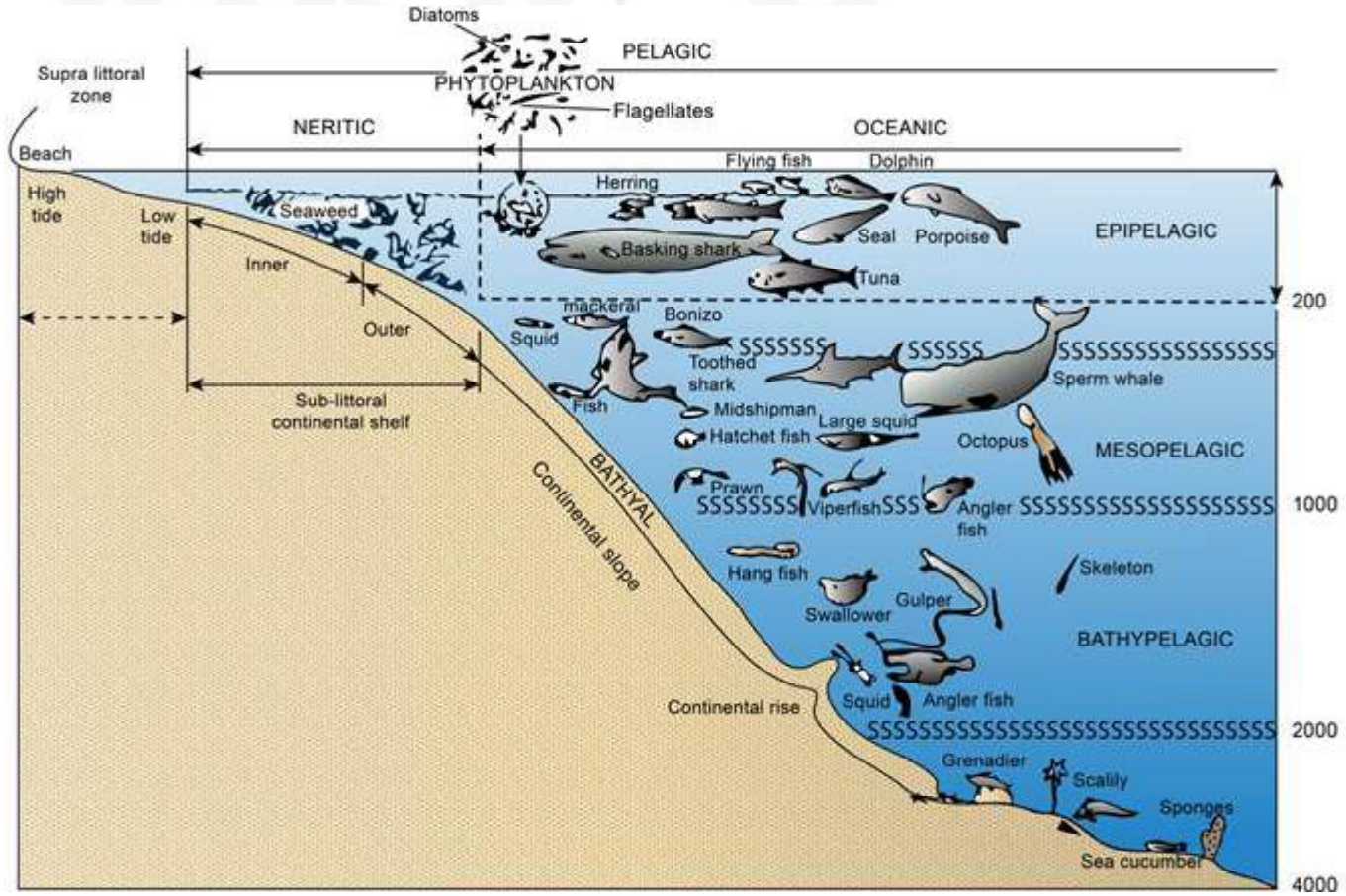


**Fig 3.7: Major regions of the ocean.**

### Biota of Oceans

Life in the sea is not particularly abundant, though the diversity of organisms is high. Almost every major group of animals and every major group of algae occur somewhere in the oceans, with the exception of vascular plants and insects. On the basis of depth-wise differences in life forms, the expanse of marine ecosystems has been divided into littoral, neritic, pelagic and benthic zones. Let us now read about biota of each one of these.

i) **Biota of Littoral Zone:** This zone is the shore region of the marine ecosystems and is subject to violence of waves and tides, fluctuation of water level and variability of temperature, light, salinity and moisture. In common language supra littoral zone is termed as a beach. There are few species of plants present in this zone.

Common animals found here are snails, clams, barnacles, crustaceans, annelids, sea anemones and sea urchin. The animals here exhibit zonation with respect to tides. Animals more resistant to desiccation usually occurring at higher levels than those that are less resistant.

ii) **Biota of the Neritic Oceanic Zone:** This relatively shallow, coastal zone is rich in species and high in productivity owing to factors such as penetration of light to considerable depths and high concentrations of nutrients.

The most productive phytoplanktons are the dinoflagellates and diatoms, though red, brown and green algae attached to the bottom in the shallow regions may be significant. The zooplanktons are usually similar to those of the pelagic zone though some purely open-sea species are replaced by neritic species.

Almost all commercial species of fish as well as whales, seals, sea-otters, sea snakes and large squids are found here. Fishes are numerous and include several shark species as well as sea trout and salmon.

A wide variety of animals among which are clams, shrimps, snails, lobsters, crabs, sea cucumber, starfish, brittle stars, anemones, sponges, bryozoa, annelids and foraminifera and exhibits more diversity than those of the deeper waters.

iii) **Biota of Pelagic Zone:** Pelagic region constitutes 90 per cent of the total ocean surface and is less rich in species and numbers of organisms than the two regions discussed before.

The most abundant pelagic phytoplanktons are still the dinoflagellates and diatoms which are the chief photosynthetic feeders, others are carnivores. Sea cucumbers and sea urchins crawl on the floor eating detritus and bacteria and serve as food for the carnivorous brittle stars and crabs.

iv) **Biota of Benthic Zone :** It forms the floor of the ocean. Organisms here are hetrotrophic Rooted animals are sea lilies, sea fan, sponges etc. Snails and clams remain embedded in mud while starfish, sea cucumbers and sea urchins move on its surface.

### 3.5.5 Estuaries

All the rivers and lakes ultimately drain into the sea. However, many rivers develop a highly specialized zone before joining the proper sea. This zone is called estuary. An estuary is a transitional zone between rivers and sea representing unique ecological features and biotic communities. Estuaries are the most productive ecosystems of the world. An estuary is semi-enclosed part of the coastal ocean containing brackish water that has free connection with the sea on one side and on the other side it is connected with a river mouth and receives fresh water. In India, estuaries can be seen in plenty along the coast of Kerala or in Sunderbans.

Eustuary is a very important food source and almost all the major marine fisheries of the world are totally dependent on the estuaries for their continuance, because the adult fishes often resort to estuaries for laying eggs, i.e., spawning.

**Features of Estuaries**

The most dominant feature of the estuarine environment is the fluctuation in salinity. Though salinity gradient exists sometime in an estuary but the pattern of gradient varies seasonally, with the topography, with the tides and with the amount of fresh water.

**Biota of Estuaries**

The estuarine community is a mixture of three components: Marine, Fresh water and Brackish water, but overall estuarine diversity is still lower than that of the river or marine community. This is because of tremendous variation in the estuary's physical environment. Thus, the great productivity of estuaries is built on a narrow base.

The plants of the estuary are of four basic types: (i) Phytoplankton; (ii) marginal marsh vegetation; (iii) mud-flat algae; (iv) epiphytic plants growing on the marginal marsh vegetation. Diatoms and filamentous blue-green algae found in high number are the sites of intense photosynthesis. Oysters, crabs and some sea shrimps are also found.

## SAQ 5

State whether the following statements are true or false :

a) The estuaries are characterised by high salt content in their substratum.

b) The estuaries do not support large organisms.

c) The estuaries are the most productive ecosystem of the biosphere.

d) Estuaries are a nursery ground for a large number of fishes.

## 3.6 SUMMARY

- Forests occupy approximately 40% of the land. The forest biomes can be classified as coniferous forest, temperate deciduous forest, temperate evergreen forest, temperate rain forest, tropical rain forest, tropical seasonal forest, sub-tropical forest etc.
- Grassland ecosystems are found where rainfall is about 25-75 cm every year. Grassland ecosystems are important to maintain the crop of many

domesticated and wild herbivores such as horses, buffaloes, camels, deers, zebras which provide food, milk, wool, leather, transportation to man.

- Desert ecosystems are found in the regions where rainfall of less than 25 cm.
- Ecosystems consisting of water as the main habitat are known as aquatic ecosystems. There are three kinds of aquatic ecosystems – fresh water, saline and brackish water ecosystems.
- Fresh waters are again of two types. The static water ecosystems are called as lentic systems and are exemplified by various lakes impoundments and wetlands. The lotic systems are characterised by flowing water and are exemplified by rivers.
- Rivers are main channels which supply surplus rainwater from land to sea. Each river has a slow moving and a fast moving zone. In slow moving one main factor limiting the growth of organisms is the availability of dissolved oxygen. In the fast moving waters the speed of water current is the main factor limiting the growth.
- Saline ecosystems comprise all the oceans of the world and contain a major portion of the total biomass of the earth. Oceans are also the main reservoir of air and water vapour in the atmosphere.
- Estuaries are examples of brackish water ecosystems. Their salt content varies seasonally. They are the most productive ecosystems of the world. They are also the most delicately balanced ecological systems, because the factors governing the functions of estuarine ecosystems are intricately dependent upon each other. One should be careful before deciding to dump garbage, sewage or industrial wastes into such ecosystems.

## 3.7 TERMINAL QUESTIONS

1. Describe the importance of forests in our life.
2. Describe how desert plants and animals adapt themselves to the conditions present in desert.
3. Discuss the economic importance of grassland ecosystem.
4. Discuss which is the most dynamic ecosystem in your view and why.
5. Give a brief account of marine and estuarine ecosystem.

## 3.8 ANSWERS

### Self-Assessment Questions

1. a) i) Biotic communities, ii) Deciduous, iii) Equator

   b) See Section 3.2 Importance of forest.

   c) See Section 3.2. types of forest

2. a) See Section3.3 Grassland Ecosystem

   b) See Section 3.3 Grassland Ecosystem - Economic importance

3. c, 2. b, 3. a

4. i) e, ii) d, iii) a, iv) c, v) b

5. a) T, b) F, c) T, d) T

## Terminal Questions

1. See Section 3.2 Importance of forest.
2. See Section 3.4 Desert ecosystem.
3. See Section 3.3 Grassland ecosystem.
4. Describe the ecosystem which you find is most dynamic in your view and support your answer
5. See Section 3.5.4 Marine ecosystem.

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**Acknowledgement of Figures**

1. Fig. 3.2 : Desert Ecosystem https://en.wikipedia.org/wiki/Desert_ecology #/media/File:Algeria_Sahara_Desert_Photo_From_Drone_5.jpg
2. Fig. 3.5 : Loktak Lake: www.flamingotravels.com/image/loktak_big.jpg

# New Ecological Paradigm (NEP) Scale

*The New Ecological Paradigm scale is a measure of endorsement of a "pro-ecological" world view. It is used extensively in environmental education, outdoor recreation, and other realms where differences in behavior or attitudes are believed to be explained by underlying values, a world view, or a paradigm. The scale is constructed from individual responses to fifteen statements that measure agreement or disagreement.*

The New Ecological Paradigm (NEP) scale, which is sometimes referred to as the revised NEP, is a survey-based metric devised by the US environmental sociologist Riley Dunlap and colleagues. It is designed to measure the environmental concern of groups of people using a survey instrument constructed of fifteen statements. Respondents are asked to indicate the strength of their agreement or disagreement with each statement. Responses to these fifteen statements are then used to construct various statistical measures of environmental concern. The NEP scale is considered a measure of environmental world view or paradigm (framework of thought).

## History of the NEP

The roots of the NEP are in the US environmental movement of the 1960s and 1970s, inspired by the publication of Rachel Carson's *Silent Spring*. Social psychologists hypothesized that the prevailing world view of the population, called the dominant social paradigm (DSP), was changing to reflect greater environmental concern. Developing valid and reliable measures of the environmental world view would help scholars better understand the trajectory of these changes and their relationship to demographic, economic, and behavior change in the US population.

Among the various efforts to measure such change, Riley Dunlap and colleagues at Washington State University developed an instrument they called the New Environmental Paradigm (sometimes called the original NEP), which they published in 1978. The idea was that this instrument could measure where a population was in its transition from the DSP to a new, more environmentally conscious world view, a change that the NEP scale developers thought was likely to happen. The original NEP had twelve items (statements) that appeared to represent a single scale in the way in which populations responded to them.

The original NEP was criticized for several shortcomings, including a lack of internal consistency among individual responses, poor correlation between the scale and behavior, and "dated" language used in the instrument's statements. Dunlap and colleagues then developed the New Ecological Paradigm Scale to respond to criticisms of the original. This is sometimes referred to as the revised NEP scale to differentiate it from the New Environmental Paradigm scale.

The revised NEP has fifteen statements, called items. (See table 1 on the next page.) Eight of the items, if agreed to by a respondent, are meant to reflect endorsement of the new paradigm, while agreement with the other seven items represents endorsement of the DSP. Using a Likert scale, a commonly used rating scale, respondents are asked to indicate their strength of agreement with each statement (strongly agree, agree, unsure, disagree, strongly disagree).

The authors asserted that the revised NEP had several strengths, making it a reliable and valid tool for measuring a population's environmental world view. In particular, they said the new scale was internally consistent

Table 1. Revised NEP Statements

1. We are approaching the limit of the number of people the Earth can support.
2. Humans have the right to modify the natural environment to suit their needs.
3. When humans interfere with nature it often produces disastrous consequences.
4. Human ingenuity will insure that we do not make the Earth unlivable.
5. Humans are seriously abusing the environment.
6. The Earth has plenty of natural resources if we just learn how to develop them.
7. Plants and animals have as much right as humans to exist.
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.
9. Despite our special abilities, humans are still subject to the laws of nature.
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
11. The Earth is like a spaceship with very limited room and resources.
12. Humans were meant to rule over the rest of nature.
13. The balance of nature is very delicate and easily upset.
14. Humans will eventually learn enough about how nature works to be able to control it.
15. If things continue on their present course, we will soon experience a major ecological catastrophe.

*Source:* Dunlap et al. (2000).

*The seven even numbered items, if agreed to by a respondent, are meant to represent statements endorsed by the dominant social paradigm (DSP). The eight odd items, if agreed to by a respondent, are meant to reflect endorsement of the new environmental paradigm (NEP).*

(people who responded to some items in one pattern tended to respond to other items in a consistent manner) and that it represented a measure of a single scale (that it had unidimensionality).

## Use and Critiques

The revised NEP is used widely in the United States and in many other nations. It is used in cross-sectional assessments of the relationship of environmental world views to attitudes on public policy, to recreation participation patterns, and to pro-environmental behaviors. It is also used in before-and-after studies of the effects of some intervention or activity, such as the impact of educational programs on environmental world views. It is probably the most widely used measure of environmental values or attitudes, worldwide.

The revised NEP scale has its critics. There are three broad categories of criticism. First is the assertion that the revised NEP scale is missing certain elements of a pro-ecological world view and thus is incomplete. Specifically, it is said that the scale leaves out expressions of a biocentric or ecocentric world view that comes from late twentieth-century environmental ethics literature.

A second line of criticism concerns the validity of the scale. This comes typically from researchers who have tried to document links between NEP scale results and pro-environmental behavior. When links between NEP scale results and behavior are weak, some researchers suggest that the scale fails to measure a world view accurately. Tests of the NEP scale as a predictor of environmental behavior are part of extensive social-psychological research to explain the root causes of environmental behavior.

Finally, there is considerable debate about the dimensionality of the revised NEP scale. Dunlap and colleagues argued that the NEP in both of its iterations measures a single dimension, endorsement of a world view that could be measured simply by adding up the responses. Numerous studies have used a statistical technique called principal components analysis to test this. These studies had different results, suggesting that the NEP captured not one dimension but often three or more dimensions. This variability in results leads some to question both the NEP's validity (does it measure the phenomena it is claiming to measure?) and its reliability (does it measure those phenomena in the same way across different populations or across time?).

## Future of the NEP Scale

Given its extensive use in many settings, the New Ecological Paradigm scale will continue to be used widely. Because no other instrument has been so

  

extensively accepted as a measure of environmental world views, it will continue to be valuable, if for no other reason than it gives researchers comparisons to make across study types, population types, and time. The growing body of research will create additional opportunities to test the NEP for its reliability and validity.

More importantly, it is clear that underlying values will have significant effects on debates around sustainability. Advocates for the usefulness of the revised NEP scale believe that progress toward sustainability would be reflected in shifts in NEP scale scores in the general population from endorsement of the dominant social paradigm toward endorsement of a New Ecological Paradigm. As such, the revised NEP scale would be a fundamental metric of progress toward sustainability. In the same manner, public information or sustainability education campaigns would be deemed successful if they caused a similar shift. For the NEP scale to serve this function effectively, however, there will need to be greater acceptance of its validity and reliability as a metric of sustainability values.

Mark W. ANDERSON
*University of Maine, Orono*

*See also* Challenges to Measuring Sustainability; Citizen Science; Community and Stakeholder Input; Environmental Justice Indicators; Focus Groups; Participatory Action Research; Quantitative vs. Qualitative Studies; Sustainability Science; Transdisciplinary Research; Weak vs. Strong Sustainability Debate

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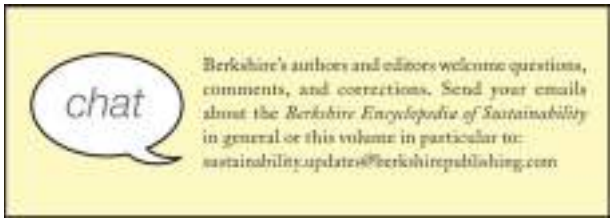


  

## POPULATION ECOLOGY

A group of individuals of a particular species occupying a definite space in which the individuals interact, interbreed and exchange genetic information is referred to as *population*. Thus one can speak of population of a bird species, population of locust species in a crop field, and so on. Population is a unit of community through which energy flows and nutrients are cycled. It is a self-regulatory system that helps in maintaining the stability of ecosystem. A population can be divided into small subgroups called *demes* or local populations. The branch of ecology which deals with the characteristics, structure and regulation of population is called ***population ecology***.

**Ecological Amplitude and Law of Tolerance.** A range of environmental conditions within which a species shows its characteristic growth potentiality is called *ecological amplitude* or tolerance. The geographical distribution of a species is determined by the environmental factors limiting the ecological amplitude and different ecological forms or *ecotypes* of the species. According to McMillan (1959), the species with one or few ecotypes may have narrow ecological amplitude, as for example, *Stipa spartea,* but the species represented by several ecotypes, each having its own phenotypic expression, have wide ecological amplitude, *e.g., Andropogon.*

According to Shelford's (1913) *Law of Tolerance,* each environmental factor has two limits—*the maximum* and *the minimum* limits within which a species survives. They are called limits of tolerance. Maximum growth and vigour of a species is exhibited at the *optimum.* Since the environment is dynamic and it keeps on changing from time to time, it acts as a natural check on population. Physiological stress and loss of vigour begin to appear towards the limits of tolerance and the individuals of one species are unable to compete with the better adapted individuals of other species and consequently they become infrequent.

The subject of population ecology is very wide but only the following aspects of population study will be discussed here :

(*i*) Characteristics of population

(*ii*) Population structure including (*a*) analysis of population dispersal and (*b*) various types of interactions.

## CHARACTERISTICS OF POPULATION

The population has the following characters :

1. **Population density**
2. Natality
3. **Mortality**
4. Population growth
5. **Age distribution of population**
6. Population fluctuations.

## 1. Population Density

Population density refers to the size of any population in relation to some unit of space. It is expressed in terms of the number of individuals or biomass per unit area or volume, as for example, 500 teak trees per hectare; 40 lions per 100 $km^2$, 5 million diatoms per cubic metre of water. Population density is seldom static and it changes with time and space. Population size can be measured by several methods :

(*i*) *Abundance*—Absolute number of individuals in population.

(*ii*) *Numerical Density*—Number of individuals per unit area or volume. It is expressed when the size of individuals in the population is relatively uniform, as in mammals, insects and birds.

(*iii*) *Biomass Density*—Biomass density is expressed in terms of wet weight, dry weight, volume, and carbon and nitrogen weight per unit area or volume.

Population density can be expressed in two ways :

(*i*) **Crude Population Density.** When the density is expressed with reference to total area at a particular time.

(*ii*) **Ecological Density.** When the density is expressed with reference to total area of habitat available to the species.

The distribution between crude density and ecological density becomes important because the patterns of distribution of individuals in nature are different and individuals of some species like *Cassia tora, Oplismenus burmanni* are found more crowded in shady places than in other parts of the same area. Thus population density calculated in total area would be crude density and the densities for the shade areas and open areas separately would be ecological densities.

Population density can be calculated by the following equation :

$$D = \frac{n/a}{t}$$

where $D$ is population density; $n$ is the number of individuals; $a$ is area and $t$ is unit time. Density of human population can be obtained by dividing the total number of persons in the area by the total land area of the region. Density of population of a country can be obtained by dividing the total number of persons living in the given region by total land area of that region. Average population density in developing countries is more as compared to those in developed countries. Netherlands is smaller than India but its population density is greater (319/$km^2$ in Netherlands and 168/$km^2$ in India). Area of India is 2.5% of the world but 15% population of the world lives in India alone. The population density of India is 4% higher than that of Europe and more than 7 times that of U.S.A.

Population density is affected by a number of environmental factors, such as geographical factors, mortality, natality, emigration and immigration and socio-economic factors.

## 2. Natality

Natality refers to the rate of reproduction or birth per unit time. It is an expression of the production of new individuals in the population by birth, hatching, germination or fission.

Natality is calculated by the following formula :

$$\text{Birth rate or Natality } (B) = \frac{\text{Number of births per unit time}}{\text{Average population}}$$

The maximum number of births produced per individual under ideal conditions of environment is called *potential natality*. It is also called *reproductive* or *biotic potential, absolute natality* or *maximum natality*.

Natality varies from organism to organism. It depends upon the population density and environmental factors. It is a general rule that if the population density is usually low, the birth rate is also low. This is so because the chances of mating between males and females are low. If population density is unusually high, the birth rate may also be low due to poor nutrition or physiological or psychological problems related to crowding. The maximum or absolute natality is observed when the species exists under ideal ecological and genetic conditions. The actual number of births occurring under the existing environmental conditions is much less as compared to absolute natality. It is referred to as *ecological natality* or *realised natality.* It is not constant for population and may vary with the size of population as well as with the time.

### 3. Mortality

Mortality refers to the number of deaths in population per unit time.

Mortality rate $= \frac{D}{t}$ where $D$ is the number of deaths in the time $t$.

Mortality can be expressed in the following two ways:

(*i*) **Minimum or Specific or Potential Mortality.** It represents the minimum of theoretical loss of individuals under ideal or non-limiting condition. Thus, even under the best conditions individuals of a population would die of old age determined by their physiological longevity. So it is constant for a population.

(*ii*) **Ecological or Realised Mortality.** It refers to the death of individuals of a population under existing environmental conditions. Since it varies with environmental conditions, it is never constant. The maximum mortality occurs at the egg, larval, seedling and old age.

Mortality is affected by a number of factors, such as, density, competition, disease, predation and environment. Death rates vary among the species and are correlated with birth rates. When the rate of natality is equal to the rate of mortality the population is stationary.

A birth-death ratio $\left(\frac{\text{Births}}{\text{deaths}} \times 100\right)$ is called *Vital index.* For a population, the survival of individuals is more important than the death. The number of births in relation to the carrying capacity of the habitat is a fundamental factor influencing the mortality rate. When more youngs are born than the habitat can support, the surplus must either die or leave the area. Because the number of survivors is more important than the number of dying individuals, mortality is better expressed as survival or as *life expectancy.* The life expectancy refers to the average number of years the members of a population have left to live.

**Life Tables and Survivorship Curve.** The species differ in respect of birth rates, average life span and mortality rate. When sufficient informations about a species are available, *life-table* can be formulated which provides vital statistics of mortality and life expectancy for the individuals of different age-groups in the population. In such tables age is usually represented by the subscript index $x$ which is some convenient fraction of species life span, such as, years or stage of development. The life table is set up on the basis of an initial cohort or group of 100, 1000, 10,000 10,00,00 individuals and the number of living in the beginning of each successive age interval is symbolised as $lx$. Plotting these data gives a survivorship curve for a species. The number of dying individuals within each age group is denoted as $dx$. The rate of mortality during each age interval ($qx$) is commonly expressed as the percentage of the number at the beginning of the interval.

$$qx = \frac{dx}{lx} \times 100$$

Survival rate is the difference between the mortality rate and 100 per cent (*i.e.*, 100—$qx$) and is denoted by $\delta x$. Life expectancy ($ex$), thus, is the mean time between any specified age and the time of death of all individuals in the age group.

**Types of Survivorship Curve.** If it could be assumed that all members of an original population have the same capacity for survival (environmental effects for the moment are ignored), plotting the number of surviving individuals against time would produce a survivorship curve in the form of a right angle. There are three general types of survivorship curves which represent different natures of survivors in different types of population (Fig. 4.1).

(*i*) **First Type or Highly Convex Curve.** Curve *A* in the Fig. 4.1 is the characteristic of the species in which the population mortality rate is low until near the end of life span under ideal environmental conditions. Thus, all the members born at the same time live out the full physiological life span characteristic of the species and all die at about the same time. Many species of animals as deer, mountain sheep, and modern man show such curves.

(*ii*) **Second Type or Diagonal Curve.** Survivorship curve *B* in the figure 4.1 is characteristic of organisms in which rate of mortality is fairly constant at all age levels, a more or less uniform percentage decrease in the number that survives.

(*iii*) **Third Type or Highly Concave Curve.** Survivorship Curve *C* in the Fig. 4.1 is characteristic of such species in which mortality rate is high during the early stage and constant in all other age-groups. Oyster, some birds, oak trees, etc. show this type of curves.

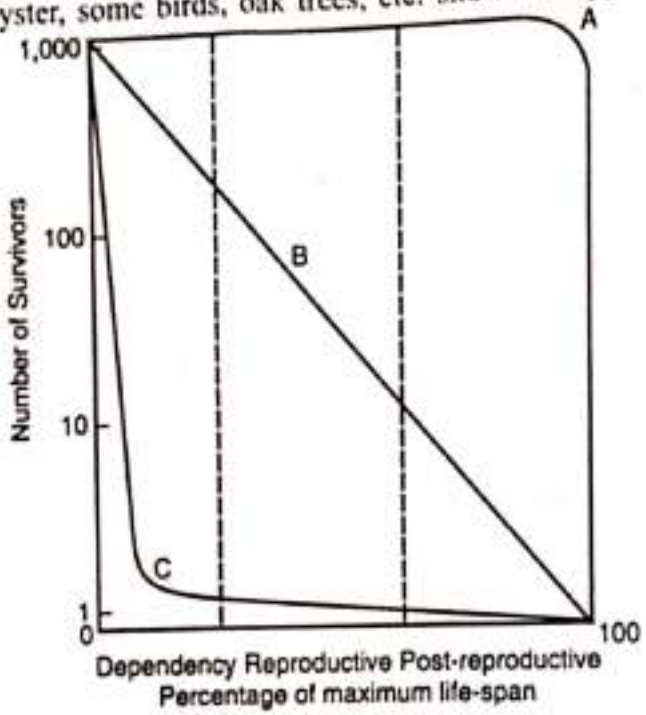


**Fig. 4.1.** To construct a survivorship curve, a total population of individuals, such as one thousand is considered at age 0 (birth). At even increments of time, the total number of survivors from this thousand is plotted, and the curve is drawn. The slopes of the three basic types of survivorship curves show the following rates of changes : A—Curve for organisms living out the full physiological life span of the species (Type 1). B—Curve for organisms in which the rate of mortality is fairly constant at all age levels—a more or less uniform percentage decrease in the number that survives (Type 2). C–Curve for organisms with high mortality during the early stage in life (Type 3).

## 4. Population Growth

The growth is one of the dynamic features of species population. Population size increases in a characteristic way. When the number of individuals of population is plotted on the *y*-axis and the times on the *x*-axis, a curve is obtained that indicates the trend in the growth of population size in a given time. This curve is called *population growth curve*. There are two types of growth curves

(*i*) **Sigmoid Curve.** When a few organisms are introduced in an area, the population increase is very slow in the beginning (*positive acceleration phase* or *lag phase*), in the middle phase the population increase becomes very rapid (logarithmic phase) and finally in the last phase the

population increase is slowed down (*negative acceleration phase*) until an equilibrium is attained around which the population size fluctuates according to variability of environment. The level beyond which no major increase can occur is referred to as *saturation level* or *carrying capacity*. In the last phase the new organisms are almost equal to the number of dying individuals and thus there is no increase in population size. In this way, one gets sigmoid or *S*-shaped growth curve (Fig. 4.2).

(*ii*) **J-Shaped Curve.** The second type of growth curve is J-shaped. Here in the first phase there is no increase in population size because it needs some time for adjustment in the new environment. Soon after the population is established in the new environment, it starts multiplying rapidly. This increase in population is continued till large amount of food materials exist in the habitat. After some time, due to increase in population size, food supply in the habitat becomes limited which ultimately results in decrease in population size. This will result in J-shaped growth curve rather than *S*-shaped (Fig. 4.2).

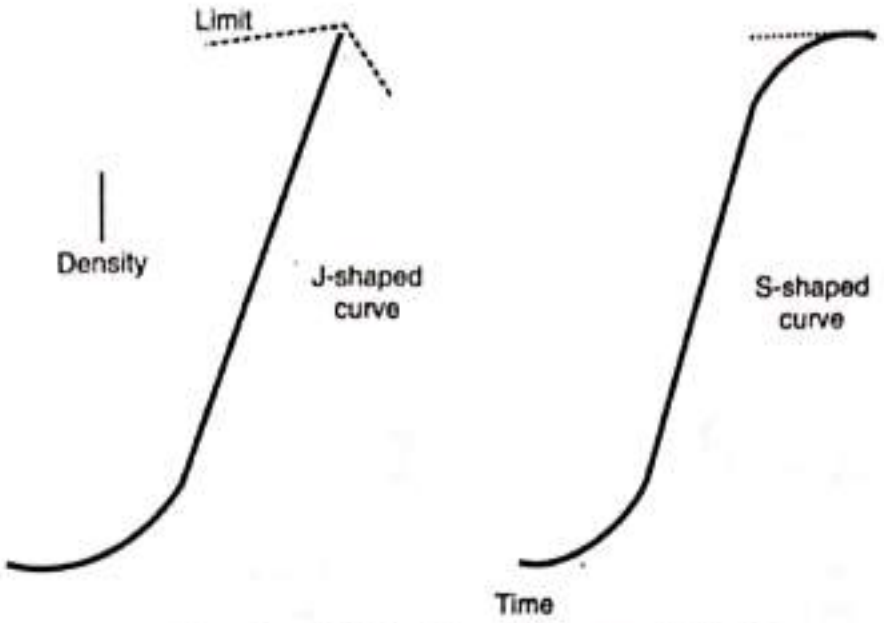


**Fig. 4.2.** J-Shaped and S-shaped population growth curves.

## 5. Age Distribution

Age distribution is an other important characteristic of population which influences natality and mortality. Mortality, usually varies with age, as chances of death are more in early and later periods of life span. Similarly, natality is restricted to certain age groups, as for example, in middle age-groups in higher animals. According to Bodenheimer (1958), the individuals of a population can be divided into *pre-reproductive, reproductive* and *post-reproductive* groups. The individuals of pre-reproductive group are young, those of reproductive group are mature and those in post-reproductive group are old.

The distribution of ages may be constant or variable. It is directly related to the growth rate of the population. Depending upon the proportion of the three age-groups, populations can be said to be *growing, mature* or *stable*, and *diminishing*. In other words, the ratio of various age groups in a population determines the reproductive status of the population. Rapidly increasing population contains a large proportion of young individuals, a *stable population* shows even distribution of individuals in reproductive age-group and a *declining population* contains a large proportion of old individuals.

**Age Pyramids.** Age pyramid is a model in which the numbers or proportions of individuals in various age groups at any given time are geometrically presented. In an age pyramid, the number of pre-reproductive individuals is shown at the base, that of reproductive age group in

the middle and the number of post-reproductive individuals at the top. The shape of age-pyramid changes with the change in the population age distribution over a period of time (Fig. 4.3). The age pyramid indicates whether a population is expanding or stable or diminishing and accordingly three hypothetical age pyramids have been suggested. These are as follows:

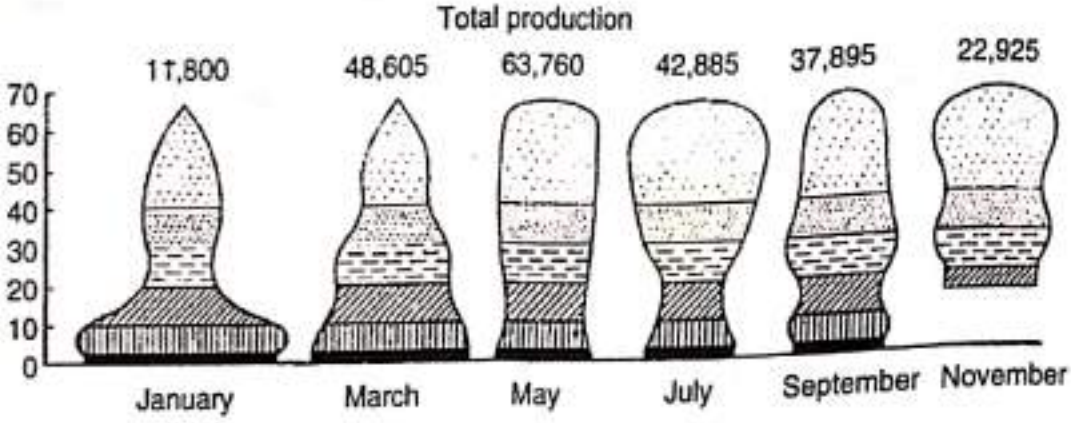


**Fig. 4.3.** Progressive change in age distribution of honey bees over a single season.

(*i*) **Pyramid with broad base.** This pyramid shows a high percentage of young individuals and an exponential growth of population due to high birth rate, as for example in yeast, housefly, *Paramecium* (Fig. 4.4A).

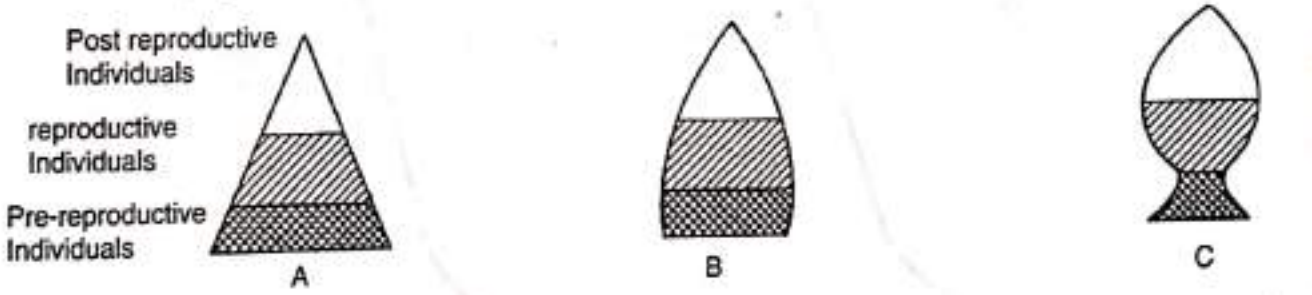


**Fig. 4.4.** A. Pyramid with broad base. B. Bell shaped pyramid. C. Urn-shaped or pyramid with narrow base.

(*ii*) **Bell-shaped pyramid.** This type of age pyramid shows a **stationary** or **stable** population having, more or less equal number of young and middle-aged individuals and post-reproductive individuals being the smallest in number (Fig. 4.4 B).

(*iii*) **Pyramid with narrow base.** This is an urn-shaped pyramid which shows increased numbers of middle aged and old organisms as compared to young ones in the population. It is indicative of contracting or diminishing population (Fig. 4.4 C).

## 6. Population Fluctuations

The size and density of natural population show a changing pattern over a period of time. This is called population fluctuation. There are three types of variations in the pattern of population change :

(*i*) **Non-fluctuating.** When the population remains static over the years, it is said to be non-fluctuating.

(*ii*) **Cyclic.** The cyclic variations may be (*i*) *seasonal*, and (*ii*) *annual*. Sometimes *seasonal changes* occur in the population and there are additions to the population at the time of maximum reproduction and losses under adverse climatic conditions. Common examples of seasonal variations are met in mosquitoes and houseflies which are abundant in particular season and so also the weeds in the field during the rainy season.

When the population of a species shows regular ups and downs over the years, it is called annual cyclic variation. It appears in the form of a sigmoid curve with regular drops in population after peaks.

(*iii*) **Irruptive.** When the change in population density does not occur at regular intervals or in response to any obvious environmental factor, it is said to be **irruptive fluctuation.** In this, there is a sudden exponential or logarithmic increase in population density in short time, followed by equally quick drop in population density due to deaths, and final return to normal level or even below that level.

- **Introduction**

In present days one of the greatest challenges facing every nation is population pressure, which exhausts the vital development and blocks social progress of that country. The exponential growth of the population and its increasing stress on physical and cultural resources has made a doubt on future development also.

- **Population growth**

About 10 to 20 million years back humans appeared on earth. Then the world's population grew at different rates at different times. Hundreds of years before the birth of Christ, the world's population was only 25 cores, and it took more than a thousand years for the population to double. According to the report of the United State Census Bureau, the current population of the world is 762.40 crores (August 2018) while the population of the world in 2010 was 690.87 crores. In the year 1650 after the birth of Christ, the population of the world was only 55 crores, in 1750 AD i.e. in the next 100 years, the population increased to 72 crores. Later, in 1900 AD, the world's population increased to 161 million. Later, in 1950, the world's population increased to 251 million. Subsequently, this population in the world increased to 500 crores in 1986. Later, in the year 2000, the world's population increased to 601 crores, and then in 2010, the world's population increased further to reach 690.87 crores. Currently, the world population has further increased to 811 crores as of January 2024. If the world population continues to grow at this rate, the estimated population in 2050 is 980 million.

The difference between total births and total deaths in a country in any year is considered the natural growth of the population of that region. Again, the amount of population obtained by adding immigration to the natural increase in the population of its region and excluding migration is called population growth but this abnormal increase in the world's population at a rapid rate is known as the population explosion. China is currently the world's largest populous country. The country has a total population of 141 crores (2018) and is the second most populous country after India. The population of our country is currently 121.01 crores (2011).

World Population Growth

| Year | Pop. | ±% p.a. |
|---|---|---|
| **1950** | 2,525,149,000 | — |
| **1960** | 3,018,344,000 | +1.80% |
| **1970** | 3,682,488,000 | +2.01% |
| **1980** | 4,439,632,000 | +1.89% |
| **1990** | 5,309,668,000 | +1.81% |
| **2000** | 6,126,622,000 | +1.44% |
| **2010** | 6,929,725,000 | +1.24% |
| **2021** | 7,909,295,151 | +1.21% |

Data Source: https://en.wikipedia.org/wiki/List_of_continents_and_continental_subregions_by_population

- **Continent-wise Population Growth**

The world's population is not evenly distributed across continents. Some areas are highly populated and some are uninhabited. Currently, the annual growth rate of the world population is 1.17%. Asia has the largest population in terms of continents at 469.45 crore. It is followed by the African continent (139.37 crore), Africa and Asia have the highest population growth rates in the world due to declining mortality rates. The growth rates of other continents like Europe, North America, South America, and Oceania are shown below -

**Distribution of populations by continent**

| | Continent | Population (2021)[1][2][3] | % (world) | ±% p.a. (2010–2013) |
|---|---|---|---|---|
| | **World** | **7,909,295,151** | **100%** | **1.17%** |
| 1 | **Asia** | 4,694,576,167 | 59.4% | 1.04% |
| 2 | **Africa** | 1,393,676,444 | 17.6% | 2.57% |
| 3 | **Europe** | 745,173,774 | 9.4% | 0.08% |
| 4 | **North America** | 595,783,465 | 7.5% | 0.96% |
| 5 | **South America** | 434,254,119 | 5.5% | 1.06% |
| 6 | **Oceania** | 44,491,724 | 0.6% | 1.47% |
| 7 | **Antarctica** | 0 | 0% | 0% |

**Data Source: https://en.wikipedia.org/wiki/List_of_continents_and_continental_subregions_by_population**

- **Causes of Excess Growth of Population**
  - Increase in the birth rate
  - A decrease in the infant mortality rate
  - Increased Life Expectancy
  - Migration
  - High level of illiteracy
  - Early marriage
- **Development**

Development is the process by which a nation or community improves its economic, social, and political circumstances while simultaneously protecting and preserving its natural resources, including its people.

- **Characteristics of Development**
  - Improvement in Quality of life.
  - The amount of false unemployment can be reduced.
  - Increase in per capita income through development.
  - Development by balancing population and natural resources.
  - It helps people to achieve competence and ability.
  - Development indicates the improvement of education, health, distribution of resources, environment, and quality of life.

- **The Role of the population in the development of any country**

Population is one of the factors that play a significant role in the development of economic development of a country. Because economists believe that, the country's population is considered human resources. If the country's population is properly used for development, the gross production of the country or GDP may increase. However, how much the population of a country or region affects the economic development of that country cannot be clearly said. Sometimes growth of the population of any country helps its development on the one hand, on the other hand, overpopulation creates obstacles to development.

- **Malthus's Theory of Population Growth**

Thomas Robert Malthus (1766-1834) was the first who point out the actual relationship between population growth and economic development. In 1798 he published his landmark study 'An essay on the principle of population'. Here Malthus explained human resources in terms of two factors namely population and food supply. The basic premise of Malthus's theory was that the population would grow at a Geometric rate (1:2:4:8:16:32 etc.) in an uncontrolled system while food supplies would increase at an Arithmetic rate (1:2:3:4:5:6 etc). According to him, the population will increase exponentially but the food supply will increase at a parallel rate. So, population growth and food supply growth will never be equal. If the population continues to grow uncontrollably, there will never be a balance between the demand for food and the supply of food, so food problems are inevitable and this will result in poverty, famine, and unemployment. As an economist, he asked to control this increase in population by positive check and preventive check methods.

- **Negative Impact of Population Growth on Economic Development**

Rapid population increase, in the opinion of many economists, actually impedes rather than advances the economic development of developing nations. Notable economists among them are Adam Smith, Ricardo, Malthus, Nelson, and others. How the increase in population either impedes or negatively impacts economic development.

It is stated that:

- **Population pressure and food supply:** As a result of the rapid growth of the population, the demand for food tends to increase. To meet food demand; both production and supply must increase. As a result, large quantities of food grains have to be imported to meet the food needs of the growing population. To meet the food needs of the rising population, a significant amount of food grains must be imported. Importing necessary goods for economic development is rendered impossible by the waste of precious foreign cash on food grains. Furthermore, because of the country's fast population growth, the governments of developing nations frequently have to provide food grains to the general public through subsidies at relatively low prices which creates pressure on the government budget and hinders economic development.
- **Population pressure and Per Capita Income:** A decline in per capita income occurs when the population expands more quickly than the rate at which the national income is growing. Because population expansion lowers per capita income despite an increase in national revenue, in this case, population growth impedes economic development. Due to the country's rapid population increase, the people cannot fully profit from national income intelligence in this situation.

- **Population pressure and production of Agricultural Raw Materials:** Due to the rapid growth of the population, increasing the production of food grains requires a large part of the cultivable land to be used for the production of food grains. As a result, there is less arable land available for the production of enough agricultural raw materials for the industry, for that reason, there is less production and supply of agricultural raw materials, which hinders the growth of industries that rely on agricultural raw materials as well as the expansion of the economy as a whole.
- **Population and unemployment problem:** Rapid population growth, leads to capital formation in underdeveloped countries. The majority of people in none of these countries have seen their share of the non-agricultural sector, including industry; expand at a rate that has not kept up with population growth. A portion is compelled or jobless. Consequently, agriculture serves as a primary source of income for a sizable portion of the populace. The agriculture sector was thus severely strained by the growing population. Consequently, agricultural production is dropping on the one hand, while open and hidden unemployment among farmers is increasing on the other. As a result, it can be said that high population increase hinders economic development in developing nations by creating extremely difficult job conditions.
- **Population pressure and Poverty:** in developing countries, population growth can contribute to or be a direct result of poverty. Basic education is denied to the impoverished masses in developing countries. Due to a lack of education, people get married at a very young age; As a result, the population continues to grow rapidly. For this reason, poverty has an indirect effect on the population.
- **Population pressure and Infrastructure:** Governments of developing countries are unable to construct adequate infrastructure because of their countries' rapid population expansion. In actuality, the rate of human resource development is extremely low in each of these nations due to insufficient government spending on health, education, transportation, communication infrastructure, and other areas. The population is growing at a rate that makes it impossible to accelerate economic development since sufficient soft resources are not being produced.
- **Population pressure and depletion of natural resources**. Depletion of natural resources, particularly in developing countries is largely caused by population pressure. The risk of floods is increased due to the loosening of soil cover and deforestation which is caused by population growth and settlement expansion. The disturbance of natural equilibrium leads to an increase in both floods and the likelihood of droughts. As a result, the government is now investing more in rehabilitation to better shield the population from natural disasters. In terms of economic progress, this kind of bias is intolerable.

So, it can be said that population pressure in any country creates a severe problem for its development.

- **Trends of Population Growth in India**

India is the second most populous country in the world. The population growth rate is very high (17.64%). 2184 crores in India. In 1911 it rose to 25.21 crores and the ruling rate was 1.75%.In 1921 the population grew with a decennial growth rate of -0.3%. 1901-1951. India's population has grown by only 12.27 crores in the last 30 years. 1951-2011 i.e. in 30 years there has been an increase of 44.9 crores i.e. a population increase of about 1.42 crores per year. In present India, the growth rate has slowed down slightly since the 1960s. In 1991 the growth

rate was 23.87% but in 2001 it was 21.54%. Currently, India's population growth rate has further declined to 17.65% (2011) with Nagaland being the only kingdom to have recorded the highest population growth (-0.47%) (2011).

- **Effects of Population Growth on the Economy in India**

In a developing country like India, this massive population growth is becoming a hindrance in the way of development in the national life. The following are the results of increasing the concentration.

**1. Constraints on national income:** National income and rate of economic development slow down when population increases. The population grows at a geometric rate but the production of the country grows at an arithmetical rate. As a result, the rate of total production will fall below the rate of population growth and create a drag on national income.

**2 Food scarcities**: Although India is self-sufficient in food grains production, India has to import food grains from abroad. The reason for this is the increasing population growth. With the increase in population, it is not possible to supply food everywhere according to the demand. The increased population suffers from food shortages, starvation, and malnutrition.

**3. Depletion of agricultural land:** Due to the increase in population, the amount of agricultural land is gradually decreasing due to the establishment of houses and various types of industries on agricultural land. In 1961 the per capita land area in India was 1.11 acres. In 1981 it came down to 0.62 acres i.e. about a 44% reduction of agricultural land in 20 years.

**4. Unproductive Population Growth:** Population growth in India is 17.64% per decade. On the other hand, advances in science and medicine have reduced the incidence of disease and prevented epidemics and famines. As a result, the unproductive population (0-15 years and 60+) has grown rapidly. This has created a big problem for India.

5. Increase in Unemployment: The increase in population is putting increasing pressure on employment. Hypocrisy is being observed in agricultural countries like India. As a result of the increase in unemployment, various social problems and economic problems are created.

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Sem-1 VAC study material
Department of Geography
Barasat Government College
MODULE II
Syllabus: Environmental degradation: Causes and Effects

## Introduction

The environment is something we are very familiar with. It's everything that makes up our surroundings and affects our ability to live on the earth. Environmental degradation is a very serious problem worldwide which covers a variety of issues including pollution, biodiversity loss, and animal extinction, deforestation and desertification, global warming, and a lot more (Brown *et al.*, 1987; Tian *et al.*, 2004). The environmental degradation is deterioration of the environmental through depletion of resources which includes all the biotic and abiotic element that form our surrounding that is air, water, soil, plant, animals, and all other living and non-living element of the planet of earth (Bourque *et al.*, 2005; Malcolm and Pitelka, 2000). Environmental degradation is also having a useful aspect, more new genes have been created, and some species have grown as someones have declined. For natural selection, species are constantly regenerating as the environment changes, and human activity is the main driver's power. Human is also a product of nature; this shift is to natural replacement.

Most of the people about three-fourths of its population depends directly for their livelihood on activities based on natural resource and the remainder of the population relies on these resources directly for food, fuel, industrial output, and recreation (Raven *et al.*, 1998). Most of the natural resources including the environment in India are in a serious state of degradation. The use of agriculture fertilizer is a major factor for the degradation of soil quality, soil erosion, salinity and general loss of fertility of agricultural land as well as the loss of the production of the quality crop. Similarly, groundwater aquifers are overexploited in many arid and semi-arid areas, surface water sources are highly polluted and consequently, water for drinking and irrigation is increasingly getting scarce and polluted. Fishery yields are declining, and air quality is deteriorating. Increasing levels of air, water, and land pollution pose a serious threat to human health and longevity (Malik *et al.*, 2014; Malik *et al.*, 2018; Yadav *et al.*, 2019). Good environmental management is essential for economic growth and development. It is not a sometime mistakenly asserted just a luxury for wealthy countries concerned with aesthetics. Climate change and environmental degradation affect all types of development projects in all countries. If the development agencies are seriously contributing to the reduction of poverty in the communities in which they work, they must give consideration to the climatic and environmental hazards which impact their projects. Climate change and environmental degradation are proceeding rapidly and are already affecting many communities in developing countries. O'Neill *et al*. (2010) reported that slowing population growth could provide 16-29% of the emissions reductions, and suggested to be necessary by 2050 to avoid dangerous climate change. His study in 35 countries suggested that, slowed population growth could save 1.4 to 2.5 billion tons of carbon emissions per year by 2050, certainly help to solve the climatic problem.

## Causes of environmental degradation

The major factor of environmental degradation is human (modern urbanization, industrialization, overpopulation growth, deforestation, etc.) and natural (flood, typhoons, droughts, rising temperatures, fires, etc.) cause. Environmental pollution refers to the degradation of the quality and quantity of natural resources. Different kinds of human activities are the main reasons for environmental degradation. The automobile and industries increase the number of poisonous gases like $SO_x$, $NO_x$, CO, and smoke in the atmosphere. Unplanned urbanization and industrialization have caused water, air, soil, and sound pollution. Industrialization, urbanization, and sewage waste help to increase pollution of the sources of water (Olorode *et al.*, 2015). Similarly, the smoke emitted by vehicles and industries like Chlorofluorocarbon, nitrogen oxide, carbon monoxide, and other dust particles pollutes the air. Since man began to use tools and gradually formed a society, he began to play an important role in the evolution of the natural environment shown in Figure 1.

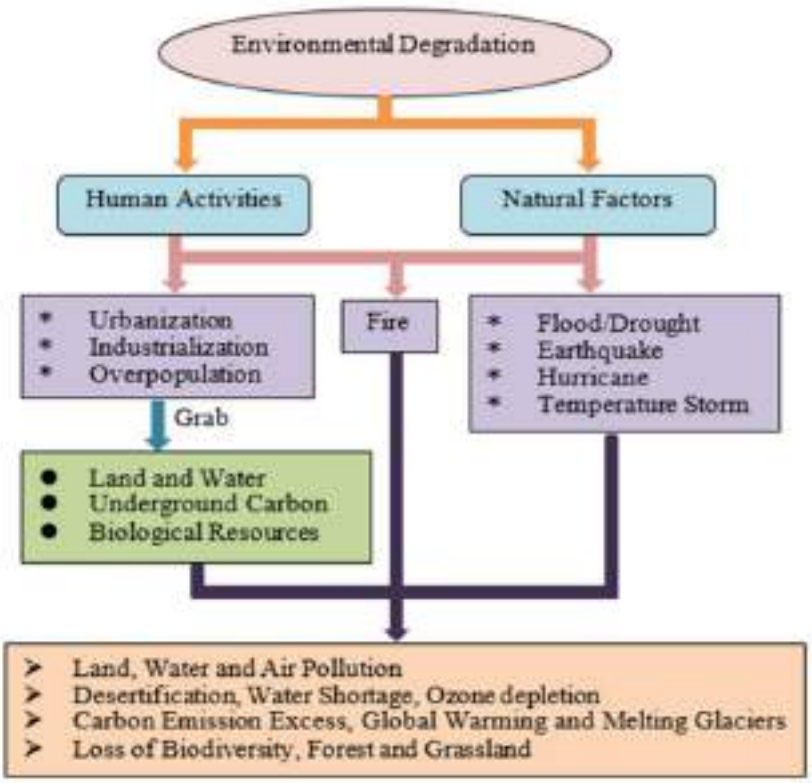


*Figure 1. Different causes of environmental degradation.*

### Land degradation

Land degradation is a worldwide problem: land degradation may occur naturally as well as manmade activities. The climate change majorly combined with human activities for continuous soil degradation. Wilcox *et al.* (2003), Vanacker *et al.* (2014), Maurya and Malik (2016a), noted that surface soil disturbances can modify surface topographical features and the vegetation patch structure (Mohr *et al*., 2013; Malik and Maurya, 2015). The deforestation, desalination, waterlogging desertification, wasteland and soil erosion. FAO estimated that about 2 billion peo-ple (or ¾ of the population of developing countries at that time) depended on biomass for their daily energy consumption (Kumar *et al*., 2020).

### Pollution

Air pollution refers to the release of harmful contaminants (chemicals, toxic gases, particulates, biological molecules, etc.) into the earth's atmosphere. These contaminants are quite detrimental, and in some cases, pose serious health issues. Water pollution is said to occur when toxic pollutants and particulate matter are introduced into water bodies such as lakes, rivers, and seas. These contaminants are generally introduced by human activities like improper sewage treatment and oil spills. Pollution is a very serious worldwide problem, pollution resulted in the deterioration of the quality of natural biotic and abiotic factors (Rahman *et al*., 2017; Cheng *et al*., 2016). Water pollution is a very big problem especially in developing countries in the world. The water covered about 71% of the total earth's surface and groundwater. The groundwater scarcity is especially in the developing countries of the worldwide (Karikari and Ansa, 2006). Water is one of the more demandable of all urban and rural amenities and indispensable for human activities including water for drinking and irrigation, recreational opportunities and habitat for economically important fisheries. Pollution poses a serious risk to life, especially when the water is a source of drinking and for domestic purposes for humans, polluted waters are potent agents of diseases such as cholera, typhoid, and tuberculosis. Olaniran (1995) defined water pollution to be the presence of excessive amounts of a hazard (pollutants) in water in such a way that it is no longer suitable for drinking, bathing, cooking or other uses. Pollution is the introduction of contamination into the environment**.** Water pollution is generally induced by humans. It results from the actions of humans carried on to a better self. These could be treated under the various activities that man engages in, which leads to pollution. The growth of the human population, industrial and agricultural practices is the major cause of pollution (Maurya and Malik, 2016a). As they respire, the decomposers use up dissolved oxygen ($O_2$) and the Biological Oxygen Demand (BOD) reduces. The flora and fauna of the rivers experience change and reduction in number due to death by suffocation (Maurya and Malik, 2016b; Maurya *et al*., 2019). The growing problem of pollution of the river ecosystem has necessitated the monitoring of water quality. Freshwater is a finite resource, essential for agriculture, industry and even human existence, without freshwater

of adequate quantity and quality, sustainable development will not be possible. Industry and automobiles are the primary and secondary contributors to air pollution worldwide (Kay, 1999); the automobiles are used every gallon of gasoline manufactured, distributed and then burned in a vehicle, produced along with carbon dioxide, carbon monoxides, sulfur dioxide, nitrogen dioxide, and particulate matter; these emissions contribute to increased global warming (Alexander and Kanner, 1995; Mark, 1997).

The environmental protection agency (EPA) estimates that industrial workers suffer up to 300,000 pesticide-related acute illnesses and injuries per year, mostly cholinergic symptoms from anticholinesterases and lung disease from airborne exposure (Hansen and Donohoe, 2002; Mellon *et al*., 1995). These are toxic, remain in the environment long-term, resist degradation, and can travel long distances.

### Global warming

Global warming which is also referred to as climate change is the observed rise in the average temperature of the Earth's climate system the global surface temperature is likely to rise a further 0.3 to 1.7 °C in the lowest emissions scenario, and 2.6 to 4.8 °C in the highest emissions scenario. These readings have been recorded by the "national science academies of the major industrialized nations". Future climate change and impacts will differ from region to region. Expected effects include an increase in global temperatures, rising sea levels, deforestation, imbalance climatic condition, changing precipitation, and expansion of deserts (Cunningham *et al*., 1999). Global warming has several adverse effects on human health, and agricultural production. It leads to an increase in heat-related diseases, civil conflict, decreases economic sources shown in Figure 2. Besides, it also indirectly affects human health due to the higher incidence of malaria, dengue, yellow fever and viral encephalitis caused by the expansion of mosquitoes and other disease carriers to warm areas. The adverse effect on agricultural production is due to the increased frequency of droughts, floods and hurricanes and increased incidence of pests, causing a shortage of food.

### Overpopulation

It is very likely that population growth as a missing scientific agenda accounts in part for the reduced public knowledge and interest in this issue. The extent of environmental degradation varies across countries and regions of the world. Rapid population growth puts a strain on natural resources which results in degradation of our environment. The mortality rate has gone down due to better medical facilities which have resulted in increased lifespan. More population simply means more demand for food, clothes, and shelter. You need more space to grow food and provide homes to millions of people. This results in deforestation loss of biodiversity, destruction of the ecosystem which is another factor of environmental degradation shown in Figure 3.

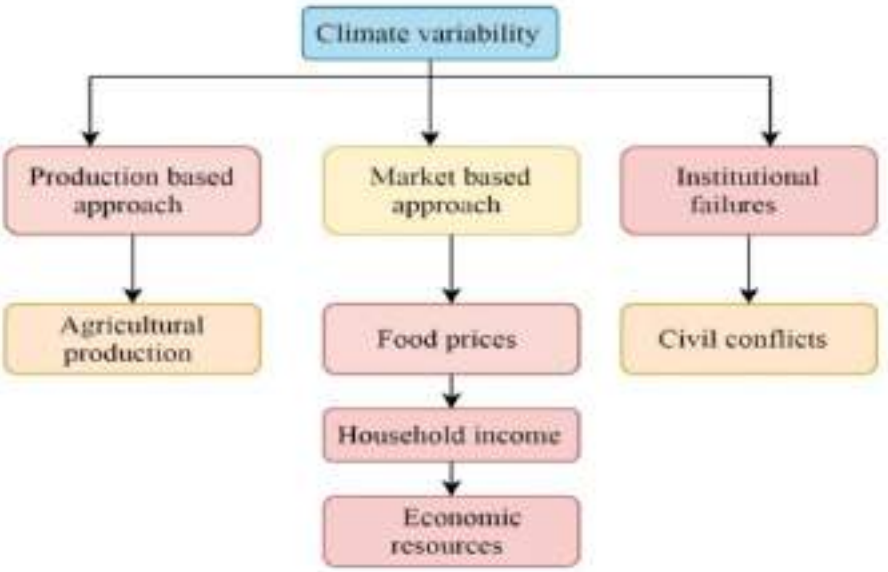


*Figure 2. Climate variability matters for food insecurity- diagrammatic presentation.*

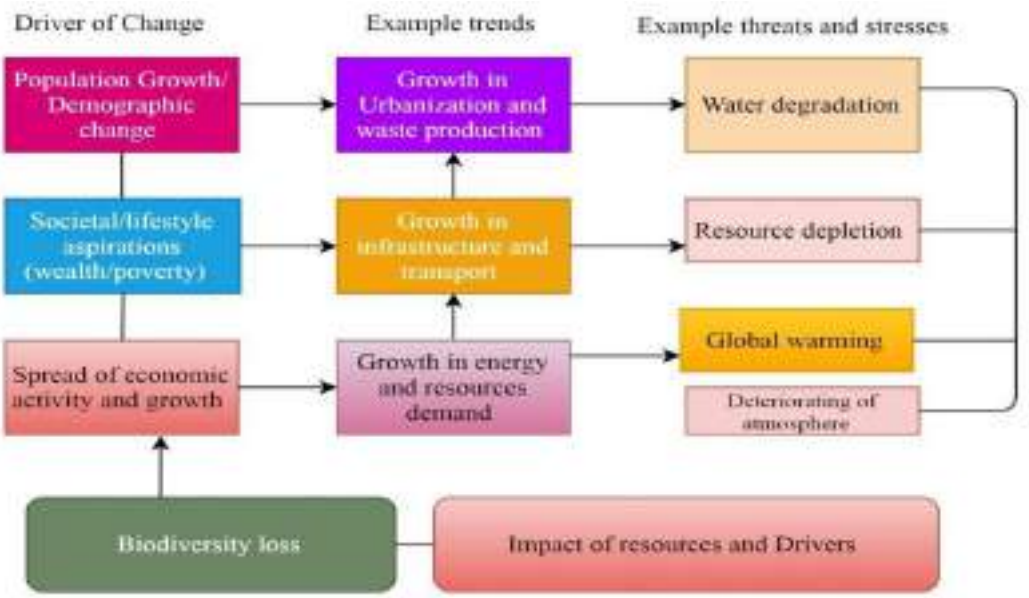


*Figure 3. Flow chart indicated the loss of biodiversity through the developmental aspect (Source: Foresight, 2000).*

### Landfills

Landfills pollute the environment and destroy the beauty of the city. Landfills come within the city due to the large amount of waste that gets generated by households, industries, factories, and hospitals. Landfills pose a great risk to the health of the environment and the people who live there. Landfills produce a foul smell when burned and cause huge environmental degradation.

### Deforestation

Forests are invaluable property of a nation because they provide raw materials to modern industries, timber for building purposes, habitats for numerous types of animals and micro-organisms. Good fertile and nutrient-rich soils having a high content of organic matter offer protection to soils by binding the soils through the network of their roots and by protecting the soils from the direct impact of falling raindrops. They encourage and increase the infiltration of rainwater and thus allow maximum recharge of groundwater resources, minimize surface run-off and hence reduce the frequency, intensity, and dimension of floods. Deforestation is the cutting down of trees to make way for more homes and industries. Rapid growth in population and urban sprawl are two of the major causes of deforestation. Apart from that, the use of forest land for agriculture, animal grazing, harvests for fuelwood and logging are some of the other causes of deforestation. Deforestation contributes to global warming as decreased forest size puts carbon back into the environment.

Deforestation gives birth to several problems encompassing environmental degradation through accelerated rate of soil erosion, increase in the sediment load of the rivers, siltation or reservoirs and river beds, increase in the frequency and dimension of Hoods and droughts, changes in the pattern of distribution of precipitation, intensification of greenhouse effects increase in the destructive force of the atmospheric storms, etc.

### Natural causes

Things like avalanches, quakes, tidal waves, storms, and fires can totally crush nearby animal and plant groups to the point where they can no longer survive in those areas. This can either come to fruition through physical demolition as the result of a specific disaster or by the long-term degradation of assets by the presentation of an obtrusive foreign species to the environment. The latter frequently happens after tidal waves, when reptiles and bugs are washed ashore, of course, humans aren't totally to blame for this whole thing. Earth itself causes ecological issues, as well. While environmental degradation is most normally connected with the things that people do, the truth of the matter is that the environment is always changing. With or without the effect of human exercises, a few biological systems degrade to the point where they can't help the life that is supposed to live there.

### The economic logic

Environmental change is one of the myriads of pressures or demands made upon state resources and attention. Many of the responses to environmental stress that occur involve uncoordinated human responses greatly affected by markets. Accordingly, producers and consumers respond to changes in prices, relative incomes, and external constraints. But frequently market 'signals' do not reflect social values, as in the case of intergenerational equity, for example, or the deleterious effects of environmental degradation are not internalized in market prices and remain as 'externalities'. As a result, states often choose to intervene with collective actions aimed at managing environmental change and reducing the associated adverse social and economic effects.

## Effects of environmental degradation

### Impact on human health

Human health might be at the receiving end as a result of environmental degradation. Areas exposed to toxic air pollutants can cause respiratory problems like pneumonia and asthma. Millions of people are known to have died off due to the indirect effects of air pollution (Adakole and Oladimeji, 2006).

### Loss of biodiversity

Biodiversity is important for maintaining the balance of the ecosystem in the form of combating pollution, restoring nutrients, protecting water sources and stabilizing climate. Deforestation, global warming, overpopulation, and pollution are a few of the major causes of loss of biodiversity.

### Ozone layer depletion

The ozone layer is responsible for protecting the earth from harmful ultraviolet rays. The presence of chlorofluorocarbons, hydrochlorofluorocarbons in the atmosphere is causing the ozone layer to deplete. As it will deplete, it will emit harmful radiation back to the earth (Buhaug *et al*., 2010).

### loss for the tourism industry

The deterioration of the environment can be a huge setback for the tourism industry that relies on tourists for their daily livelihood. Environmental damage in the form of loss of green cover, loss of biodiversity, huge landfills, increased air, and water pollution can be a big turn off for most of the tourists.

### Economic impact

The huge cost that a country may have to borne due to environmental degradation can have a big

economic impact in terms of restoration of green cover, cleaning up of landfills and protection of endangered species. The economic impact can also be in terms of the loss of the tourism industry. As you can see, there are a lot of things that can have an effect on the environment. If we are not careful, we can contribute to the environmental degradation that is occurring all around the world. We can, however, take action to stop it and take care of the world that we live in by providing environmental education to the people which will help them pick familiarity with their surroundings that will enable to take care of environmental concerns thus making it more useful and protected for our children and other future generations.

## Extents of environmental degradation

### Land degradation

Trash and garbage are a common sight in urban and rural areas of India. It is a major source of pollution. Indian cities alone generate more than 100 million tons of solid waste a year. Street corners are piled with trash. Public places and sidewalks are despoiled with filth and litter, rivers and canals act as garbage dumps. Soils are a key element in the climate change equation and perhaps the least well understood. Although models of soil organic matter decomposition predict increasing rates with increasing temperature, field measurements seem to contradict model results (Sax *et al*., 2002). In addition to increases in $CO_2$ emissions, industrialization has increased the amount of nitrogen deposition. Nitrogen deposition from human activities may help forests that are nitrogen-limited, but excess nitrogen deposition can lead to soil acidification and reduced nutrient availability to plants (Aber *et al*., 2001; Magnani *et al*., 2007).

### Degradation of water resources

Microbe contamination of groundwater due to sewage outfalls and high concentration of nutrients in marine and coastal waters due to agricultural runoff are among the most serious threats (Kumar *et al*., 2019a). Contact with unsafe drinking or bathing water can impose serious risks (both acute and delayed) on human health. While tap water is subject to treatment and is required to meet detailed testing and purity standards, it is not always disinfected of diarrhea inducing microorganisms, as illustrated by waterborne disease outbreaks such as that caused by Cryptosporidium in Milwaukie in 1993, which affected over 400,000people. Furthermore, faecal coliforms are not prohibited in bottled water (Nation Staff, 1996), and water bottled and sold within the same state is not subject to Food and Drug Administration standards (Hammitt *et al*., 2006).

Today 40% of waters are unfit for fishing or swimming, and levels of mercury in fish in 40 states. Clean Water Act of 1972 states to publish a list of all bodies of water that fail to meet water quality

standards, and for the states to set pollution limits and scale back pollution in watersheds until standards are met, compliance is negligible and enforcement weak. Discharge of untreated sewage is the single most important cause for pollution of surface and groundwater in India (Kumar *et al.*, 2019b). There is a large gap between the generation and treatment of domestic wastewater in India. The problem is not only that India lacks sufficient treatment capacity but also that the sewage treatment plants that exist do not operate and are not maintained.

In a National Resources Defence Council study of the quality of bottled water (Nation Staff, 1996), approximately one-fifth of samples exceeded bacterial purity guidelines and/or safe levels of arsenic or other synthetic organic chemicals (AJS, 1999). Between 25% and 40% of bottled water was merely repackaged municipal tap water. The cost of illness approach and Shuval calculates the disability-adjusted life years (DALY), to quantify the health burden from illnesses associated with exposure to polluted recreational coastal waters. India is recognized as has to have major issues with water pollution, predominately due to untreated sewerage. Rivers such as the Ganges, the Yamuna, and Mithi Rivers, all flowing through highly populated areas, thus polluted.

Effluents are another by-product of industries which poses threat to the environment, leather and tanning industries, petroleum industries and chemical manufacturing industries create major waste products that are released directly into nearby streams without treatment, creating river pollution and causing harm to aquatic life. The majority of the government-owned sewage treatment plants remain closed most of the time due to improper design or poor maintenance or lack of reliable electricity supply to operate the plants, together with absentee employees and poor management. According to a World Health Organization study, out of India's 3,119 towns and cities, just 209 have partial sewage treatment facilities, and only 8 have full wastewater treatment facilities. Over 100 Indian cities dump untreated sewage directly into the Ganges River. Investment is needed to bridge the gap between 29000 million liters per day of sewage India generates, and a treatment capacity of a mere 6000 million liter per day.

### Drought, desertification, and Water Scarcity

Drought and water scarcity are the third main climate change impact that may significantly contribute to climate-related migration. Droughts, desertification, and water scarcity are likely to increase because of global warming. These phenomena are projected to affect about one-third of the world's current population. Droughts are likely to displace millions of people all over the world, affecting food insecurity and human livelihoods. Sea level rise will extend areas of salinization of groundwater and estuaries, resulting in a decrease in freshwater availability for humans and ecosystems in coastal areas. Moreover, changing precipitation patterns create pressures on the availability of clean water supplies.

**Degradation of fisheries**

In many parts of the world, fish is one of the important components of the human diet. Due to this reason, fish caught from natural water bodies increased highly. This fact can tell us the need of studying the fish stocks in the natural water bodies especially the commercial fishes to manage them in an optimum way. Losses in fisheries include natural and fishing material losses of fish due to spoilage, breakage, size, discarding bycatch and operational losses. Although the extent of the problem varies from place to place, the country as a whole loses huge quantities of fish after capture before it reaches consumers. The need for assessment is a first step towards overcoming losses and defining solutions to the existing problem, Figure 4 indicated that trade work and GDP production economic scale structure technique and conservation of environmental policies structure.

The main reasons for losses were the fishing method, inadequate handling facilities, and delay between catch, collection and distribution, absence of regulations governing quality and standards of fish to be sold for human consumption, lack of regular supervision from the government side and poor extension service and fragmentation of duties and responsibilities in different institutions. Nevertheless, the protection of marine and coastal areas and habitat restoration should not be seen as solutions replacing conventional management approaches, but need to be components of an integrated program of the coastal zone and fisheries management.

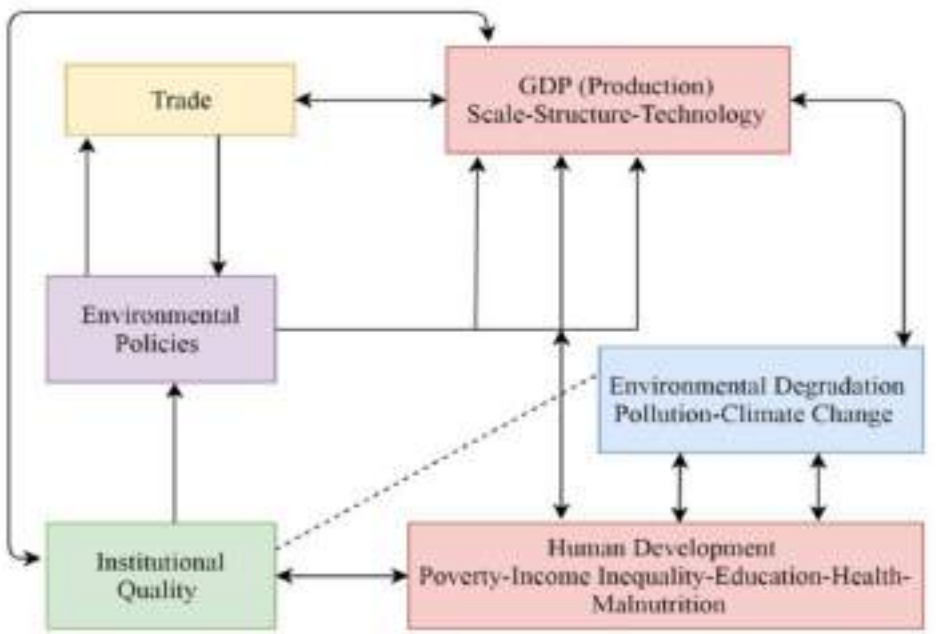


*Figure 4. Relationship between environmental degradation and economic development.*

### Loss of biodiversity

India is a treasure chest of biodiversity which hosts a large variety of plants and has been identified as one of the eight important "Vavilorian" centers of origin and crop diversity. India accounts for 8% of the total global biodiversity with an estimated 49,000 species of plants of which 4900 are endemic (Groom *et al*., 2010). The ecosystems of the Himalayas, the Khasi and Mizo hills of northeastern India, the Vindhya and Satpura ranges of northern peninsular India, and the Western Ghats contain nearly 90 percent of the country's higher plant species and are therefore of special importance to traditional medicine.

Biodiversity is declining on two scales- β diversity (the difference in biodiversity between regions species identities in more and more locations are becoming similar) and γ diversity (global biodiversity is declining), but at particular locations, α diversity may be increasing due to the addition of invaders (Sax *et al*., 2002; Sax and Gaines, 2003). Sax and Gaines (2003) make clear that this phenomenon is not restricted to islands – rather, local biodiversity is increasing in many continental locations as well. Few authors documented declines in a number of components of biodiversity (Pimm *et al*., 1995; Vitousek *et al*., 1997; Sala *et al*., 2000). The pertinent fact is that levels of extinction over the last 300 years are at least several hundred times greater than expected based on the geological record (Diamond, 1989; Dirzo and Raven, 2003). The destruction of wildlife is a different factor that is the reduction of forest and human interfere, hunting it is believed to have been amongst the most significant factors driving the extinction of large wildlife species Table 1 and Table 2 indicated that some endangered flora and fauna respectively. In India hunting has been recognized as a major factor in historical declines of wildlife.

### Education and environmental preferences

Education is an essential tool for environmental protection. Education enhances one's ability to receive, decode and understand information, and that information processing and interpretation have an impact on learning and change behaviors. In recent years, education has been considered a vehicle for sustainable development and thus for the fight against pollution. Education is "a permanent learning process that contributes to the training of citizens whose goal is the acquisition of knowledge, soft skills, and know-how and good manners. The positive effect of education on environmental quality can be channeled in three ways. Firstly, educated people tend to be more conscious of environmental problems and therefore would have behaviors and lifestyles in favor of environmental improvement and demand for environmentally friendly products and decreases the population growth Figure 5.

### Mitigation of environmental degradation

There are ways which can help to decrease degradation in our environment. Some of these include:

Table 1. Endangered flora, causes for loss of biodiversity and places last found (Sources: Anil *et al.*, 2014).

| Species endangered | Place of interest | Causes |
|---|---|---|
| *Rauvolfia serpentine, Terminalia chebula, Sapindus lauri-folius and Jatropha curcas* | Western Ghats | Destructive harvesting followed by unscientific handling |
| *Catuneregam spinnosa, Garcinia cambogea, Acacia pinnata, Ficus benghalensis, Zanthoxzyllum rhesta, Hemides-mus indicus, Terminalia chebula, Wrightia zeylanica, Cin-namomum verum, Bombax ceiba, Sapindus laurifolius, Alangium salvifolium and Calophyllum inophyllum* | Maradavally, Shimoga district | Medicinal use and deforestation |
| *Abrus precatorius, Adenanthera paronina, Aegle marmelos, Caesalpinia bonducella, Cardiospermum halicacabum, Corallocarpus epigaeus, Gloriosa superba, Andrographis paniculata* | Devrayanadurga forests, Tumkur, Deccan Plateau | Destructive harvesting and medicinal use |
| *Lichen genera Parmotrema, Everniastrum, and Rimelia* | Ramnagar and other places in India | Commercial use |
| Arunchal Hopea Tree (*Hopea shingkeng*) | Arunachal Pradesh | Construction of house posts |
| *Hubbardia heptaneuron* | Karnataka | Construction of the Linganamakki reservoir |
| *Sapria himalayana* | Himalayas | Human Influx |

Table 2. Endangered birds, causes for loss of biodiversity and places last found (Sources: Anil *et al.*, 2014).

| Species endangered | Place of interest | Causes |
|---|---|---|
| Seychelles Parakeet (*Psittacula wardi*) | Indian Ocean islands | Intense persecution by farmers and coconut plant owners. |
| Pink-headed Duck (*Rhodonessa caryophy llacea*) and the Himalayan Quail (*Ophrysia superciliosa*) (Adams *et al*., 2003) | Not reported | Annihilated, unrecorded |
| Great Indian Bustard (*Ardeotis nigriceps*), Bengal Florican (*Houbaropsis bengalensis*), Jerdon's Courser (*Rhinoptilus bitorquatus*), Forest Owlet (*Heteroglaux blewitti*), White bellied (*Heron Ardea insignis*) (IUCN endangered red list) | Not reported | Not reported |
| Narcondam Hornbill (*Aceros narcondami*) (IUCN vulnerable species list) | Not reported | Not reported |
| Sarus crane | Himalayas | Hunting |
| Great Indian hornbill *(Buceros bicornis*) | Arunachal Pradesh | Human traditions |
| Long-billed vulture (LBV: *Gyps indicus*), Slender-billed vulture (*Gyps tenuirostris*), and Oriental white-backed vulture, (OWBV: *Gyps bengalensis*) | Northern and Central India | Pesticides |

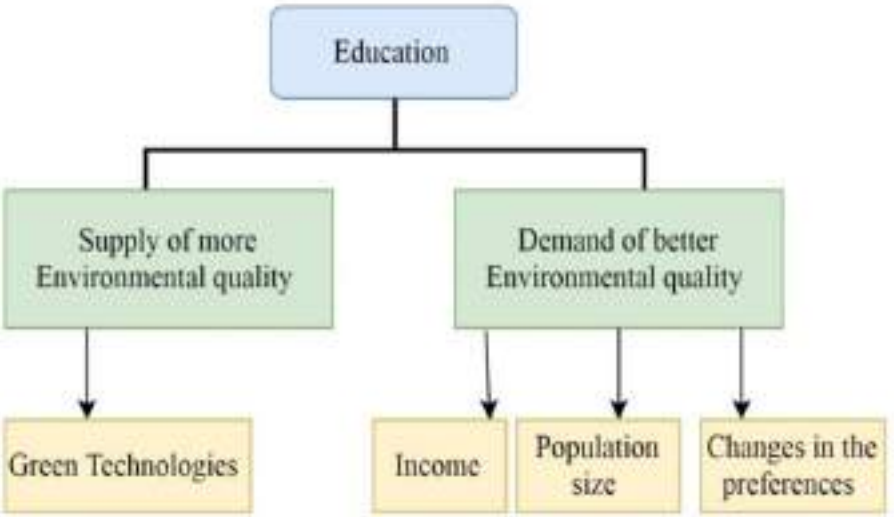


*Figure 5. Impact of education on environmental quality.*

- Purchase recycled products
- Conserve water
- Do not litter or throw waste into inappropriate places
- Conserve energy
- Join an awareness group
- Talk with others about the impacts of environmental degradation

The damage that we cause to the environment is currently not counted as a cost in economic and social terms. This lack of "environmental value" has allowed us to over-exploit "free" natural resources - which are, of course, not free. It has also led to over-production of cheap goods with very short life spans which are liberally discarded into the environment after use, and then new cheap goods are purchased and discarded again, this cycle goes on and on - affecting the planet's capacity to restore its environmental services in good time. We have to change this paradigm of our interaction with the environment. Certainly, don't have the right to exploit and destroy it without thinking about the future generations of humans and animals who will be hereafter us. We are drawing the flow diagram for the mitigation strategies and remediation of soil for the improvement of quality of soil shown in Figure 6, and different environmental component in Figure 7. All countries people have flowed the sustainable development goals their practice of conservation of environmental degradation shown in Figure 8.


*Figure 6. Strategies of mitigation and remediation for slightly and heavily contaminated soil.*

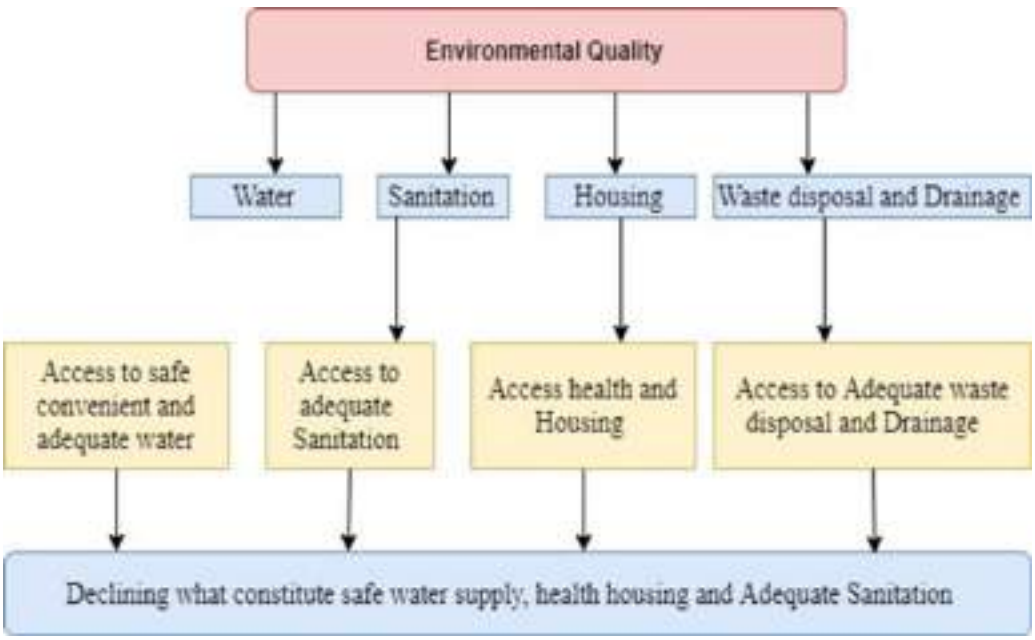


*Figure 7. Different components of environmental quality.*

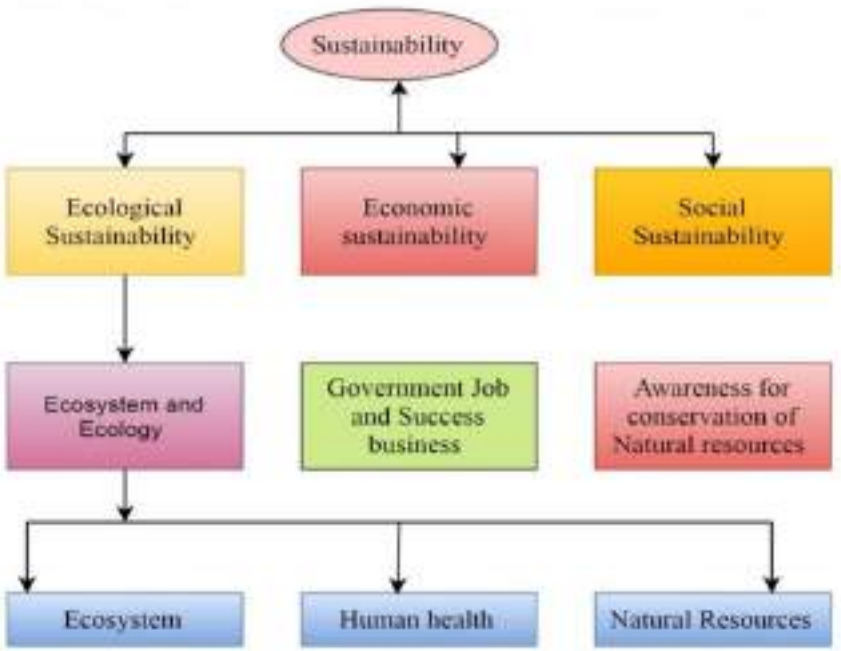


*Figure 8. Sustainability components of human environment.*

- Institutional instruction
- Direct control and regulation
- Economic instruction
- Technological measures
- Educational

In 2000, India's Supreme Court directed all Indian cities to implement a comprehensive waste-management program that would include a household collection of segregated waste, recycling and composting. These directions have simply been ignored. No major city runs a comprehensive program of the kind envisioned by the Supreme Court (Gov. of India).

## Conclusion and recommendations

Environmental degradation is one of the most urgent environmental issues. Depending upon the damage, some environments may never recover. The plants and animals that inhabited these places will be lost forever. The primary causes of environmental degradation in India are attributed to the rapid growth of the population in combination with economic development and

the overuse of natural resources. In order to reduce any future impacts, city planners, industry, and resource managers must consider the long-term effects of development on the environment. Major environmental calamities in India include land degradation, deforestation, soil erosion, habitat destruction and loss of biodiversity. Economic growth and changing consumption patterns have led to rising demand for energy and increasing transport activities. Air, water and noise pollution together with water scarcity dominate the environmental issues in India. According to the World Bank estimate, between 1995 through 2010, India has made one of the fastest progress in the world, in addressing its environmental issues and improving its environmental quality. Still, India has a long way to go to reach environmental quality similar to those enjoyed in developed economies.

There are ways which can help to decrease the degradation of our environment. The most effective method to control pollution and depletion is through completing the legal framework. There are some drawbacks existing in contemporary law, which encourages malfeasances implicitly. Therefore, the government must enhance filling the gap in the legal system to avoid illegal activities. Amendment to provisions relating to the exploitation of natural resources is urgent since over-exploitation is the main reason for the loss of biodiversity. The government has long shaped its perception of economic, as well as social methods to solve the problem of pollution, but the implementation remains limited. Eliminating environmental pollution and recovering our ecology requires more than a single effort to be successful. Authority of all levels must involve not only in policy-making but also in the implementation and supervision of progress, so that the national long-term environmental target can be attained, resulting in sustain-able development.

- The government can utilize economic reward and punishment system to encourage forestation.
- Purchase recycled products
- Conserve water
- Do not litter or toss waste into inappropriate places
- Conserve energy
- Join an awareness group
- Talk with others about the impacts of environmental degradation
- Be an advocate to save our planet!
- improve the quality of drinking water
- Prevent casual use of other unapproved sources
- Increase the quality of water used
- Improve accessibility and of domestic supply

- Improve hygiene
- Strict laws should be passed to control water pollution by individuals and different bodies
- Safety measures to be implemented to prevent oil spillage.
- Chemical waste should be converted to harmless biodegradable substances before being dumped into the rivers and streams
- Refuse should be burnt in an incinerator with built-inn devices to prevent water pollution.
- By making people be aware of the causes and dangers of air pollution
- By improving machinery so that more efficient fuel combustion occurs.
- Control by ventilation- suitable ventilation system should be provided in the kitchen of every house so that the gases produced by burning of wood, coal, oil, etc. can be exhausted very quickly
- Control by vehicle rules- the design of vehicle should be such that complete combustion of fuel takes place in the engine
- Control by forestation- the planting of trees should be planted at parks and public place

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Syllabus: Global environmental issues; deforestation & afforestation; measures of environmental protection; environmental impact assessment; natural resource management

The world environment is facing a dire crisis today due to various types of pollution around us and its spread and effects. Therefore, many global environmental problems such as greenhouse effect, global warming, weight loss, acid rain, El Nino etc. have arisen today. Therefore, people all over the world today can feel the extreme consequences of the near future and want to jointly invent various solutions to protect the environment.

The atmosphere, which surrounds the earth, plays an immense role in maintaining and balancing the environment in various climate changes. An example is the thick ozone layer in the stratosphere. This gas layer is protecting all living things like a shield by not letting the terrible ultraviolet rays of sunlight or Ultra Violet (UV) rays fall on the earth's surface.

It is this atmosphere that in turn warms the Earth and makes life possible for all living things. Through the biogeochemical cycle, the atmosphere, the atmosphere and the atmosphere are closely related. Therefore, if the atmosphere is damaged in any way, then the earth and the atmosphere are affected. Which affects the entire biosphere.

## GREEN HOUSE EFFECT

Like the glass roof of a greenhouse, various gases in the atmosphere such as $CO_2$, methane, O3, $NO_2$, chlorofluorocarbons (CFCs) and water vapor absorb the infrared rays of sunlight (radiation) and combine its heat energy, resulting in an increase in global warming. causing

So, the greenhouse gas layer is almost acting as a one-way filter, allowing sunlight to reach the Earth's surface but not allowing 100% of the infrared rays to be evenly reflected back into space. A greenhouse similarly allows sunlight to pass through to its sheltered plants but does not allow high-wavelength heat energy to return. So, we feel warm inside the greenhouse even on very cold days. Similarly, the Earth's surface would freeze if the natural greenhouse effect did not protect the Earth.

If the levels of greenhouse gases accumulate in the atmosphere due to human activities, then the world environment will face a terrible disaster in the near future.

Effects of Greenhouse gases on environment

| GHGs | Major Sources | Impact (in Percent) |
|---|---|---|
| CO2 | Combustion of fossil fuels, forest destruction | 50% |
| CFC | Refrigerators and other air conditioning appliances, aerosol, foam, perfume | 20% |
| CH4 | Inhalation of organic matter, mainly in agriculture, closed reservoir | 16% |
| O3 | fossil fuel combustion | 8% |
| NOx | Combustion of fossil fuels, fertilizers, soil, Agricultural waste incineration | 6% |
| Water vapour | Natural evaporation of sea, river channels is | huge amount |

The most significant greenhouse gas is $CO_2$. As this gas is one of the components in the photosynthesis process, it also plays an important role in regulating the temperature of the environment. Atmospheric CO levels 100 years ago were 275 ppm. Currently it is around 360 ppm. It is estimated that around 2040 that level could be 450 ppm. Another study revealed that about 14 billion tons of $CO_2$ is being added to the Earth's atmosphere every year.

Atmospheric $CO_2$ levels have risen so much through the burning of fossil fuels. Of these, 25 percent of the world's population (industrialized countries) burn 70 percent of all fossil fuels. The USA leads the way and accounts for 20 percent of the world's total $CO_2$ emissions. Where the population is about 33 billion. In this regard, India's population is second at over 140 billion. India's role in environmental damage in terms of population can therefore be said to be negligible.

Another major cause of increasing $CO_2$ levels in the environment is indiscriminate deforestation. Like fossil fuels, forestry is also a large store of carbon. On the other hand, Banani absorbs $CO_2$ through daily photosynthesis and maintains the balance of the environment. So, unless rapid reforestation is done along with controlled deforestation, the amount of $CO_2$ in the atmosphere will continue to increase. At the same time, the temperature of the environment will increase.

Although $CO_2$ is primarily blamed for this global warming, another greenhouse gas contributing to this is chlorofluorocarbons (CFCs). All of this gas is man-made. CFCs not only cause global warming but also damage the crucial O, layer of the stratosphere.

Another problem with CFCs is their persistence in the environment. They can remain intact in the atmosphere for about 100 years. CFCs are 15,000 times more effective than $CO_2$ in blocking the return of heat energy to space as a greenhouse gas. So, its production in percentage is half that of $CO_2$ but its role is undeniable. Aerosols rich in CFCs are used extensively in Third World countries for air conditioning or fragrance production.

Currently the USA and Japan have phased out the production of CFCs. Air conditioning has evolved into a high-tech innovation. Montreal Protocol of 1987 for this. The role of Helsinki Declaration of 1989, London Conference of 1990 is particularly important. Thus, efforts are being made to control the levels of toxic vapours in the global atmosphere. Water vapor is the most important of the greenhouse gases. Although it is controlled naturally, the role of global warming is very important in increasing its level to a large extent.

## GLOBAL WARMING

In the 1980s, various scientific studies made the whole world aware that various greenhouse gases in nature are the reason for the increase in the quality of the earth. The United Nations Environment Program established the Intergovernmental Panel on Climate Change (IPCC) soon after. About 200 environmental scientists are responsible for implementing all the regulations and restrictions. Their first study was published in 1990 and the second study in 1996. They concluded that-

(1) Earth's average temperature has increased by 0.3-0.6°C over the past 100 years.

(2) At the current rate of greenhouse gas emissions into the atmosphere, it is likely that by 2050 the global temperature will increase by 1.6°C to 5.5°C (2.8°C on average).

If the temperature continues to rise at this rate, the dire effects it will have on the global environment are as follows:

**(a) Rising Sea level:**

Global development has led to an increase of 10.3 cm in August 2022 in August 2022 relative to 1993 in mean sea level elevation across the globe (NASA's satellite record) due to melting glaciers and increasing sea water volume. According to the IPCC study, the global average sea

level rise by 2100 is estimated to be 67 cm. As a result, large areas of coastal areas will be flooded. Islands and countries like Bangladesh will be a disaster. The daily eruption of sea storms, tsunamis, etc. are but signs of this terrible future.

**(b) Melting of Ice Caps :**

As these temperatures rise, the ice caps of Greenland and Antarctica begin to melt. That level will increase in future. As a result, the melting of the polar ice caps will increase the sea level further in the colder waters.

**(c) Disruption of water cycle:**

All these changes in weather affect the water cycle. The periodicity and persistence of droughts and floods will be greatly affected. As on one side the world area will increase under the influence of floods, severe drought will continue elsewhere. The situation in the desert region will become more complicated.

**(d) Changing forests and natural areas:**

This change in climate will necessarily affect the geographical location of the plant kingdom. If CO levels are greater than 500 ppm, deforestation will occur worldwide. The entire fauna and ecosystem sheltered by these large forests will immediately face danger.

**(e) Challenges to agriculture and food supply:**

Climate change, namely an increase in $CO_2$ levels of 500 ppm, will cause a reduction in crop production in various locations. Dry, long summers will increase the need for irrigation. As a result, more water level will decrease, energy consumption will increase, more pollution will increase. That type of weather is favourable for pests and their prevalence will increase. Immediately, the level of pesticides and the resulting pollution will increase.

**(f) Adverse effect on public health (Worsening public health):**

Death rate will increase due to heat stress at high temperature. As air pollution increases, respiratory diseases, allergies etc. will increase. The rise of diseases like malaria, dengue, yellow fever, encephalitis, cholera etc. in tropical countries is threatening that future.

## OZONE LAYER DEPLETION

An important part of the atmosphere is the ozone layer (O3-layer) which extends from an altitude of about 10 km-25 km in the stratosphere. 20-25 km high pronounced ozone is naturally present here.

Ultraviolet rays (UV-rays) from the sun break atmospheric $O_2$ molecules into atomic oxygen (O). That molecular oxygen then combines with O2 to form ozone (O3). O3 again dissociates into $O_2$ and O by absorbing UV.

$$O2 + UV \longrightarrow O + O$$

$$O + O + UV \longrightarrow O3$$

$$03 + UV \longrightarrow O + O2$$

Thus, in nature, through the creation and dissociation of O3, the balance of O2 and O3 is maintained on the one hand, and harmful UV rays are absorbed on the other hand, thereby protecting the entire biosphere in nature. UV rays that come from sunlight are blocked in this ozone layer.

By absorbing UV-radiation, ozone dissociates itself and blocks its entry to the Earth's surface. If these rays come on the living world, the rate of mutation or mutation and the prevalence of skin cancer, cataract, blindness etc. will increase greatly.

In the late 1970s scientists noticed that the total ozone ($0_3$) in the stratospheric ozone layer had gradually decreased to about 4%. Also, ozone depletion has been observed in polar region during winter and spring time. It is called ozone hole or ozone hole. In the Arctic and Antarctic regions, the weight level drops to 30%, i.e. a reduction of about 70%. A special study in 1987 showed that wherever the concentration of ozone in the ozone layer decreased, the concentration of chlorine increased. From this, scientists became convinced of the contribution of chlorofluorocarbons (CFCs) to the depletion of the ozone layer.

**Causes of ozone layer depletion:**

One of the causes of ozone layer depletion is industrial chemicals. Particularly significant chemicals such as halocarbons used in refrigerators, various solvents, propellants, foam blowing agents. Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons HCHCs, halons etc. are called ozone depleting substances or ODS. After these gases are released, they slowly reach the stratosphere in the wind. Here the molecules of the halogen group are dissociated into atoms as a result of photodissociation. which acts as a catalyst in ozone depletion.

Many free radicals act as catalysts in ozone dissociation. The most important free radicals are hydroxyl radical (OH), nitric oxide radical (NO), chlorine radical (Cl-), bromine radical (Br) etc. All of them are very reactive. Cl and Br levels have increased abnormally due to human activities. The main source of which is chlorofluorocarbons. It is unshakable in the troposphere but breaks down rapidly in the stratosphere under the action of UV rays.

$$CFCs + UVC \longrightarrow Cl^{-} + CFCl_2$$

Super active O molecules, in the presence of $CI^{-}$ catalysts, break down and convert to more stable $O_2$ molecules.

$$Cl^{-} + O_3 \longrightarrow ClO + O_2$$

$$ClO + O_3 \longrightarrow Cl^{-} + 2\,O_2$$

The $CI^{-}$ element thus breaks down large amounts of O3 by repeating this two-step chemical reaction countless times. This is one of the causes of ozone depletion.

A $CI^{-}$ element can destroy 100,000 ozone molecules over a period of about 100 years. It is then converted to hydrogen chloride (HCI) and chlorine nitrate ($CIONO_2$), O, exiting the catalytic cycle and returning to the troposphere. In this case Br has more catalytic power but its amount in stratosphere is very less.

Not only CFCs but also nitrogen oxides, hydrochloric acid etc. emitted by new generation aircrafts, missiles or spaceships have been proved to be significant causes of ozone layer depletion. Various chemicals emitted from supersonic transport (SST) of developed countries such as France's Concorde aircraft, USA's missiles such as rockets, solid fuel for missiles, etc. are responsible for creating 03 holes.

**• Chlorofluorocarbons (CFC):**

Thomas Midgley Jr. discovered chlorofluorocarbons (CFCs) as refrigerants in 1930. A company called Du Pont (Du Pont) gave its commercial name Freon (Freon). Since these CFCs are not harmful, insoluble in water, non-flammable, stable and less reactive, their use in various applications has become almost routine. In addition to refrigerators, air conditioning, as non-toxic aerosols, fragrances, room fresheners, etc., their use in foam or plastic industries also began to increase. But stability, which was one of the reasons for their use, is why CFCs are now strictly banned in developed countries around the world because of that stability and serious damage to the ozone layer.

According to scientists, the healing of the Earth's ozone hole will be delayed if proper measures are not taken now.

**Harmful effects of ozone depletion:**

In the presence of excessive UV-B rays, the body produces excess vitamin-D. If the level of vitamin-D in the blood is more than 100mg/ml, the calcium in the blood increases excessively. However, excess vitamin-D synthesis in the body is regulated. However, in many cases, when it is disturbed, the mortality rate of people increases.

• Apart from humans, many terrestrial animals such as dogs, cats, sheep etc. and various aquatic animals including whales have harmful effects of UV-B rays.

• Nitrogen fixing cyano bacteria living in the soil of arable land are damaged by excess UV-rays. As a result the productivity of the land decreases.

• Exposure to excessive UV rays in plants reduces photosynthesis and food intake. As a result the normal growth of the plant may be affected.

**Remedial measure for ozone depletion**

• Avoiding as much as possible the use of substances harmful to ozone gas like CFCs, halogenated hydrocarbons, methyl bromide, nitrous oxide etc.

• Reducing the use of petroleum vehicles.

• Using environmentally friendly substances like vinegar, bicarbonate etc. instead of using various cleaning solvents that are harmful to the environment.

• Use of local products reduces the need for vehicles by reducing the use of exported products. This reduces the amount of nitrous oxide in the environment. which is helpful in ozone depletion.

• Encouraging the use of air coolers based on the theory of latent heat instead of air conditioners. Air conditioners, refrigerators, cars etc. are properly maintained so that no harmful gases are released into the environment.

• Use of hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) as cooling agents. They also destroy the ozone layer but to a much lesser extent than CFCs.

High-tech countries responded when the Montreal Protocol countries issued a complete ban on the preparation and use of CFCs after the 1987 Copenhagen gathering. This protocol has also been quite effective in developing countries.

In 1994, the United Nations General Assembly designated 16 September as World Ozone Day or World Ozone Day. The Montreal Protocol is specially remembered on this day

## ACID RAIN

Acidic reagents are created in nature from various natural causes such as respiration of plants and all animals, volcanic eruptions, lightning, combustion of fossil fuels by humans or internal combustion in various engines. Notable among them are $SO_2$, NO, O3, H2O2, OH etc.

After reacting with water in the atmosphere, these acidic reagents fall to the earth's surface as acid rain. Various acidic gases in the atmosphere dissolve in water vapor to form acids. As a result, this pH level drops significantly during acid rain. Acid rain is when the pH level of rainwater falls below 5.65.

Although it is a global problem, most of the data on damage caused by acid rain comes from Canada, England, Germany, France, Scandinavia and America. Acid rain in New Hampshire in 1969 had a pH of 21. In 1974 it was 2.4 in Scotland. Typical precipitation in the northeastern USA has an average pH of 4.0, meaning it is quite acidic.

**The damage caused by acid rain is various:**

Buildings, monuments, etc. contain lime or CaCO3. The $H_2SO_4$ of acid rain turns this lime into gypsum (Gypsum) or $CaSO_1$ which is easily dissolved in water. Thus damage is caused to the house or building. Metals are similarly affected.

• Its impact on Banani ecosystem is also significant. The impact of acid rain on deforestation is easily understood. Acid rain is being identified as one of the main causes of deforestation in Central Europe, Northeast America and other parts of the world.

• Apart from directly accumulating on the plants and causing damage to the plants, this acid rain damages the plants by accumulating on the soil and destroying the absorption capacity of the roots. Beneficial microbes in the soil are also destroyed by this acid. Indirectly causes damage to plants.

• Acid rain also affects wetland ecosystems. Many lakes have undergone food web changes. Falling below pH 5.5 reduces production of many economically important aquatic organisms such as fish.

Acid rain is also a problem in India's metropolitan and industrial cities. Analysis of rainwater samples from Nagpur, Assam's Mohanbari, Allahabad, Visakhapatnam and Kodaikanal showed pH values ranging from 4.77 to 5.32 over the past decade.

The rate at which thermal power generation, coal burning, petroleum-based vehicles are increasing in and around these cities will have a more dire impact on human life and the environment in the near future.

**Some important measures to reduce acid rain:**

Controlling the emission of carbon dioxide, sulphur dioxide and various oxides of nitrogen into the air. This requires (a) stopping wastage of fuel. (b) Use of refined fuels (c) Discharge of fuel fumes to the environment by releasing oxides of sulphur and nitrogen

by doing (d) Desulphurisation of fuel gas. (e) Use of catalytic converters for internal combustion of fossil fuels. (1) Use of coal washing to reduce sulphur levels. (g) Use of limestone or limestone (calcium carbonate) as a slurry in factory chimneys to help the flue gas release sulphur dioxide. (h) Using hydropower, wind power, geothermal power, solar power and nuclear power etc. as alternative energy sources.

## EL-NINO OR SOUTHERN OSCILLATION

El Niño is a tropical storm that occurs along the west coast of Peru mainly around Christmas. (El Nino means child of Jesus Christ). Gilbert Walker (Gilbert Walker) in 1904 and Jacob Bjerknes (Jacob Bjerknes) in 1966 and 1969 informed people about this southern storm caused by atmospheric pressure across the Pacific Ocean. According to Gilbert, if the air pressure increases in the eastern part of the Pacific Ocean, it decreases in the western part. On the other hand, an increase in air pressure on the west coast causes a decrease in air pressure on the east coast. He called it Oscillation. Jerkness said that sea surface temperatures cause vortex in the central Pacific oceans. Warm air from the western Pacific rises, flows eastward, and takes shelter in the Eastern Pacific oceans. Along the way that air becomes progressively hotter and collects huge water vapour. In this way, the rain cloud is formed and the warm ocean storm or El-Nino is created.

As a result of this, on the one hand, storms are created in the North and East American coasts, and the Western Pacific countries, such as Australia, then create droughts. El Niño also increases rainfall in distant regions such as the western United States and Mexico, and temperatures in the USA, Canada, and Alaska become above average during these storms.

**Consequences of El-Nino:**

• Ecosystems are naturally affected by these natural changes. Production of seasore adjacent fish decreases. All nearby birds that survive eating them are affected. The number of phytoplankton decreases significantly and marine productivity decreases. Due to this, the number of sea cow (*sindhughotak*) and seal fish decreased. Thus, significant changes in the ocean and coastal ecosystems of South America are caused by El-Nino.

• Distant continents are also affected as a result of El Niño. The 1982-83 El Niño caused many storms in North America. NASA is generally responsible for El Niño by searching for the cause of ocean storms such as Katrina, Rita etc. originating in America.

• El Niños in North and South America, on the other hand, cause severe droughts in Australia. Its effect is considerable on the flora and fauna of the region.

## DEFORESTATION

Deforestation is the purposeful clearing of forested land. Throughout history and into modern times, forests have been razed to make space for agriculture and animal grazing, and to obtain wood for fuel, manufacturing, and construction. Deforestation has greatly altered landscapes around the world.

the large-scale removal of trees from forests (or other lands) for the facilitation of human activities. It is a serious environmental concern since it can result in the loss of biodiversity, damage to natural habitats, disturbances in the water cycle, and soil erosion.

**Causes of deforestation:**

Direct causes of deforestation are agricultural expansion, wood extraction (e.g., logging or wood harvest for domestic fuel or charcoal), and infrastructure expansion such as road building and urbanization.

**Effects of deforestation:**

- Major climate change: Increase in temperature and pollution level.
- Desertification and soil erosion.
- Increase in the greenhouse gases in the atmosphere.
- Decrease in groundwater level.
- Loss of food and habitat of animals which leads to their extinction.

**Practical Ways to Stop Deforestation:**

1. Plant More Trees. Engage in tree-planting initiatives in your community or through global organizations.
2. Go Paperless. ...
3. Support Responsible Companies. ...
4. Buy Certified Wood Products. ...
5. Buy and Use Responsibly. ...
6. Avoid Palm Oil. ...
7. Recycle and Buy Recycled Products. ...
8. Educate Others.

**Disadvantages:**

The loss of trees and other vegetation can cause climate change, desertification, soil erosion, fewer crops, flooding, increased greenhouse gases in the atmosphere, and a host of problems for Indigenous people.

## AFFORESTATION

**Afforestation** is the planting of saplings, trees to increase forest cover. This is a measure taken to protect and conserve our environment from the harmful effects of pollution and human development.

Afforestation is the planting or adding of trees in an area where there was never a forest or plantation. This is a method to create a new forest. Reforestation is the

replanting of trees in an area where there was once a forest which was destroyed or damaged.

**Major types of afforestation:**

1. Natural regeneration,
2. Commercial plantations, and
3. Agroforestry.

**Purposes of afforestation:**

Its purpose is to restore an area that has been destroyed due to previous overuse of the land or to reduce the amount of erosion in the soil in an area and establish a more fertile and stable soil base.

In addition to several essential products, forests also play an important role in protecting our environment by:

- Promoting rainfall.
- Reduces noise pollution.
- Maintains the ecological balance.
- Acts as a wind barrier from heavy winds.
- Provide moisture and lower the temperature.
- Generally total porosity and water holding capacity of soils increased after afforestation.

There are several benefits from afforestation such as carbon sequestration, increasing rainfall, prevention of topsoil erosion (from water and wind), flood and landslide mitigation, barriers against high winds, shelter for wildlife, employment and alternative sources of wood products.

**Examples:**

Large-scale afforestation programs were prominent in United Kingdom forestry during the twentieth century to reduce reliance on imported wood. Afforestation programs have been used to expand the forest resources in Brazil, Chile, New Zealand, and other countries.

China's nationwide Grain-for-Green Program (GFGP) is the largest reforestation programme in the world. Initiated in 1999 primarily to control soil erosion, GFGP uses cash payments to incentivize rural households to reestablish forest, shrub and/or grassland on sloped cropland and scrubland

**Some Disadvantages of afforestation:**

- Expensive procedure as it requires more manpower to perform various jobs.
- If trees do not get proper space while growing, it may cause damages above and below ground levels.
- Trees need proper maintenance to grow. Fruit trees require more maintenance to grow.

## NATURAL RESOURCE MANAGEMENT:

Natural resource management deals with managing the way in which people and natural landscapes interact. It brings together natural heritage management, land use planning, water management, bio-diversity conservation, and the future sustainability of industries like agriculture, mining, tourism, fisheries and forestry. The objectives of natural resource management are as follows: To maintain ecological diversity. To provide resources for future generations. To maintain employment facilities for people.
To maintain a balance in the ecosystem. To avoid further destruction of the environment. To avoid over-consumption of natural resources.

**Scope:**

Natural Resource Management (NRM) refers to the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries, and wild flora and fauna. Together, these resources provide the ecosystem services that provide better quality to human life.

**Purpose:**

Natural Resource Management (NRM) refers to the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries, and wild flora and fauna. Together, these resources provide the ecosystem services that provide better quality to human life.

**Importat Natural Resources:**

(1) forest provides us with food, timber, fuel, and shelter, (2) air provide us with oxygen to breathe, (3) land is used for cultivation and growing food products, (4) sunlight gives us solar energy which is an important alternative source of energy, etc.

- Trees. Paper, furniture, fuel.
- Cotton. Clothing.
- oil/petroleum. Plastic, fuel.
- Natural gas. Fuel.
- Coal. Fuel.
- iron ore. Steel products (cans, bridges)
- Bauxite ore. Aluminum products (cans, car.
- Gold. Jewelry, dental material.

Crude oil: Oil is the most valuable natural resource in the world. It is used to fuel transportation, generate electricity, and produce a variety of products, including plastics and chemicals. Natural gas: Natural gas is another valuable energy source, used for heating and generating electricity.

**Sustainable Management of Natural Resources:**

It means conserving the resources to use them efficiently and avoid their misuse for individual purposes. Management of natural resources: Management of natural resources is highly important both for us and future generations.

**Simple Things One Can Do to Help Protect the Earth:**

1. Reduce, reuse, and recycle useable items. Cut what you throw away
2. Volunteer for cleanups our community
3. Educate self and others
4. Conserve water
5. Choose sustainable
6. Shopping wisely
7. Use long-lasting light bulbs
8. Plant a tree.

## ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

EIA full form is Environmental Impact Assessment. In simple terms, the meaning of EIA is that it is a process through which an environmental impact of a proposed development is evaluated.

**Important Steps to Conducting a Mining EIA:**

- Environmental screening. Screening is the first stage in an EIA. ...
- Scoping. This second stage allows you to prioritize critical issues to keep in mind during an EIA while eliminating others. ...
- Impact assessment and mitigation. ...
- Impact management. ...
- EIA report. ...
- Review and licensing. ...

- Monitoring.

EIA collects, analyses, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment.

The National Environmental Act, 1998 requires environmental impact assessment for large scale projects in sensitive areas. It is enforced by the Central Environmental Authority.

**Example of EIA:**

An environmental impact assessment example would be the need to assess what a new manufacturing facility in a region means as far as air quality, water quality, noise pollution, ecosystem upset, and more.

**The objectives of EIA**

(i) to identify, predict and evaluate the economic, environmental and social impact of development activities (ii) to provide information on the environmental consequences for decision making and (iii) to promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

**Stages of the EIA process;**

- Screening. Deciding if an EIA is required.
- Scoping. Deciding what needs to be covered in the assessment and reported in the 'EIA Report'
- Preparing the EIA Report. ...
- Making an application and consultation. ...
- Decision making. ...
- Post decision.

**Limitations of EIA:**

- the appropriate use of screening criteria to determine if EIAs are needed.
- quality control of the data and data gaps.
- quality of the process and methodological rigour.
- lack of harmonised procedures for involving the public.
- focus on site boundaries.

the key elements of environmental impact assessment include scoping, baseline data collection, impact assessment, mitigation measures, monitoring and evaluation, and public participation.

Scoping occurs early in the project cycle at the same time as outline planning and pre-feasibility studies. Scoping is the process of identifying the key environmental issues and is perhaps the most important step in an EIA.

**Good EIA:**

The EIA report should be clear, concise, consistent, and comprehensive, and should cover all the relevant aspects of the assessment, such as the scope and objectives, the baseline study, the alternatives and impacts, the stakeholder involvement, the mitigation measures, the monitoring plan, and the conclusions.

**VALUE ADDED COURSE ON ENVIRONMENTAL SCIENCE**

**UNIT-II**

**(From Department of Botany)**

আমাদের পারিপার্শিক বিভিন্ন প্রকার দূষণ ও তার নানামুখী বিস্তার ও প্রভাবের কারণে বিশ্ব পরিবেশ আজ এক ভয়াবহ সংকটের সম্মুখে। তাই আজ সৃষ্টি হয়েছে একাধিক বিশ্ব পরিবেশ সমস্যা যেমন-গ্রীনহাউস এফেক্ট, বিশ্বউষ্ণায়ণ, ওজনস্তর হ্রাস, অম্লবৃষ্টি, এলনিনো প্রভৃতি। তাই বিশ্ব ব্যাপী মানুষ আজ অদূর ভবিষ্যতের চরম পরিণতির কথা অনুভব করতে পারছে এবং মিলিতভাবে উদ্ভাবন করতে চাইছে পরিবেশ রক্ষার নানা প্রতিকার।

বায়ুমণ্ডল, যা পৃথিবীকে ঘিরে আছে, পরিবেশের নানাবিধ পরিবর্তনে পরিবেশ রক্ষায় ও ভারসাম্য নিয়ন্ত্রণে তার অপরিসীম ভূমিকা রয়েছে। উদাহরণ হিসাবে বলা যায় স্ট্রাটোস্ফিয়ারে থাকা ঘন ওজোন স্তরের কথা। এই গ্যাসস্তর সূর্যালোকের ভয়ানক অতিবেগুনী রশ্মি বা Ultra Violet (UV) রশ্মি পৃথিবী পৃষ্ঠে পড়তে না দিয়ে ঢাল-এর মত রক্ষা করে চলেছে সকল জীবজগৎ কে।

এই বায়ুমণ্ডলই আবার পৃথিবীকে উষ্ণতা দিয়ে সকল জীবের জীবনধারণকে সম্ভব করে তোলে। জৈব-ভূরাসায়নিক চক্র (Biogeochemical cycle) এর মাধ্যমে বায়ুমণ্ডল, ভূমণ্ডল এবং বারিমণ্ডল এক নিবিড় সম্পর্কে আবন্ধ। তাই বায়ুমণ্ডল কোনরকম ভাবে ক্ষতিগ্রস্থ হলে তার প্রভাবে ভূমণ্ডল ও বারিমণ্ডল ক্ষতিগ্রস্থ হয়। যার প্রভাব পড়ে সমগ্র জীবমণ্ডলের উপর।

## গ্রীন হাউস এফেক্ট (Greenhouse Effect)

গ্রীন হাউসের কাঁচের ছাদের মত বায়ুমণ্ডলের বিভিন্ন গ্যাস যেমন $CO_2$, মিথেন, O3, $NO_2$, ক্লোরোফ্লুরো কার্বন (CFC ) এবং জলীয় বাষ্প সূর্যালোকের ইনফ্রারেড (Infrared) রশ্মি (বিকীরণ) শোষণ করে তার তাপশক্তিকে সংবন্ধন করছে যার ফলে পৃথিবী পৃষ্ঠের উয়তা ক্রমে বৃদ্ধি পেয়ে বিশ্ব উন্নায়ন ঘটাচ্ছে। সুতরাং গ্রীনহাউস গ্যাসস্তর প্রায় একটি একমুখী ছাঁকনির (one way filter) কাজ করছে, যা সূর্যালোক পৃথিবীপৃষ্ঠে আসতে দিচ্ছে কিন্তু ইনফ্রারেড রশ্মিকে সমমাত্রায় প্রতিফলিত হয়ে মহাকাশে 100% ফিরে যেতে দিচ্ছে না। গ্রীনহাউসও একইভাবে সূর্যালোককে প্রবেশ করতে দেয় তার আশ্রিত চারাগাছদের কাছে কিন্তু উচ্চ-তরঙ্গদৈর্ঘ্যের তাপশক্তিকে ফিরে যেতে দেয় না। তাই খুব শীতল দিনেও গ্রীনহাউসের ভিতর আমরা উন্নতা বোধ করি। তেমনই পৃথিবীপৃষ্ঠ হীমশীতল হয়ে জমেই যেত যদি না প্রাকৃতিক গ্রীনহাউস এফেক্ট এই পৃথিবীকে রক্ষা করত।

<u>পরিবেশে গ্রীনহাউস গ্যাসসমুহের প্রভাব (Effects of Greenhouse gases on environment):</u>

| **গ্রীনহাউস গ্যাস** | **মুখ্য উৎসগুলি** | **প্রভাব (শতাংশে)** |
|---|---|---|
| CO2 | জীবাশ্ম জ্বালানির দহন, বনানী ধ্বংস | 50% |
| CFC | ফ্রীজ ও অন্যান্য শীততাপ নিয়ন্ত্রণ যন্ত্র, এরোসল (aerosol), ফোম, সুগন্ধি | 20% |
| মিথেন | জৈব পদার্থের অবাত শ্বসন, মূলতঃ কৃষিক্ষেত্রে, | 16% |

| | | |
|---|---|---|
| | বন্ধ জলাশয়ে | |
| O3 | জীবাশ্ম জ্বালানির দহন | 8% |
| নাইট্রোজেনের অক্সাইড | জীবাশ্ম জ্বালানির দহন, সার, মাটি, | |
| | কৃষিক্ষেত্রের বর্জ্যপদার্থের দহন | 6% |
| জলীয় বাষ্প | সমুদ্র, নদী নালার স্বাভাবিক বাষ্পীভবন | বিপুল পরিমাণ |

সবচেয়ে উল্লেখযোগ্য গ্রীনহাউস গ্যাস হল $CO_2$। এই গ্যাস যেমন সালোকসংশ্লেষ প্রক্রিয়ায় অন্যতম উপাদান, পরিবেশের তাপমাত্রা নিয়ন্ত্রণেও এর ভূমিকা বিশেষ গুরুত্বপূর্ণ। 100 বছর আগে বায়ুমণ্ডলের CO-র মাত্রা ছিল 275 ppm। বর্তমানে তা প্রায় 360 ppm। অনুমান করা হচ্ছে 2040 সালের কাছাকাছি ঐ মাত্রা 450 ppm হতে পারে। প্রতিবছর পৃথিবীর বায়ুমণ্ডলে প্রায় 18 বিলিয়ন টন $CO_2$ যুক্ত হচ্ছে বলে অন্য এক সমীক্ষায় প্রকাশ।

জীবাশ্ম জ্বালানির দহনের মাধ্যমেই বায়ুমণ্ডলের $CO_2$-র মাত্রা এত বেড়ে উঠেছে। এর মধ্যে পৃথিবীর জনসংখ্যার 25 শতাংশ (শিল্পসমৃদ্ধ দেশগুলি) মোট জীবাশ্ম জ্বালানির 70 শতাংশ দহন করে। USA এই ব্যাপারে সবচেয়ে এগিয়ে আছে এবং পৃথিবীর মোট $CO_2$ সৃষ্টির 20 শতাংশ সেই দেশ থেকেই। যেখানে জনসংখ্যা প্রায় 33 বিলিয়ন। এই ব্যাপারে ভারতবর্ষের জনসংখ্যা দ্বিতীয়প্রায় 180 বিলিয়নের ওপরে। জনসংখ্যার বিচারে পরিবেশের ক্ষতি সাধনে ভারতবর্ষের ভূমিকা তাই সামান্যই বলা 'যেতে পারে।

পরিবেশের $CO_2$-র মাত্রাবৃদ্ধির অন্য বৃহত্তম কারণ হল নির্বিচারে বনানী হ্রাস। জীবাশ্ম জ্বালানির মতই, বনানীও কার্বনের বৃহৎ সঞ্চয়। অন্যদিকে নিত্য সালোকসংশ্লেষের মাধ্যমে $CO_2$ শোষণ করে ও পরিবেশের ভারসাম্য রক্ষা করে বনানী। তাই নিয়ন্ত্রিত বৃক্ষমোচনের সাথে সাথে যদি দ্রুত বনসৃজন না করা হয় তবে বায়ুমণ্ডলে $CO_2$-র পরিমাণ বৃদ্ধি পেতেই থাকবে। সাথে সাথে বৃদ্ধি পাবে পরিবেশের তাপমাত্রা।

যদিও $CO_2$ কেই মূলতঃ এই গ্লোবাল ওয়ার্মিং-এর জন্য দায়ী করা হয়ে থাকে, এই কাজে আর এক সহযোগী গ্রীনহাউস গ্যাস হল ক্লোরোফ্লুরোকার্বন (CFC)। এই গ্যাসের পুরোটাই মানব সৃষ্ট। CFC শুধুমাত্র গ্লোবাল ওয়ার্মিং করে তাই নয় স্ট্রাটোস্ফিয়ারের অত্যন্ত গুরুত্বপূর্ণ O, স্তরকেও ক্ষতিগ্রস্ত করে।

CFC-র আর এক সমস্যা হল পরিবেশে এর স্থায়িত্ব। প্রায় 100 বছর এরা বায়ুমণ্ডলে অবিকৃত ভাবে থেকে ক্ষতিসাধন করতে পারে। CFC গ্রীনহাউস গ্যাস হিসাবে তাপশক্তির মহাকাশে ফিরে যাওয়ার পথে বাধা সৃষ্টির কাজে $CO_2$ থেকে 15000 গুণ বেশী কার্যকর। তাই শতাংশে এর উৎপাদন $CO_2$-র তুলনায় অর্ধেক হলেও এর ভূমিকা অনস্বীকার্য। তৃতীয় বিশ্বের দেশগুলিতে যথেচ্ছ পরিমাণ CFC সমৃদ্ধ এরোসলের ব্যবহার চলছে শীততাপ নিয়ন্ত্রণে বা সুগন্ধি উৎপাদনে।

বর্তমানে USA এবং জাপান CFC-এর উৎপাদন বন্ধ করে দিয়েছে। শীততাপ নিয়ন্ত্রণের পরিবর্ত উচ্চ প্রযুক্তির উদ্ভাবন হয়েছে। এর জন্য 1987-এর মনট্রিল প্রোটোকল (Montreal Protocol). 1989-এর হেলসিঙ্কি ডিক্লেরেশন (Helsinki Declaration), 1990-র লন্ডন সম্মেলন (London Conference)-এর ভূমিকা বিশেষ গুরুত্বপূর্ণ। এইভাবে বিশ্বপরিমণ্ডলে বিষবাষ্পের মাত্রা নিয়ন্ত্রণের প্রচেষ্টা চলছে। গ্রীনহাউস গ্যাসগুলির মধ্যে জলীয় বাষ্প অত্যন্ত গুরুত্বপূর্ণ। প্রাকৃতিক ভাবে নিয়ন্ত্রিত হলেও অনেকাংশে এর মাত্রা বৃদ্ধিতে বিশ্ব উষ্ণায়ণএর ভূমিকা বিশেষ গুরুত্বপূর্ণ।

## বিশ্ব উন্নায়ন (Global Warming)

1980-র দশকেই বিভিন্ন বিজ্ঞান গবেষণায় সমগ্র বিশ্ববাসী জেনে যায় যে প্রকৃতির বিভিন্ন গ্রীনহাউস গ্যাসই পৃথিবীর উন্নতা বৃদ্ধির কারণ। রাষ্ট্রসঙ্ঘের (United Nations) পরিবেশ কার্যক্রম এর পরই স্থাপন করে ইন্টারগভর্মেন্ট প্যানেল অন ক্লাইমেট চেঞ্জ (IPCC)। যাদের মধ্যে প্রায় 200 জন পরিবেশ বিজ্ঞানীর দায়িত্ব হয় এই সংক্রান্ত যাবতীয় নিয়মনীতি ও নিষেধাজ্ঞা প্রবর্তনের। তাদের প্রথম সমীক্ষা 1990 সালে দ্বিতীয় সমীক্ষা 1996 সালে প্রকাশিত হয়। এতে তারা সিদ্ধান্তে পৌঁছান যে-

(1) পৃথিবীর গড় তাপমাত্রা গত 100 বছরের 0.3-0.6°C বৃদ্ধি পেয়েছে।

(2) যেভাবে বর্তমানে গ্রীনহাউস গ্যাস বায়ুমণ্ডলে নিক্ষিপ্ত হচ্ছে তাতে2050 সালের মধ্যেই সম্ভাবনা আছে যে পৃথিবীর তাপমাত্রা 1.6°C থেকে 5.5°C (গড় 2.8°C) বৃদ্ধি পাবে ।

এই হারে তাপমাত্রা বৃদ্ধি পেতে থাকলে বিশ্বপরিবেশের উপর তা কি ভয়ানক প্রভাব ফেলবে তা নিম্নরূপ:

**(ক) সমুদ্রতলের উচ্চতা বৃদ্ধি (Rising Sea level):**

বিশ্ব উন্নয়নের ফলে হিমবাহের গলন এবং সমুদ্র জলের আয়তন বৃদ্ধির কারণে সমগ্র পৃথিবীর গড় জলতলের উচ্চতা 1993-র সাপেক্ষে আগস্ট 2022-এ 10.3 cm বৃদ্ধি পেয়েছে (NASA-এর স্যাটেলাইট রেকর্ড)। IPCC-র সমীক্ষা অনুযায়ী 2100 সালে পৃথিবীর গড় সমুদ্রতলের উচ্চতা বৃদ্ধি 67 cm অনুমান করা হয়েছ। এর ফলে উপকূলভাগের বিস্তীর্ণ অঞ্চলের ভূভাগ প্লাবিত হবে। দ্বীপপুঞ্জগুলির ও বাংলাদেশের মত দেশগুলি চরম বিপর্যয় হবে। সামুদ্রিক ঝড়, সুনামী ইত্যাদির নিত্য আস্ফালন কিন্তু এই ভয়ংকর ভবিষ্যতেরই সংকেত মাত্র।

**(খ) মেরুর বরফের গলন (Meltiny of Ice Caps):**

এই তাপমাত্রা বৃদ্ধির সাথে সাথে গ্রীনল্যান্ড এবং অ্যান্টার্কটিকার বরফ গলতে শুরু করেছে। ভবিষ্যতে সেই মাত্রা আরো বৃদ্ধি পাবে। ফলস্বরূপ মেরুর বরফ গলে সমুদ্রপৃষ্ঠ আরো বৃদ্ধি পাবে শীতল জলে।

**(গ) জলচক্রের বিপর্যয় (Disruption of water cycle):**

আবহাওয়ার এই সব পরিবর্তনের প্রভাব পড়ে জলচক্রে। খরা ও বন্যার পর্যায়ক্রম ও স্থায়িত্ব ভীষণ ভাবে প্রভাবিত হবে। একদিকে যেমন বন্যার কবলে বাড়বে বিশ্ব ভূভাগ, পাশে পাশেই অন্য কোথাও চলতে থাকবে প্রবল খরা। মরু অঞ্চলের পরিস্থিতি হয়ে উঠবে আরো সঙ্গীন।

**(ঘ) বনানি ও প্রাকৃতিক অঞ্চলের পরিবর্তন (Changing forests and natural areas) :**

জলবায়ুর এই পরিবর্তন আবশ্যিকভাবে উদ্ভিদসম্রাজ্যের ভৌগোলিক অবস্থানকে প্রভাবিত করবেই। CO এর মাত্রা 500 ppm-এর বেশী হলে বনানির সংকোচন হবে পৃথিবী জুড়েই। সাথে সাথে বিপদের সম্মুখীন হবে এইসকল বৃহৎ বনানির আশ্রয় থাকা সমগ্র জীবজন্তু ও ইকোসিস্টেম।

**(৬) কৃষিক্ষেত্রের ও খাদ্য উৎপাদনে সমস্যা (Challenges to agriculture and food supply) :**

জলবায়ুর পরিবর্তন, যথা $CO_2$-র মাত্রা 500 ppm বৃদ্ধি বিভিন্ন স্থানের শস্যের উৎপাদন হ্রাসের কারণ ঘটবে। শুষ্ক, বহুদিনব্যাপী গ্রীষ্মে সেচের প্রয়োজনীয়তা বাড়বে। ফলে আরো জলস্তর হ্রাস, শক্তির ব্যবহার বাড়বে, আরো দূষণ বাড়বে। ঐ ধরনের আবহাওয়া কীট পতঙ্গদের ক্ষেত্রে উপযোগী বলে তাদের প্রাদুর্ভাব বাড়বে। সাথে সাথেই কীটনাশক ও তদসৃষ্ট দূষণের মাত্রা বাড়বে।

**(চ) জনস্বাস্থ্যের উপর বিরূপ প্রভাব (Worsening public health):**

বেশী তাপমাত্রায় তাপীয় চাপে (Heat stress) মৃত্যুর হার বাড়বে। বায়ুর দূষণ বাড়লে শ্বাসরোগ, অ্যালার্জি ইত্যাদি বাড়তে থাকবে। গ্রীষ্মপ্রধান দেশগুলির রোগসমূহ যেমন ম্যালেরিয়া, ডেঙ্গু, পীতজ্বর, এনসেফেলাইটিস, কলেরা ইত্যাদির বৃদ্ধি কিন্তু সেই ভবিষ্যতেরই সংকতে দিচ্ছে।

## ওজোনস্তর হ্রাস (Ozone depletion)

বায়ুমণ্ডলের স্ট্রাটোস্ফিয়ারের নীচের দিকে প্রায় 10 km-25 km উচ্চতা পর্যন্ত বিস্তৃত ওজোনস্তর (O3-স্তর) একটি গুরুত্বপূর্ণ অংশ। এখানে 20-25km উচ্চতায় ওজোন সবচাইতে ঘনভাবে থাকে।

সূর্যকিরণের অতিবেগুনী রশ্মি (UV-ray) বায়ুমণ্ডলের $O_2$ অণুকে ভেঙে পারমাণবিক অক্সিজেন (O) তৈরী করে। সেই আণবিক অক্সিজেন তখন O2 এর সঙ্গে যুক্ত হয়ে ওজোন (O3) তৈরী করে। O3 আবার UV শোষণ করে $O_2$ এবং O তে বিয়োজিত হয়।

$$O2 + UV \longrightarrow O + O$$

$$O + O + UV \longrightarrow O3$$

$$03 + UV \longrightarrow O + O2$$

প্রকৃতিতে এইভাবে O3 সৃষ্টি এবং বিয়োজনের মাধ্যমে একদিকে যেমন O2 এবং O3-র ভারসাম্য বজায় থাকে অন্যদিকে ক্ষতিকর UV রশ্মি শোষিত হয় ফলে প্রকৃতিতে সমগ্র জীবজগতে সুরক্ষিত থাকছে।

এই ওজোন স্তরে UV রশ্মি যা সূর্যালোক থেকে আসে তা প্রতিহত হচ্ছে।

UV- রশ্মি কে শোষণ করে নিজে আলোক বিয়োজিত হয়ে ওজোন পৃথিবী পৃষ্ঠে এর প্রবেশ রুদ্ধ করছে। এই রশ্মি জীবজগতের উপর এসে পড়লে পরিব্যক্তি বা পরিব্যাক্তি এর হার এবং তার থেকে ত্বকের ক্যান্সার, চোখের ছানি (cataract), অন্ধত্ব প্রভৃতির প্রাদুর্ভাব ভীষণ ভাবে বৃদ্ধি পাবে।

1970-এর শেষের দিকে বিজ্ঞানীদের নজরে আসে যে স্ট্রাটোস্ফিয়ারের ওজোনস্তরের মোট ওজেন ($O_3$)-এর ধীরে ধীরে প্রায় 4% কমে গেছে। এছাড়াও মেরু অঞ্চলের শীতকালীন এবং বসন্তকালীন (Winter and Spring time) ওজোন হ্রাস ব্যাপক মাত্রায় দেখা গেছে। ইহাকে ওজোন গহবর বা ওজোন হোল (ozone hole) আক্ষা দেওয়া হয়েছে। উত্তরমেরু (Arctic) এবং দক্ষিণমেরু (Antarctic) অঞ্চলে ওজনের মাত্রা 30%-এ নেমে আসে অর্থাৎ প্রায় 70% হ্রাস পায়। 1987-এ একটি বিশেষ গবেষণায় দেখা গেছে যেখানেই ওজোনস্তরের ওজোন এর ঘনত্ব কমছে সেখানে ততই ক্লোরিণের ঘনত্ব বেড়েছে। এর থেকেই ওজোনস্তর হ্রাসে ক্লোরোফ্লোরোকার্বনের (CFCs) অবদানের ব্যাপারে বিজ্ঞানীরা নিশ্চিত হন।

**ওজোনস্তর হ্রাসের কারণ (Causes of ozone layer depletion)**

ওজোনস্তর হ্রাসের অন্যতম কারণ হল শিল্প উৎপাদিত রাসায়নিক পদার্থসমূহ। বিশেষ উল্লেখযোগ্য রাসায়নিক পদার্থ যেমন রেফ্রিজারেটরে ব্যবহৃত হ্যালোকার্বন, বিভিন্ন সলভেন্ট, প্রোপেল্যান্ট, ফোম-প্রবাহনে সহায়ক পদার্থ (Foam blowing agents)। ক্লোরোফ্লুরোকার্বনসমূহ (CFCs), হাইড্রোক্লোরোফ্লোরোকার্বন HCHCs, হ্যালন সমূহ (Halons) প্রভৃতিকে ওজোন হ্রাসকারী পদার্থ (ozone depleting substances) বা ODS বলে। এই গ্যাসসমূহ নিষ্কাষনের পর ধীরে ধীরে বাতাসের আলোড়নে স্ট্রাটোস্ফিয়ারে পৌঁছায়। এখানে হ্যালোজেন গোষ্ঠির অণুসকল আলোক বিয়োজনের (photodissociation) ফলে পরমাণুতে বিশ্লিষ্ট হয়। যা ওজোন হ্রাসে অনুঘটকের কাজ করে।

একাধিক মুক্ত মূলক (Free radicals) ওজোন বিয়োজনে অনুঘটকের কাজ করে। সবচাইতে গুরুত্বপূর্ণ মুক্ত মূলকগুলি হল-হাইড্রক্সিল মূলক (OH), নাইট্রিক অক্সাইড মূলক (NO), ক্লোরিন মূলক (Cl-), ব্রোমিন মূলক (Br) প্রভৃতি। এরা প্রত্যেকেই ভীষণ ক্রিয়াশীল (reactive)। মনুষ্য ক্রিয়াকলাপে $Cl^-$ এবং $Br^-$ এর মাত্রা অস্বাভাবিক ভাবে বৃদ্ধি পেয়েছে। যার প্রধান উৎস হল ক্লোরোফ্লুরোকার্বন। ইহা ট্রোপোস্ফিয়ারে অবিক্রিত থাকলেও স্ট্রাটোস্ফিয়ারে UV রশ্মির ক্রিয়ায় দ্রুত ভেঙে যায়।

$$CFCs + UVC \longrightarrow Cl^- + CFCl_2$$

অতিসক্রিয় O, অণু Cl অনুঘটকের উপস্থিতিতে, ভেঙে অধিকতর স্থায়ী $O_2$ অণুতে রূপান্তরিত হয়।

$$Cl^- + O_3 \longrightarrow ClO + O_2$$

$$ClO + O_3 \longrightarrow Cl^- + 2\,O_2$$

$Cl^-$ মূলক এইভাবে অজস্র বার এই দুই ধাপ রাসায়নিক বিক্রিয়া পুনরাবৃত্তি করে প্রচুর সংখ্যক $O_3$ ভেঙে দেয়। ইহাই ওজোনস্তর হ্রাসের অন্যতম কারণ।

একটি $Cl^-$ মূলক প্রায় 100 বছর কাল ধরে 100,000 ওজোন অণু ধ্বংস করতে পারে। পরে ইহা হাইড্রোজেন ক্লোরাইড (HCl) এবং ক্লোরিন নাইট্রেট ($ClONO_2$)-এ রূপান্তরিত হয়ে O, অনুঘটন চক্র থেকে বেরিয়ে এসে আবার ট্রোপোস্ফিয়ারে ফিরে আসে। এক্ষেত্রে $Br^-$ এর অনুঘটন ক্ষমতা আরো বেশী কিন্তু স্ট্রাটোস্ফিয়ারে এর পরিমাণ খুবই কম।

শুধুমাত্র CFC-ই নয় নতুন প্রজন্মের বিমান, মিসাইল বা মহাকাশযানগুলির থেকে নির্গত নাইট্রোজেনের অক্সাইড, হাইড্রোক্লোরিক অ্যাসিড ইত্যাদিও এই ওজোন স্তর কমার উল্লেখযোগ্য কারণ হিসাবে প্রমাণিত হয়েছে। উন্নত দেশের সুপারসোনিক ট্রান্সপোর্ট (SST) যেমন ফ্রান্সের কনকড বিমান, USA-র ক্ষেপনাস্ত্র যথা রকেট, মিসাইলের কঠিন জ্বালানী ইত্যাদি থেকে নির্গত বিভিন্ন রাসায়নিক 03 হোল সৃষ্টির মূলে।

• ক্লোরোফ্লুরোকার্বনস (Chloroflurocarbons)

থমাস মিদগলে জুনিয়র, (Thomas Midgley Jr.) 1930 সালে রেফ্রিজারেন্ট হিসেবে ক্লোরোফ্লুরোকার্বনস (CFCs) আবিষ্কার করেন। ডু পন্ট (Du Pont) নামক একটি সংস্থা এর বাণিজ্যিক নামকরণ করে ফ্রিওন (Freon)। এই CFC ক্ষতিকর নয়, জলে অদ্রাব্য, দাহ্য নয়, স্থায়ী এবং কম বিক্রিয়াশীল হওয়ায় বিভিন্ন কাজে এদের ব্যবহার প্রায় নিয়মে এসে দাঁড়িয়েছিল। ফ্রীজ, শীততাপ নিয়ন্ত্রণ ছাড়াও বিষক্রিয়াহীন এরোসল হিসাবে সুগন্ধি, রুম ফ্রেশনার ইত্যাদি, ফোম বা প্লাষ্টিক শিল্পেও এদের ব্যবহার বাড়তে লাগল। কিন্তু যে স্থায়িত্ব এদের ব্যবহারের অন্যতম কারণ ছিল, সেই স্থায়িত্বের জন্যই আর ওজোন স্তরে মারাত্মক ক্ষতি করার জন্যই বিশ্বের উন্নত দেশগুলিতে আজ CFCs-র উপর চরম নিষেধাজ্ঞা। বিজ্ঞানীদের অনুমান অনুযায়ী এখনই যথাযথ ব্যবস্থা না নিলে পৃথিবীর ওজেন গহবর নিরাময় বিলম্বিত হয়ে পরবে।

**ওজোনস্তর হ্রাসের ক্ষতিকর প্রভাবসমূহ (Harmful effects of ozone depletion):**

মাত্রাতিরিক্ত UV-B রশ্মির উপস্থিতিতে শরীরে মাত্রাতিরিক্ত ভিটামিন-D তৈরী হয়। রক্তে ভিটামিন-D এর মাত্রা 100mg/ml অপেক্ষা বেশী হলে রক্তে ক্যালসিয়াম অতিরিক্ত মাত্রায় বৃদ্ধি পায়। যদিও শরীরে প্রয়োজনাতিরিক্ত ভিটামিন-D সংশ্লেষণ নিয়ন্ত্রিত হয়। তবু অনেক ক্ষেত্রেই ইহা বিঘ্নিত হলে মানুষের মৃত্যুহার বৃদ্ধি পায়।

• মানুষ ব্যতীত অনেক স্থলজ প্রাণী যেমন কুকুর, বেড়াল, ভেড়া প্রভৃতি এবং তিমি সহ বিভিন্ন জলজ প্রাণীর ওপর UV-B রশ্মির ক্ষতিকর প্রভাব দেখা যায়।

• আবাদি জমির মাটিতে বসবাসকারী নাইট্রোজেন বন্ধনকারী সায়ানো ব্যাকটেরিয়া অতিরিক্ত UV-রশ্মিতে ক্ষতিগ্রস্থ হয়। ফলে জমির উৎপাদনশীলতা কমে যায়।

• উদ্ভিদে মাত্রাতিরিক্ত UV রশ্মির প্রভাবে সালোকসংলেষ ও খাদ্য উপাদান হ্রাস পায়। যার ফলে উদ্ভিদের স্বাভাবিক বৃদ্ধি ক্ষতিগ্রস্থ হতে পারে।

**ওজোন হ্রাস-এর প্রতিকার (Remedial measure for ozone depletion):**

• ওজোন গ্যাসের পক্ষে ক্ষতিকর পদার্থসমূহর যেমন CFCs, হ্যালোজেন যুক্ত হাইড্রোকার্বন, মিথাইল ব্রোমাইড, নাইট্রাস অক্সাইড প্রভৃতির ব্যবহার যতটা সম্ভব এড়িয়ে চলা।

• পেট্রোলিয়াম চালিত যানবাহন ব্যবহার কমিয়ে ফেলা।

• পরিবেশের পক্ষে ক্ষতিকর বিভিন্ন ক্লিনিং সলভেন্ট ব্যবহার না করে পরিবেশ বান্ধব নানা পদার্থ যেমন ভিনিগার, বাইকার্বোনেট প্রভৃতি ব্যবহার করা।

• রপ্তানিকৃত দ্রব্য ব্যবহার কমিয়ে স্থানিয় দ্রব্য ব্যবহারে যানবাহনের প্রয়োজনিতা হ্রাস পায়। এর ফলে পরিবেশে নাইট্রাস অক্সাইডের পরিমাণ হ্রাস পায়। যা ওজোন হ্রাসে সহায়ক।

• এয়ার কন্ডিশনার এর পরিবর্তে লীনতাপের (latent heat) তত্ত্বের ভিত্তিতে নির্মিত এয়ার কুলার ব্যবহার উৎসাহিত করা। এয়ার কন্ডিশনার, রেফ্রিজারেটর, গাড়ি প্রভৃতি ঠিকমতো রক্ষণাবেক্ষণ করা যার ফলে ক্ষতিকর গ্যাস পরিবেশে না মিশে যায়।

• কুলিং এজেন্টে হিসেবে হাইড্রোক্লোরোফ্লুরোকার্বনস (HCFCs) এবং হাইড্রোফ্লুরোকার্বন (HFCs) ব্যবহার করা। এরাও ওজোনস্তর ধ্বংস করে কিন্তু CFCs অপেক্ষা অনেকাংশে কম মাত্রায়।

মন্ট্রিল প্রোটোকল (Montreal Protocol) দেশগুলি 1987 সালের কোপেনহাগেন সমাবেশের পর CFC প্রস্তুতি ও ব্যবহারের উপর সম্পূর্ণ নিষেধাজ্ঞা জারি করলে উচ্চ প্রযুক্তির দেশগুলি তাতে সাড়া দেয়। উন্নয়নশীল দেশগুলিতেও এই প্রোটোকল যথেষ্ট কার্যকরী হয়েছে।

1994-এ ইউনাইটেড নেশনস্ জেনারেল অ্যাসেমব্লি 16 সেপ্টেম্বর (16 September) বিশ্ব ওজোনস্তর সংরক্ষণ দিবস বা বিশ্ব ওজোন দিবস হিসেবে চিহ্নিত করেছেন। এই দিনটিতে মন্ট্রিল প্রোটোকল বিশেষভাবে স্মরণ করা হয়।

## অম্ল বৃষ্টি (Acid Rain)

বিভিন্ন প্রাকৃতিক কারণ যেমন গাছপালা ও সকল জীবজন্তুর শ্বসন, আগ্নেয়গিরির অগ্নুৎপাত, বজ্রপাত, মানুষ দ্বারা জীবাশ্ম জ্বালানির দহন বা বিভিন্ন ইঞ্জিনে অন্তঃদহন (internal combustion) থেকেই প্রকৃতিতে অম্লধর্মী বিকারকের সৃষ্টি হয়। এদের মধ্যে উল্লেখযোগ্য হল $SO_2$, NO, O3, H2O2, OH ইত্যাদি। এই অম্লধর্মী বিকারক গুলি বায়ুমণ্ডলে জলের সাথে বিক্রীয়ার পর পৃথিবীপৃষ্ঠে অম্লবৃষ্টি (Acid Rain) রূপে নেমে আসে।

বায়ুমণ্ডলের নানা আম্লিক গ্যাস জলীয় বাষ্পে দ্রবীভূত হয়ে অ্যাসিড তৈরী করে। ফলে অম্লবৃষ্টির সময় এই pH-এর মাত্রা অনেক নেমে যায়। বৃষ্টির জলের pH-এর মাত্রা 5.65 এর নীচে নেমে যাওয়া মানে অম্লবৃষ্টি।

যদিও এটি একটি বিশ্ব-সমস্যা, অম্লবৃষ্টির ফলে ক্ষয়ক্ষতির বেশীরভাগ তথ্য আসে কানাডা, ইংল্যান্ড, জার্মানী, ফ্রান্স, স্ক্যান্ডিনেভিয়া ও আমেরিকা থেকেই। 1969 সালে নিউ হ্যাম্পশায়ারে যে অম্লবৃষ্টি হয় তার pH

ছিল 21। 1974-এ স্কটল্যান্ডে তা ছিল 2.4। উত্তরপূর্ব USA-এর সাধারণ বৃষ্টিপাতের গড় pH 4.0, অর্থাৎ তা বেশ আম্লিক।

**অম্লবৃষ্টির ফলে যে ক্ষয়ক্ষতি হয় তা নানারকম:**

বাড়ীঘর, স্মৃতিসৌধ ইত্যাদিতে চুন বা CaCO3 থাকে। অম্লবৃষ্টির $H_2SO_4$ এই চুনকে জিপসাম (Gypsum) বা $CaSO_1$-এ পরিণত করে যা সহজেই জলে দ্রবীভূত হয়। এইভাবে বাড়ীঘর বা সৌধে ক্ষত সৃষ্টি হয়। ধাতুও একইভাবে আক্রান্ত হয়।

• বনানী বাস্তুতন্ত্রের উপর এর প্রভাবও উল্লেখযোগ্য। বৃক্ষনিধনে অম্লবৃষ্টির প্রভাব সহজেই অনুমেয়। মধ্য ইউরোপে, উত্তরপূর্ব আমেরিকায় ও পৃথিবীর অন্যান্য অংশে বনধ্বংসের অন্যতম কারণ হিসাবে অম্লবৃষ্টিকে চিহ্নিত করা হচ্ছে।

• সরাসরি গাছপালায় সঞ্চিত হয়ে উদ্ভিদের ক্ষতিসাধন করা ছাড়াও মাটিতে সঞ্চিত হয়ে শিকড়ের শোষণ ক্ষমতা নষ্ট করেও উদ্ভিদের ক্ষতি করে এই অম্লবৃষ্টি। মাটিতে বসবাসকারী উদ্ভিদের উপযোগী জীবাণু ধ্বংসও হয় এই অম্লের প্রভাবে। পরোক্ষে উদ্ভিদের ক্ষতি সাধন করে।

• জলাভূমির বাস্তুতন্ত্রেও অম্লবৃষ্টির প্রভাব রয়েছে। অনেক হ্রদের খাদ্যজালকের পরিবর্তন ঘটেছে। pH 5.5-এর নীচে চলে গেলে অনেক অর্থনৈতিকভাবে গুরুত্বপূর্ণ জলজ প্রাণী যেমন মাছের উৎপাদন হ্রাস পায়।

**ভারতবর্ষের মহানগরী এবং শিল্পনগরীগুলিতেও অম্লবৃষ্টির সমস্যা:**

বৃষ্টির জলের নমুনা বিশ্লেষণ করে নাগপুর, আসামের মোহনবাড়ী, এলাহাবাদ, বিশাখাপত্তনম এবং কোডাইকানাল-এর বিগত দশকের pH-এর মান 4.77 থেকে 5.32-র মধ্যে পাওয়া গেছে।

এই সকল শহরগুলিতে এবং তার পারিপার্শ্বে যে হারে তাপবিদ্যুৎ উৎপাদন, কয়লার দহন, পেট্রোলিয়াম নির্ভর যানবাহনের পরিমাণ বাড়ছে তাতে অদূর ভবিষ্যতে মানবজীবন ও পরিবেশে আরো ভয়ানক প্রভাব পড়বে।

**অম্লবৃষ্টি প্রশমনের কয়েকটি উল্লেখযোগ্য উপায় (Some important measures to reduce acid rain):**

বাতাসে কার্বনডাই-অক্সাইড, সালফারডাই-অক্সাইড এবং নাইট্রোজেনের বিভিন্ন অক্সাইড বর্জন নিয়ন্ত্রণে আনা। এর জন্য প্রয়োজন

(a) জ্বালানীর অপচয় বন্ধ করা।

(b) পরিশোধিত জ্বালানী ব্যবহার

করা।

(c) সালফার এবং নাইট্রোজেন-এর অক্সাইড সমূহ মুক্ত করে জ্বালানীকৃত ধোঁয়া পরিবেশে বর্জন করে।

(d) জ্বালানী গ্যাসকে সালফার মুক্ত করে ব্যবহার করা।

(e) জীবাশ্ম জ্বালানীর অন্তঃদহনের জন্য ক্যাটালাইটিক কনভার্টার ব্যবহার করা।

(f) সালফার এর মাত্রা কমাতে কয়লা ধুয়ে ব্যবহার করা।

(g) কলকারখানার চিমনিতে পাতলা কাই (slurry) হিসেবে লাইমস্টোন বা চুনাপাথর (ক্যালসিয়াম কার্বনেট) ব্যবহার করা যা ধোঁয়াকে সালফার ডাই অক্সাইড মুক্ত করতে সাহায্য করে।

(h) বিকল্প শক্তির উৎস হিসেবে জলবিদ্যুৎ, বায়ুশক্তি, ভূ-তাপীয় শক্তি (geothermal power), সৌরশক্তি এবং আনবিক শক্তি (nucler power) প্রভৃতি ব্যবহার করা।

## এল-নিনো বা দক্ষিণী তরঙ্গমালা (El-Nino or Southern Oscillation)

এলনিনো হল একটি উয় সামুদ্রিক ঝঞ্ঝা যা পেরুর পশ্চিমতটে মূলতঃ ক্রিস্মাসের সময় দেখা যায়। (El Nino শব্দের অর্থ যীশুখৃষ্টের সন্তান)। প্রশান্ত মহাসাগর ব্যাপী বায়ুমণ্ডলের চাপের ফলে সৃষ্ট এই দক্ষিণী ঝঞ্ঝাবার্তা সম্বন্ধে 1904 সালে গিলবার্ট ওয়াকার (Gilbert Walker) এবং 1966 ও 1969 সালে জ্যাকব জার্কনেস (Jacob Bjerknes) মানুষকে অবহিত করান। গিলবার্টের মতে প্রশান্ত মহাসাগরের পূর্বতটে বায়ু চাপ বৃদ্ধি পেলে পশ্চিমতটে তা কমে যায়। অন্যদিকে, পশ্চিমতটে বায়ু চাপের বৃদ্ধি পূর্বতটে বায়ু চাপ কমে যাওয়ার কারণ। উনি একেই দোদুল্যমানতা (Oscillation) নামে অবিহিত করেন। জার্কনেস বলেন, সমুদ্রতলের তাপমাত্রা মধ্য প্রশান্ত মহাসাগরে ঘূর্ণাবর্তের সৃষ্টি করে। পশ্চিম প্রশান্ত মহাসাগরের তপ্ত বায়ু উপরে ওঠে, পূর্বদিকে ধাবিত হয় এবং পূর্ব প্রশান্ত মহাসাগরের গর্ভে আশ্রয় নেয়। এই পথে সেই বায়ু ক্রমশঃ আরো তপ্ত হয়ে ওঠে এবং জলীয় বাষ্প সংগ্রহ করে। এইভাবে বৃষ্টিমেঘ (Rain Cloud) সৃষ্টি হয়ে তপ্ত সামুদ্রিক ঝঞ্ঝা বা এল-নিনোর সৃষ্টি হয়।

এর ফলে একদিকে উত্তর ও পূর্ব আমেরিকার তটভূমিতে যেমন ঝড়ঝঞ্ঝা সৃষ্টি হয় পশ্চিম প্রশান্ত মহাসাগরীয় দেশসমূহ, যেমন অস্ট্রেলিয়ায় তখন খরা সৃষ্টি করে। এল-নিনোর ফলে দূরবর্তী অঞ্চলগুলিতেও যেমন পশ্চিম আমেরিকা ও মেক্সিকোতে বৃষ্টিপাত বেড়ে যায় আবার এই ঝঞ্ঝাবর্তের সময় USA, কানাডা ও আলাস্কার তাপমাত্রা গড় তাপমাত্রার চেয়ে বেশী হয়ে যায়।

**এল-নিনোর সমস্যা (Consequences of El-Nino):**

• স্বাভাবিকভাবেই এই প্রাকৃতিক পরিবর্তনে বাস্তুতন্ত্র প্রভাবিত হয়। তটবর্তী মাছের উৎপাদন হ্রাস পায়। যে সমস্ত তটবর্তী পাখিরা এদের খেয়ে বেঁচে থাকে তারা ক্ষতিগ্রস্ত হয়। ফাইটোপ্ল্যাংকটনের সংখ্যা উল্লেখযোগ্যভাবে হ্রাস পেয়ে সামুদ্রিক উৎপাদন হার বা Produc tivity কমে যায়। সিন্ধুঘোটক ও সীল মাছের সংখ্যা এইকারণে কমে যায়। এইভাবে দক্ষিণ আমেরিকার সমুদ্র ও সমুদ্রতটের বাস্তুতন্ত্রের উল্লেখযোগ্য পরিবর্তন ঘটে El-Nino র প্রভাবে।

• এলনিনোর ফল দূরবর্তী মহাদেশও প্রভাবিত হয়। 1982-83 র এলনিনো উত্তর আমেরিকার বহু ঝড়ঝঞ্ঝার কারণ। আমেরিকায় উদ্‌ভূত ক্যাটরিনা, রিটা প্রভৃতি সামুদ্রিক ঝড়ের কারণ অনুসন্ধান করে NASA এলনিনোকেই সামগ্রিকভাবে দায়ী করছে।

• উত্তর ও দক্ষিণ আমেরিকার এলনিনোর ফলে উল্টোদিকে অস্ট্রেলিয়াতে ভয়াবহ খরার সৃষ্টি হয়। এর প্রভাব ঐ অঞ্চলের উদ্ভিদ ও প্রাণীর উপর যথেষ্ট পড়ে।

## বন উজাড় (DEFORESTATION)

বন উজাড় হল উদ্দেশ্যমূলকভাবে বনভূমি পরিষ্কার করা। ইতিহাস জুড়ে এবং আধুনিক সময়ে, বন ধ্বংস করা হয়েছে কৃষিকাজ এবং পশুচারণ করার জন্য জায়গা তৈরি করতে এবং জ্বালানি, উত্পাদন এবং নির্মাণের জন্য কাঠ পেতে। অরণ্য উজাড় বিশ্বজুড়ে ল্যান্ডস্কেপকে ব্যাপকভাবে পরিবর্তিত করেছে।

মানুষের ক্রিয়াকলাপের সুবিধার্থে বন (বা অন্যান্য জমি) থেকে বড় আকারে গাছ অপসারণ। এটি একটি গুরুতর পরিবেশগত উদ্বেগের কারণ এটি জীববৈচিত্র্যের ক্ষতি, প্রাকৃতিক আবাসস্থলের ক্ষতি, জলচক্রে ব্যাঘাত এবং মাটির ক্ষয় হতে পারে।

বন উজাড়ের প্রত্যক্ষ কারণ হল কৃষি সম্প্রসারণ, কাঠ আহরণ (যেমন, গৃহস্থালি জ্বালানী বা কাঠকয়লার জন্য কাঠ কাটা বা কাঠ কাটা), এবং রাস্তা নির্মাণ এবং নগরায়নের মতো অবকাঠামো সম্প্রসারণ।

**<u>বন উজাড়ের প্রভাব</u> (<u>Causes of deforestation:</u>):**

• প্রধান জলবায়ু পরিবর্তন: তাপমাত্রা এবং দূষণের মাত্রা বৃদ্ধি।

• মরুকরণ এবং মাটি ক্ষয়।

• বায়ুমণ্ডলে গ্রিনহাউস গ্যাসের বৃদ্ধি।

• ভূগর্ভস্থ পানির স্তর হ্রাস।

• প্রাণীদের খাদ্য ও বাসস্থানের ক্ষতি যা তাদের বিলুপ্তির দিকে নিয়ে যায়।

**বন উজাড় বন্ধ করার ব্যবহারিক উপায় ( <u>Practical Ways to Stop Deforestation):</u>**

1. আরো গাছ লাগান। আপনার সম্প্রদায়ে বা বিশ্বব্যাপী সংস্থাগুলির মাধ্যমে বৃক্ষ রোপণ উদ্যোগে জড়িত হন।

2. কাগজবিহীন যান। ...

3. দায়বদ্ধ সংস্থাগুলিকে সমর্থন করুন। ...

4. প্রত্যয়িত কাঠের পণ্য কিনুন। ...

5. কিনুন এবং দায়িত্বের সাথে ব্যবহার করুন। ...

6. পাম তেল এড়িয়ে চলুন। ...

7. রিসাইকেল করুন এবং পুনর্ব্যবহৃত পণ্য কিনুন। ...

8. অন্যদের শিক্ষিত করুন।

**অসুবিধা (Disadvantages):**

গাছ এবং অন্যান্য গাছপালা হারানোর ফলে জলবায়ু পরিবর্তন, মরুকরণ, মাটির ক্ষয়, কম ফসল, বন্যা, বায়ুমণ্ডলে গ্রিনহাউস গ্যাস বৃদ্ধি এবং আদিবাসীদের জন্য অনেক সমস্যা হতে পারে।

## বনায়ন (AFFORESTATION)

বনায়ন হল বনের আয়তন বৃদ্ধির জন্য চারা, গাছ লাগানো। এটি দূষণ এবং মানব উন্নয়নের ক্ষতিকারক প্রভাব থেকে আমাদের পরিবেশ রক্ষা ও সংরক্ষণের জন্য নেওয়া একটি ব্যবস্থা।

বনায়ন হল এমন একটি এলাকায় বৃক্ষ রোপণ বা যোগ করা যেখানে কখনও বন বা বৃক্ষরোপণ ছিল না। এটি একটি নতুন বন তৈরি করার একটি পদ্ধতি। পুনঃবনায়ন হল এমন একটি এলাকায় গাছ প্রতিস্থাপন করা যেখানে একসময় একটি বন ছিল যা ধ্বংস বা ক্ষতিগ্রস্ত হয়েছিল।

**তিন ধরনের বনায়ন:**

1. প্রাকৃতিক পুনর্জন্ম,

2. বাণিজ্যিক আবাদ, এবং

3. কৃষি বনায়ন।

**বনায়নের উদ্দেশ্য (Purposes of afforestation):**

এর উদ্দেশ্য হল জমির পূর্ববর্তী অতিরিক্ত ব্যবহারের কারণে ধ্বংস হয়ে যাওয়া এলাকাকে পুনরুদ্ধার করা বা একটি এলাকার মাটিতে ক্ষয়ের পরিমাণ কমিয়ে আরও উর্বর ও স্থিতিশীল মাটির ভিত্তি স্থাপন করা।

বেশ কিছু প্রয়োজনীয় পণ্য ছাড়াও, বন আমাদের পরিবেশ রক্ষায় গুরুত্বপূর্ণ ভূমিকা পালন করে:

• বৃষ্টিপাত প্রচার করা।

• শব্দ দূষণ কমায়।

• পরিবেশগত ভারসাম্য বজায় রাখে।

• ভারী বাতাস থেকে একটি বায়ু বাধা হিসাবে কাজ করে।

• আর্দ্রতা প্রদান এবং তাপমাত্রা কম.

• সাধারণত বনায়নের পর মাটির সম্পূর্ণ ছিদ্রতা এবং জল ধারণ ক্ষমতা বৃদ্ধি পায়।

বনায়ন থেকে বেশ কিছু সুবিধা রয়েছে যেমন কার্বন সিকোয়েস্টেশন, ক্রমবর্ধমান বৃষ্টিপাত, মাটির উপরিভাগের ক্ষয় রোধ (জল ও বাতাস থেকে), বন্যা ও ভূমিধস প্রশমন, প্রবল বাতাসের বিরুদ্ধে বাধা, বন্যপ্রাণীর জন্য আশ্রয়, কর্মসংস্থান এবং কাঠের পণ্যের বিকল্প উৎস।

**উদাহরণ (Examples):**

উদাহরণস্বরূপ, আমদানিকৃত কাঠের উপর নির্ভরতা কমাতে বিংশ শতাব্দীতে যুক্তরাজ্যের বনায়নে বৃহৎ আকারের বনায়ন কর্মসূচি ছিল বিশিষ্ট। ব্রাজিল, চিলি, নিউজিল্যান্ড এবং অন্যান্য দেশে বনজ সম্পদ সম্প্রসারণের জন্য বনায়ন কর্মসূচি ব্যবহার করা হয়েছে।

চীনের দেশব্যাপী গ্রেইন-ফর-গ্রিন প্রোগ্রাম (GFGP) হল বিশ্বের বৃহত্তম বনায়ন কর্মসূচি। 1999 সালে প্রাথমিকভাবে মাটির ক্ষয় নিয়ন্ত্রণের জন্য শুরু করা, GFGP নগদ অর্থ প্রদান ব্যবহার করে গ্রামীণ পরিবারগুলিকে ঢালু ফসলের জমি এবং স্ক্রাবল্যান্ডে বন, ঝোপঝাড় এবং/অথবা তৃণভূমি পুনঃপ্রতিষ্ঠা করতে উৎসাহিত করতে।

**বনায়নের কিছু অসুবিধা (Some Disadvantages of afforestation):**

• ব্যয়বহুল পদ্ধতি কারণ বিভিন্ন কাজ সম্পাদনের জন্য আরও জনবল প্রয়োজন।

• যদি গাছ বেড়ে ওঠার সময় সঠিক জায়গা না পায়, তবে এটি মাটির উপরে এবং নীচে ক্ষতির কারণ হতে পারে।

• গাছের বৃদ্ধির জন্য সঠিক রক্ষণাবেক্ষণ প্রয়োজন। ফলের গাছের বৃদ্ধির জন্য আরও রক্ষণাবেক্ষণের প্রয়োজন হয়।

**প্রাকৃতিক সম্পদ ব্যবস্থাপনা (NATURAL RESOURCE MANAGEMENT):**

প্রাকৃতিক সম্পদ ব্যবস্থাপনা মানুষ এবং প্রাকৃতিক ল্যান্ডস্কেপ যেভাবে মিথস্ক্রিয়া করে তা পরিচালনা করে। এটি প্রাকৃতিক ঐতিহ্য ব্যবস্থাপনা, ভূমি ব্যবহার পরিকল্পনা, জল ব্যবস্থাপনা, জীব-বৈচিত্র্য সংরক্ষণ এবং কৃষি, খনি, পর্যটন, মৎস্য ও বনায়নের মতো শিল্পের ভবিষ্যত স্থায়িত্বকে একত্রিত করে।

প্রাকৃতিক সম্পদ ব্যবস্থাপনার উদ্দেশ্য পরিবেশগত বৈচিত্র্য বজায় রাখা। ভবিষ্যৎ প্রজন্মের জন্য সম্পদ প্রদান করা। মানুষের জন্য কর্মসংস্থান সুবিধা বজায় রাখা। ইকোসিস্টেমে ভারসাম্য বজায় রাখা। পরিবেশের আরও ধ্বংস এড়াতে। প্রাকৃতিক সম্পদের অতিরিক্ত ব্যবহার এড়ানো ।

**ব্যাপ্তি (Scope)**

প্রাকৃতিক সম্পদ ব্যবস্থাপনা (NRM) বলতে প্রধান প্রাকৃতিক সম্পদের টেকসই ব্যবহার বোঝায়, যেমন ভূমি, জল, বায়ু, খনিজ, বন, মৎস্য, এবং বন্য উদ্ভিদ ও প্রাণীজগত। একসাথে, এই সম্পদগুলি ইকোসিস্টেম পরিষেবাগুলি প্রদান করে যা মানব জীবনের উন্নত মানের প্রদান করে।

**উদ্দেশ্য (Purpose):)**

প্রাকৃতিক সম্পদ ব্যবস্থাপনা (NRM) বলতে প্রধান প্রাকৃতিক সম্পদের টেকসই ব্যবহার বোঝায়, যেমন ভূমি, জল, বায়ু, খনিজ, বন, মৎস্য, এবং বন্য উদ্ভিদ ও প্রাণীজগত। একসাথে, এই সম্পদগুলি ইকোসিস্টেম পরিষেবাগুলি প্রদান করে যা মানব জীবনের উন্নত মানের প্রদান করে।

**গুরুত্বপূর্ণ প্রাকৃতিক সম্পদ (Importat Natural Resources)**

(1) বন আমাদের খাদ্য, কাঠ, জ্বালানী এবং আশ্রয় প্রদান করে, (2) বায়ু আমাদের শ্বাস নেওয়ার জন্য অক্সিজেন সরবরাহ করে, (3) জমি চাষ এবং খাদ্য পণ্য বৃদ্ধির জন্য ব্যবহার করা হয়, (4) সূর্যালোক আমাদের সৌর শক্তি দেয় যা শক্তির একটি গুরুত্বপূর্ণ বিকল্প উৎস ইত্যাদি।

- গাছ। কাগজ, আসবাবপত্র, জ্বালানী।
- তুলা। পোশাক।
- তেল/পেট্রোলিয়াম। প্লাস্টিক, জ্বালানি।
- প্রাকৃতিক গ্যাস. জ্বালানী।
- কয়লা। জ্বালানী।
- লৌহ আকরিক. ইস্পাত পণ্য (ক্যান, সেতু)
- বক্সাইট আকরিক। অ্যালুমিনিয়াম পণ্য (ক্যান, গাড়ি।
- সোনা। গয়না, দাঁতের উপাদান।

অপরিশোধিত তেল: তেল বিশ্বের সবচেয়ে মূল্যবান প্রাকৃতিক সম্পদ। এটি পরিবহনে জ্বালানি, বিদ্যুৎ উৎপাদন এবং প্লাস্টিক এবং রাসায়নিক সহ বিভিন্ন পণ্য উত্পাদন করতে ব্যবহৃত হয়। প্রাকৃতিক গ্যাস: প্রাকৃতিক গ্যাস হল আরেকটি মূল্যবান শক্তির উৎস, যা গরম এবং বিদ্যুৎ উৎপাদনের জন্য ব্যবহৃত হয়।

**প্রাকৃতিক সম্পদের টেকসই ব্যবস্থাপনার (Sustainable Management of Natural Resources):**

প্রাকৃতিক সম্পদের টেকসই ব্যবস্থাপনার অর্থ সম্পদগুলিকে দক্ষতার সাথে ব্যবহার করতে এবং ব্যক্তিগত উদ্দেশ্যে তাদের অপব্যবহার এড়াতে সংরক্ষণ করা। প্রাকৃতিক সম্পদ ব্যবস্থাপনা: প্রাকৃতিক সম্পদ ব্যবস্থাপনা আমাদের এবং ভবিষ্যৎ প্রজন্ম উভয়ের জন্যই অত্যন্ত গুরুত্বপূর্ণ।

**পৃথিবী রক্ষা করতে সাহায্য করার জন্য একজন করতে পারেন এমন সহজ জিনিস (Simple Things One Can Do to Help Protect the Earth):**

1. হ্রাস করুন, পুনরায় ব্যবহার করুন এবং পুনর্ব্যবহার করুন। আপনি যা ফেলে দেন তা কেটে ফেলুন
2. সম্প্রদায়ের পরিষ্কারের জন্য স্বেচ্ছাসেবক
3. নিজে ও অপরকে শিক্ষিত করা
4. জল সংরক্ষণ করা
5. টেকসই চয়ন করা
6. বুদ্ধিমত্তার সাথে কেনাকাটা করা
7. দীর্ঘস্থায়ী লাইট বাল্ব ব্যবহার করা
8. একটি গাছ লাগানো

# পরিবেশগত প্রভাব মূল্যায়ন (ENVIRONMENTAL IMPACT ASSESSMENT OR EIA)

EIA এর পূর্ণরূপ হল পরিবেশগত প্রভাব মূল্যায়ন। সহজ ভাষায়, EIA এর অর্থ হল এটি এমন একটি প্রক্রিয়া যার মাধ্যমে একটি প্রস্তাবিত উন্নয়নের পরিবেশগত প্রভাব মূল্যায়ন করা হয়।

**EIA পরিচালনার জন্য গুরুত্বপূর্ণ পদক্ষেপ (Important Steps to Conducting a Mining EIA):**

• পরিবেশগত স্ক্রীনিং। EIA-তে স্ক্রীনিং হল প্রথম পর্যায়।

• **ব্যাপ্তি** । এই দ্বিতীয় পর্যায়টি আপনাকে EIA-এর সময় অন্যদের নির্মূল করার সময় মনে রাখার জন্য গুরুত্বপূর্ণ বিষয়গুলিকে অগ্রাধিকার দেওয়ার অনুমতি দেয়।

• প্রভাব মূল্যায়ন এবং প্রশমন।

• প্রভাব ব্যবস্থাপনা।

• EIA রিপোর্ট।

• পর্যালোচনা এবং লাইসেন্সিং।

• মনিটরিং।

EIA সুষ্ঠু নীতিনির্ধারণ, দক্ষ বাজার, এবং শক্তি সম্পর্কে জনসাধারণের বোঝাপড়া এবং অর্থনীতি ও পরিবেশের সাথে এর মিথস্ক্রিয়াকে উন্নীত করার জন্য স্বাধীন এবং নিরপেক্ষ শক্তি তথ্য সংগ্রহ, বিশ্লেষণ এবং প্রচার করে।

ন্যাশনাল এনভায়রনমেন্টাল অ্যাক্ট, 1998-এর জন্য সংবেদনশীল এলাকায় বড় আকারের প্রকল্পগুলির জন্য পরিবেশগত প্রভাব মূল্যায়ন প্রয়োজন। এটি কেন্দ্রীয় পরিবেশ কর্তৃপক্ষ দ্বারা প্রয়োগ করা হয়।

### EIA এর উদাহরণ (Example of EIA):

একটি পরিবেশগত প্রভাব মূল্যায়ন উদাহরণ হল একটি অঞ্চলে একটি নতুন উত্পাদন সুবিধার বায়ুর গুণমান, জলের গুণমান, শব্দ দূষণ, ইকোসিস্টেম বিপর্যস্ত এবং আরও অনেক কিছুর অর্থ কী তা মূল্যায়ন করার প্রয়োজন হবে।

### EIA এর উদ্দেশ্য (Objectives of EIA)

(i) উন্নয়ন কর্মকান্ডের অর্থনৈতিক, পরিবেশগত এবং সামাজিক প্রভাব চিহ্নিত করা, ভবিষ্যদ্বাণী করা এবং মূল্যায়ন করা (ii) সিদ্ধান্ত গ্রহণের জন্য পরিবেশগত পরিণতি সম্পর্কে তথ্য প্রদান করা এবং (iii) এর মাধ্যমে পরিবেশগতভাবে সুস্থ ও টেকসই উন্নয়নের প্রচার করা। উপযুক্ত বিকল্প সনাক্তকরণ এবং প্রশমন ব্যবস্থা।

### EIA প্রক্রিয়ার পর্যায়সমূহ (Stages of the EIA process):

• স্ক্রীনিং। একটি EIA প্রয়োজন কিনা তা নির্ধারণ করা।

• স্কোপিং। মূল্যায়নে কী কভার করতে হবে এবং 'EIA রিপোর্ট'-এ রিপোর্ট করা দরকার তা নির্ধারণ করা

• EIA রিপোর্ট প্রস্তুত করা। ...

• একটি আবেদন এবং পরামর্শ করা। ...

• সিদ্ধান্ত গ্রহণ। ...

• সিদ্ধান্ত পোস্ট করুন।

## EIA এর সীমাবদ্ধতা (Limitations of EIA):

• EIAs প্রয়োজন কিনা তা নির্ধারণ করতে স্ক্রীনিং মানদণ্ডের যথাযথ ব্যবহার।

• ডেটা এবং ডেটা ফাঁকের মান নিয়ন্ত্রণ।

• প্রক্রিয়ার গুণমান এবং পদ্ধতিগত কঠোরতা।

জনসাধারণকে সম্পৃক্ত করার জন্য সামঞ্জস্যপূর্ণ পদ্ধতির অভাব।

• সাইটের সীমানায় ফোকাস করুন।

পরিবেশগত প্রভাব মূল্যায়নের মূল উপাদানগুলির মধ্যে রয়েছে স্কোপিং, বেসলাইন ডেটা সংগ্রহ, প্রভাব মূল্যায়ন, প্রশমন ব্যবস্থা, পর্যবেক্ষণ এবং মূল্যায়ন এবং জনগণের অংশগ্রহণ।

স্কোপিং প্রকল্প চক্রের প্রথম দিকে একই সময়ে রূপরেখা পরিকল্পনা এবং প্রাক-সম্ভাব্যতা অধ্যয়ন হিসাবে ঘটে। স্কোপিং হল মূল পরিবেশগত সমস্যা চিহ্নিত করার প্রক্রিয়া এবং সম্ভবত একটি EIA-তে সবচেয়ে গুরুত্বপূর্ণ পদক্ষেপ।

## ভাল EIA (Good EIA):

EIA রিপোর্টটি স্পষ্ট, সংক্ষিপ্ত, সামঞ্জস্যপূর্ণ এবং ব্যাপক হওয়া উচিত এবং মূল্যায়নের সমস্ত প্রাসঙ্গিক দিকগুলিকে কভার করা উচিত, যেমন সুযোগ এবং উদ্দেশ্য, বেসলাইন অধ্যয়ন, বিকল্প এবং প্রভাব, স্টেকহোল্ডারদের সম্পৃক্ততা, প্রশমন ব্যবস্থা, প

**Global Warming:** Global warming refers to the rapid rise in Earth's average surface temperature over the past century, mainly due to the greenhouse gasses released by people burning fossil fuels necessary for industrialization. It is seen as a consequence of an increase in Earth's temperature due to the greenhouse effect and connected human actions. It results in the melting of ice caps and therefore increases the sea levels triggering tsunamis, cyclones, and other natural calamities.

- **Habitat Loss:** Wildlife conservation is becoming tougher because their natural habitat is constantly being threatened and destroyed. Water pollution and deforestation are the main reasons for habitat loss. Deforestation may give rise to abundant land for humans but leaves animals homeless.
- **Extinction:** Human activities are triggering extinction on an unprecedented and mass scale. The destruction of natural habitats, environmental hazards, global warming, poaching, pollution, and deforestation are some of the leading causes of this tragedy.
- **Overuse of Harmful Pesticides and Fertilizers:** With a great uptick in population, there is also a rise in food production. To aid this production, however, crops are produced through the use of toxic fertilizers and have extremely poor nutritional values to satisfy the demand for food security.
- **Urbanization:** Urbanisation refers to the increasing number of people who reside in cities. Urbanization has also contributed to a major transition and disparity in our ecological environment. This is because urbanization requires large tracts of land to be deforested and then used for building cities.
- **Ozone Layer Depletion:** The three oxygen atoms make up an ozone ring. While oxygen lends life to organisms, ozone is a toxic gas. It may be dangerous on Earth, but ozone plays a critical function in the various ambient layers of the atmosphere. UV rays are emitted by the Sun, causing harm to animals, specifically skin cancer in humans, and hence are harmful. Ozone is preventing such UV radiation from entering the planet, thus protecting all of us from UV-damage.

  Over the years, however, this defensive layer has been eroding across the world. A dramatic depletion was discovered back in the 1980s due to the CFCs (chlorofluorocarbons) used in refrigerators and fire extinguishers. This is why production firms are now mandated to produce CFC-free devices around the world.
- **Genetic Modification:** GM are selected bred crops or crops that have had DNA directly implanted into it in order to give an advantage to the crop, whether that be to sustain colder temperatures, require less water, or yield more product. Usage of fertilizers and pesticides reduces the span of soil fertility.
- **Ocean Acidification:** Ocean acidification is caused when $CO_2$ dissolves into the ocean bonding with sea water creating carbonic acid. The acid reduces the pH levels in the water. Coral reefs are home to 25% of aquatic life, many of which are responsible for the natural filtration of the ocean and production of necessary nutrients that are vital for life under the sea. However, acidification is not the only watery threat as there are other human activities causing severe changes.

## LOCAL ENVIRONMENTAL ISSUES

...nmental problem occurs when there comes a ... quality or the quantity of the environmental ... directly or indirectly affect everything on earth.

*...ental issues are defined as problems with the ... system (air, water, soil, noise etc.) that have ... as a result of human interference or mistreatment ... planet.*

A variety of environmental problems now affect our entire world. As globalization continues and the Earth's natural processes transform local problems into international issues. Some largest problems now affecting the world are: acid rain, air pollution, global warming, hazardous wastes, ozone depletion, smog, water pollution, overpopulation and rain forest destruction. It is related to not only environment but with everyone that live at the planet. It effects every human, animal, and nation on this planet.

Human have faced poor environmental conditions throughout history, but what we think of as environmental problems become more common and apparent with industrialization and urbanization. In United States, air and water pollution from the factories and dense urban living conditions attracted growing attention throughout the last centuries, and by the 1960s become recognized as significant problems. Concern over air and water pollution rapidly spread to a range of other conditions—soil erosion, pesticides contamination, deforestation, declining animal population

and species and so on through the efforts of environmental scientist, activists, and policy-makers. These diverse concerns gradually merged into environmental problems, and the **1970 Earth day** in **United States** and then the **1972 United Nation Conference** on the **Human Environment** in Stockholm helped turn "Environmental Quality" into a major international issue. By the time of the **United Nation Conference on Environment** and **Development in Rio De Janeiro in 1992,** significant **"Green Parties"** had been formed in Europe and environmental problems were the subject of citizen and governmental attention worldwide. Environmentalist, a social and environmental movement addresses environmental issues through advocacy, education and activism. The environmental issues can occurs at three levels local, regional and global.

**Local environmental issues:** Some major local environmental issues are given below:

1. Pollution
2. Water Disposal
3. Desertification
4. Water Scarcity
5. Endangered Species

Environmental pollution is defined as the undesirable change in physical, chemical and biological characteristics of our air, land and water. Pollution can be natural or man-made. The agents or substances that cause such changes are termed pollutants. These changes will waste or deteriorate our raw-material resources and the environment. Pollution adversely affects biological species, including humans. It damages our industrial processes, living conditions and cultural assets.

Other significant changes brought about through human activities are changes in the lower atmosphere. These occur due to the increase in concentration of carbon dioxide and other greenhouse gases, and the depletion of stratospheric ozone layer. These environmental changes, occurring on a global scale, are influencing the air, water, land resources, biological diversity as well as human health.

## AIR POLLUTION

Degradation of air quality and natural atmospheric conditions constitute air pollution. An air pollutant may be a gas or particulate matter (*i.e.*, suspended aerosols composed of solids and liquids). Concentrations of atmospheric pollutants depend mainly on the total mass emitted into the atmosphere, and the atmospheric conditions that affect their fate and transport. Most of the air we breathe is elemental $O_2$ and $N_2$. About 1 per cent is composed of other constituents, such as $CO_2$ and water vapour. A small part of this 1 per cent may, however, be air pollutants, including gases and particulate matter. Even such a small concentration may be extremely harmful to life and property.

### Sources of Air Pollution

The sources of air pollution can be grouped under

(*i*) Natural (*ii*) Man-made.

Natural sources of air pollution are forest fires, ash from smoking volcanoes, dust storm and decay of organic matter. Pollen grains floating in air are also a natural source.

Man-made sources are population explosion, deforestation, urbanisation and industrialisation. Certain activities of human beings release several pollutants in air such as carbon monoxide, sulphur dioxide, hydrocarbons, oxides of nitrogen, lead, arsenic, asbestos, radioactive matter and dust. Anthropogenic air pollutants enter the atmosphere from fixed and mobile sources. Fixed sources include large factories, electrical power plants, mineral smelters and different small-scale industries, while mobile sources include all sorts of transport vehicles moving by road, rail or air.

Air pollutants can be classified into two categories, viz., primary and secondary air pollutants. Primary pollutants enter the atmosphere directly from various sources. Secondary pollutants are formed during chemical reactions between primary air pollutants and other atmospheric constituents, such as water vapour. Generally, these reactions occur in the presence of sunlight.

### Harmful Effects of Air Pollution

1. Air pollution affects respiratory system of living organisms and causes bronchitis, asthma, lung cancer, pneumonia etc. Carbon monoxide (CO) emitted from motor vehicles and cigarette smoke affects the central nervous system. CO has 200 times more affinity for haemoglobin than oxygen and forms a stable compound called COHb (carboxy haemoglobin), which is poisonous and causes suffocation and death.
2. Due to depletion of ozone layer, UV radiation reaches the earth. UV radiation causes skin cancer, damage to eyes and immune system. It may also lead to variations in global rainfall, ecological disturbances and dwindling of global food supplies. (Depletion of ozone layer is caused by CFCs (Chloro Fluoro Carbons), which are used in refrigerators, fire extinguishers and aerosol sprayers.)
3. Acid rain is also a result of air pollution. This is caused by presence of oxides of nitrogen and sulphur in the air. These oxides dissolve in rain water to form nitric acid and sulphuric acid respectively.

The rain carrying acids are called acid rain. Various monuments, buildings, and statues are damaged due to corrosion by acid present in the rain. The soil also becomes acidic. The cumulative effect is the gradual degradation of soil and a decline in forest and agricultural productivity.

The green house gases, such as $CO_2$ and methane, which are produced by burning of fossil fuel (coal, petroleum etc.), agricultural activity and deforestation, trap the heat radiated from earth. This leads to an increase in earth's temperature, further leading to weather variability and rise in sea level. Increased temperature may cause melting of ice caps and glaciers, resulting in floods.

Some metals and pesticides also cause pollution. Lead, which is discharged from exhaust pipes of automobiles, is highly toxic. It causes anaemia, brain damage, convulsions and death. Certain metals cause problems in kidney, liver, circulatory system and nervous system. Many fungicides cause nerve damage and death.

Photochemical Smog: The classical example of secondary pollutant, photochemical smog is formed in traffic-congested metropolitan cities where warm conditions and intense solar radiation are present. Photochemical smog is composed mainly of ozone ($O_3$), peroxyacetyl nitrate (PAN) and NOx. It is often called brown air where solar radiation is intense. In areas or seasons of lesser solar radiation, smog formation is incomplete and the air is referred to as grey air. Automobile exhaust contains HC and NO and these play an important role in $O_3$ and PAN formation in urban environment. A simplified set of the photochemical reactions involved in smog formation is as follows :

***Reaction occurring inside engine:***

$$N_2 + O_2 \rightarrow NO$$

***Reactions occurring in atmosphere:***

$$2NO + O_2 \rightarrow 2NO_2$$

UV radiation $$NO_2 \rightarrow NO + O$$

$$O + O_2 \rightarrow O_3$$

$$NO + O_3 \rightarrow NO_2 + O_2$$

$$HC + NO + O_2 \rightarrow NO_2 + PAN$$

Smog ozone may damage plant as well as animal life. In plants, the main damage occurs in leaf. Ozone aggravates lung diseases in humans. Ozone, an effective oxidant, corrodes the heritage building surfaces and damages marble statues and other cultural assets. Several plant species are also very susceptible to PAN in smog. PAN damages chloroplasts and, thus, the photosynthetic efficiency and growth of plants are reduced. It also inhibits electron transport system and interferes with enzyme systems that play important role in cellular metabolism. In humans, PAN causes acute irritation of eyes.

7. Hydrocarbons (HCs) or volatile organic carbons (VOCs) are compounds composed of hydrogen and carbon. HCs are produced naturally during decomposition of organic matter. Methane ($CH_4$), the most abundant hydrocarbon in the atmosphere, is evolved from soil microbes (methanogens) in flooded rice fields and swamps. Benzene and its derivatives, such as formaldehyde, are carcinogenic (substance that causes cancer). Formaldehyde emitted from indoor sources, such as newly-manufactured carpeting, causes indoor pollution. Some relatively reactive HCs contribute to the generation of secondary pollutants. HCs are also generated during the burning of fossil fuels (coal and petroleum).

## Occupational Hazards of air pollution

There are certain diseases which are related to one's occupation. These are caused by constant use of certain substances that sneak into air and then enter our body.

1. Silicosis (Silico tuberculosis) occurs due to inhalation of free silica, or $SiO_2$ (Silicon dioxide), while mining or working in industries related to pottery, ceramic, glass, building and construction work. The workers get chronic cough and pain in the chest.
2. Asbestosis is caused by asbestos, which is used in making ceilings. It is also considered as cancer causing agent.
3. Byssinosis is a disabling lung disease, which is marked by chronic cough and chronic bronchitis due to inhalation of cotton fibres over a long period of time.
4. Pneumoconiosis occurs due to inhalation of coal dust from coal mining industry. The workers suffer from lungs problems.

## Prevention and Control of Air Pollution

Air pollutants can be gaseous or particulate. Different techniques for controlling these pollutants are discussed below:

### *(a) Methods of controlling gaseous pollutants*

1. **Combustion:** This technique is used when the pollutants are in the form of organic gases or vapours. During flame combustion or catalytic process, these organic pollutants are converted into water vapour and relatively less harmful products, such as $CO_2$,

2. **Absorption:** In this technique, the gaseous effluents are passed through scrubbers or absorbers. These contain a suitable liquid absor-bent, which removes or modifies one or more of the pollutants present in the gaseous effluents.

3. **Adsorption:** The gaseous effluents are passed through porous solid adsorbents kept in suitable containers. The organic and inorganic constituents of the effluent gases are trapped at the interface of the solid adsorbent by physical adsorbent.

### (b) Methods to control particulate emissions

1. Mechanical devices generally work on the basis of the following :

   (*a*) **Gravity:** In this process, the particles settle down by gravitational force.

   (*b*) Sudden change in direction of the gas flow. This causes the particles to separate out due to greater momentum.

2. **Fabric Filters:** The gases containing dust are passed through a porous medium. These porous media may be woven or filled fabrics.

   The particles present in the gas are trapped and collected in the filters. The gases freed from the particles are discharged.

3. **Wet Scrubbers:** Wet scrubbers are used in chemical, mining and metallurgical industries to trap $SO_2$, $NH_3$, metal fumes, etc.

4. **Electrostatic Precipitators:** When a gas or an air stream containing aerosols in the form of dust, fumes or mist, is passed between two electrodes, then, the aerosol particles get precipitated on the electrode.

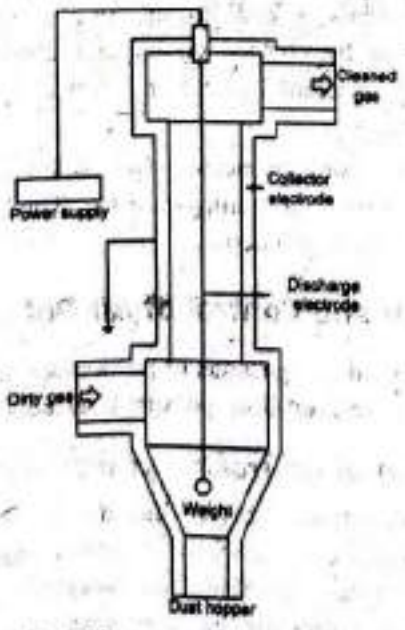


**Fig.** *Electrostatic Precipitator*

### (c) Control of Automobile Exhaust

Efficient engine (for example, multi-point fuel injection engine) can reduce the unburnt HC in auto-emissions. Catalytic converter filters in the vehicle can convert NO to nitrogen, reducing potential hazards of $NO_x$. Good quality automobile fuels can also drastically reduce the toxic contaminants in exhaust.

Lead-free petrol can reduce the load of lead in the exhaust. Automobile engines operated with compressed natural gas (CNG) have significantly lowered toxic contaminants in exhaust.

Apart from the above, following practices also help in controlling air pollution.

1. Use of better designed equipment and smokeless fuels, hearths in industries and at home.
2. More trees should be planted along road side and houses.
3. Renewable energy sources, such as wind, solar energy, ocean currents, should fulfill energy needs.
4. Tall chimneys should be installed for vertical dispersion of pollutants.

## WATER POLLUTION

Water is one of the prime necessities of life. Fresh water is a renewable resource, but its distribution is uneven. With more people making demands on the resource, water has become a scarce commodity. Pollution makes even the limited available water unfit for use.

Water is said to be polluted when there is any physical, biological or chemical change in water quality that adversely affects living organisms or makes water unsuitable for use.

### Sources of Water Pollution

On the basis of their origin, the sources of water pollution can be broadly categorized into :

1. **Point Sources:** These include factories, power plants, underground coal mines and oil wells situated close to water source. They discharge pollutants directly into the water source. But, it is generally possible to treat the pollutants before they enter the water body.
2. **Non-point Sources:** They are scattered and do not have any specific location for discharging pollutants into a particular water body. These include runoff from fields, lawns, gardens, construction sites, logging areas, roads and streets, etc. These sources are difficult to monitor, regulate

*Water pollutants can be:*

(*i*) biological (pathogens, such as viruses, bacteria, protozoa, algae and helminths),

(*ii*) chemical (organic chemicals like biocides, polychlorinated biphenyls or PCBs; inorganic chemicals, like phosphates, nitrates, fluoride, etc.; also heavy metals like As, Pb, Cd, Hg, etc.), and

(*iii*) physical (hot water from industries, oil spills from oil carriers, etc.).

These pollutants are generated by different sources and ivities, which are briefly described below:

**Municipal Wastewater:** Liquid wastes from domestic ivities such as kitchen, toilet and other household wastes are, in most cases, discharged directly into a river or o a large water body nearby.

Many rivers in India, including the river Ganga, barmati, Krishna and Cauvery are polluted by liscriminate discharge of wastewaters.

**Surface Runoff from Land:** Pollutants in surface runoff od storm water) vary according to the nature of land over hich it flows. The runoff from agricultural land is ntaminated with pesticides and residues of inorganic rtilisers. The runoff from urban areas mainly contains odegradable organic pollutants. Industrial sites may ntribute to varied types of pollutants, like heavy metals, ids and various inorganic compounds. All these pollutants the runoff heavily contaminate our surface water and oundwater resources.

**Oil Spills:** An oil spill is the accidental discharge of troleum in oceans or estuaries. Capsized oil tankers, ffshore oil mining and oil exploration operations and oil fineries mainly contribute to oil pollution of marine cosystem.

In addition to unpleasant aesthetic impact of oil-covered astal region, the death of plankton, fish and marine birds a significant ecological effect of oil spills. Oil spills are lso immensely harmful to coral reef and can drastically amage the marine and coastal biodiversity.

## ffects of Water Pollution

1. Due to water pollution human beings become victims of various water borne diseases, such as typhoid, cholera, dysentery, hepatitis, jaundice, etc. Domestic sewage contains pathogens like virus, bacteria, parasitic protozoa and worms. Contaminated water, therefore, can carry the germs of waterborne diseases like jaundice, cholera, typhoid, amoebiasis, etc. Such contamination may make the water unfit for drinking, bathing, and swimming, and even for irrigation. Heavy metal contamination of water can cause serious health problems. Mercury poisoning (Minamata disease) due to consumption of fish captured from Hg-contaminated Minamata Bay in Japan, was detected in 1952. Mercury compounds in waste-water are converted by bacterial action into extremely toxic methyl mercury, which can cause numbness of limbs, lips and tongue, deafness, blurring of vision, mental derangement. Cadmium pollution can cause itai-itai disease (ouch-ouch disease, a painful disease of bones and joints) and cancer of liver and lungs.
2. The presence of acids/alkalies in water destroys the microorganisms, thereby hindering the self-purification process in rivers.
3. **Eutrophication:** The sewage waste promotes growth of phytoplankton in water bodies. Their excessive growth then depletes the oxygen dissolved in the water. Moreover, when phyto-planktons die, their putrefaction consumes most of the oxygen content of the water. Excessive loading with nutrients and algal growth (bloom) causing reduction in $O_2$ level of water, is called eutrophication. The reduction of dissolved oxygen and the poisonous industrial wastes affect the fish population and deprives us of one of our sources of food. It also kills other animals living in fresh water.
4. **Groundwater pollution:** In India, at many places the groundwater is threatened with contamination due to seepage from industrial and municipal wastes and effluents, sewerage channels and agricultural runoff. For example, excess nitrate in drinking water is dangerous for human health and may be fatal for infants. It reacts with haemoglobin and forms non-functional methaemoglobin that impairs oxygen transport. This is called methaemoglobinemia or blue-baby syndrome.

   Excess fluoride in drinking water causes teeth deformity, hardened bones and stiff and painful joints (skeletal fluorosis). At many places in India, groundwater is contaminated with arsenic, mainly from naturally occurring arsenic in bedrocks. Overexploitation of groundwater may possibly initiate leaching of arsenic from soil and rock sources and contaminate groundwater. Chronic exposure to arsenic causes black-foot disease. Arsenic causes diarrhoea, peripheral neuritis, and hyperkeratosis, and also lung and skin cancers.

### Algal Bloom

An algal bloom is a rapid increase or accumulation in the population of algae in an aquatic system. Algal blooms may occur in freshwater as well as marine environments. Typically, only one or a small number of phytoplankton species are involved, and some blooms may be recognized by discoloration of the water resulting from the high density of pigmented cells. Although there is no officially recognized threshold level, algae can be considered to be blooming at concentrations of hundreds to thousands of cells per milliliter, depending on the severity. Algal bloom concentrations may reach millions of cells per milliliter. Algal blooms are often green, but they can also be other colors such as yellow-brown or red, depending on the species of algae.

### Thermal Pollution

Thermal pollution is the degradation of water quality by any process that changes ambient water temperature.

A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural environment at a higher temperature, the change in temperature (a) decreases oxygen supply, and (b) affects ecosystem composition. Urban runoff—stormwater discharged to surface waters from roads and parking lots—can also be a source of elevated water temperatures.

When a power plant first opens or shuts down for repair or other causes, fish and other organisms adapted to particular temperature range can be killed by the abrupt rise in water temperature known as 'thermal shock'.

Elevated temperature typically decreases the level of dissolved oxygen (DO) in water. This decrease in levels of DO can harm aquatic animals such as fish, amphibians and crustaceans.

Thermal pollution may also increase the metabolic rate of aquatic animals, as enzyme activity, resulting in these organisms consuming more food in a shorter time than if their environment were not changed. An increased metabolic rate may result in fewer resources, the more adapted organisms moving in may have an advantage over organisms that are not used to the warmer temperature. As a result one has the problem of compromising food chains of the old and new environments. Biodiversity can be decreased as a result.

## Prevention and Control of Water Pollution

*The industrial and municipal wastewaters are treated in Effluent Treatment Plant (ETP) prior to disposal in water bodies. Generally the following treatments are given in ETP.*

(i) ***Primary Treatment:*** *This physical process involves the separation of large debris, followed by* sedimentation in tanks or clarifiers.

(ii) **Secondary Treatment:** This is a biological process and is carried out by microorganisms. In this treatment, the wastewater is pumped in shallow stabilization or oxidation ponds, where the microbes oxidise its organic matter.

The process results in release of $CO_2$ and formation of sludge or biosolid. The sludge is continuously aerated to further its oxidation. Algae grown in the upper lighted zone of the wastewater provide aeration by generating $O_2$.

(iii) **Tertiary treatment**: This physico-chemical process removes turbidity in wastewater caused by the presence of nutrients (nitrogen, phosphorus, etc.), dissolved organic matter, metals or pathogens. For tertiary treatment methods, such as chlorination, evaporation, exchange absorption may be employed. These depend upon the required quality of the final treatment. After tertiary treatment, the wastewater can be discharged into natural waters or used for irrigation.

## SOIL POLLUTION

The process of soil pollution is slow and thus it may be considered as non-renewable resources. There are many natural and synthetic materials that can adversely affect the physical, chemical and biological properties of soil and its productivity. Soil pollution is extremely complex process. It may be the direct effect of different activities, like waste dumping, use of agrochemicals, mining operations and urbanisation.

### Sources and Causes of Soil Pollution

- **Mining Operations:** Opencast mining (a process where the surface of the earth is dug open to take out the underground mineral deposits) completely devastates the topsoil and contaminates the soil with toxic metals and chemicals.
- **Municipal Wastes:** Municipal wastes mainly consist of domestic and kitchen wastes, market wastes, hospital wastes, livestock and poultry wastes, slaughterhouse wastes, waste metals, and glass and ceramic wastes etc. Non-biodegradable materials like polyethylene carry-bags, waste plastic sheets, bottles, etc. persist in soil for long periods. Hospital wastes contain great amount of chemicals, metal needles, plastic and glass bottles, vials, etc. Dumping of domestic sewage and hospital organic wastes contaminate the environment with a variety of pathogens that can seriously affect human health.
- **Agrochemicals:** Pesticides and weedicides are being increasingly applied to control pests and weeds in agricultural systems. Excess inorganic fertilisers and biocide residues are contaminating the soil as well as surface and groundwater resources. Inorganic nutrients, like phosphate and nitrate are washed off

to aquatic ecosystems and accelerate eutrophication there. Nitrate can also pollute drinking water. Inorganic fertilisers and pesticide residues change the chemical properties of soil and can adversely affect soil organisms.

**E-Waste**

Electronic waste describes loosely discarded, surplus, obsolete, or broken electrical or electronic devices. Environmental groups claim that the informal processing of electronic waste in developing countries causes serious health and pollution problems. Some electronic scrap components, such as CRTs, contain contaminants such as lead, cadmium, beryllium, mercury, and brominated flame retardants.

## Waste Dumps

Land gets polluted by dumping of industrial wastes, municipal wastes, and medical or hospital wastes. Industrial solid wastes and sludge are the major sources of soil pollution by toxic organic and inorganic chemical compounds and heavy metals. The fall out from industrial emissions, for example, the fly-ash emitted by thermal power plants, can pollute surrounding land. We must keep in mind that the particulates of the industrial emissions from the tall chimneys always come back to the earth's surface sooner or later. Radioactive wastes from nuclear testing laboratories and nuclear power plants and the radioactive fall out from nuclear explosions also contaminate the soil. Radioactive materials thrive in the soil for long periods because they usually have a long half-life. Strontium-90, for example, has a half-life of 28 years, and half-life of caesium-137 is 30 years.

## Control of Soil Pollution

Control measures for soil pollution and land degradation involve safer land use, planned urbanisation, controlled developmental activities, safe disposal and management of solid wastes from industries and human habitations. Management of solid wastes involves:

(*i*) collection and categorisation of wastes,

(*ii*) recovery of resources like scrap metals, plastics, etc., for recycling and reuse, and

(*iii*) safe disposal with minimum environmental hazards.

Sewage sludge and industrial solid wastes are used as landfills. Toxic chemicals and hazardous metal-containing wastes are used as bedding material for road construction. Fly- ash is also used for similar purposes. Fly-ash bricks are also being used for building constructions. Other notable methods to get rid of the solid wastes are incineration (burning in presence of oxygen) and pyrolysis (combustion in the absence of oxygen). Municipal solid wastes containing biodegradable organic wastes, can be transformed into organic manure for agriculture.

## Land Degradation

Land and soil face several problems other than pollution. These are deforestation, erosion, flooding and water-logging, Salinization and unplanned urban development. If soil depletion and land degradation continues at current rates, it is estimated that about one-third of the arable land will be destroyed by the end of the century.

## Soil Erosion

Natural agents like water and wind, constantly tend to remove the top soil and cause erosion. Rain falling upon the unprotected top soil, washes it down into the streams. Due to the absence of plant covering, eroded soil cannot hold water. Water rushes into the rivers and overflows as flood. Dust storm also causes soil erosion. The particles of top soil are picked up in such quantities that they form clouds of dust. Human beings also cause soil erosion. The growing human habitation and expansion of urban areas lead to removal of vegetation. Once vegetation is removed, the naked soil gets exposed to wind and water. Improper tillage is another cause of soil erosion. Farmers often loosen the top soil for removing weeds and preparing seed beds. They also leave agricultural fields lying fallow for long time. These practices expose the top soil to the wind and cause erosion.

**Prevention of Soil Erosion:** We can check soil erosion by adopting the following practices:

1. Intensive cropping, and use of proper drainage canals.
2. Terracing on the sloping fields. This retards the speed of the flowing water.
3. Planting trees and sowing grasses.

## NOISE POLLUTION

As a result of rapid industrialization and urbanization during the last century, noise pollution has come to be recognized as one of the significant environmental problems faced by urban areas across the world. This is revealed by a large number of noise surveys conducted in different cities of the world. Noise pollution can be defined as the loud disturbing sound dumped into the ambient atmosphere without regard to the adverse effects it may have.

Sound travels in pressure waves and affects our eardrums. The intensity of a sound wave is the average rate per unit area at which energy is transferred by the wave onto the surface. The sound level is the logarithm of ratio of the

ambient intensity to the reference intensity. The unit of sound level is decibel (dB), a name that was chosen to recognise the work of Alexander Graham Bell. When the ambient sound intensity is equal to the reference intensity, the sound or noise level is 0 dB. Noise level can range from 0 to more than 120 dB, at which point physical discomfort starts. In view of the logarithmic nature of scale, 10, 20 and 100 decibels represent 10 times, 100 times and 1010 times the threshold intensity, respectively.

Noise can disturb man's work, rest, sleep, and communication; it can damage his hearing and evoke other psychological, physiological and possibly pathological reactions. However, because of their complexity, their variability, and the interaction of noise with other environmental factors, the adverse health effects of noise do not lend themselves to a straight forward analysis.

## Effects of Noise

- Interference with communication
- Hearing loss
- Disturbance of sleep
- Stress
- Annoyance
- Effects on work performance
- Pain

## Traffic Noise Index (TNI)

This index is specific to traffic. TNI is better correlated with annoyance and irritation because we give four time weightage to fluctuation in noise. TNI can be represented empirically as:

$$TNI = L_{90} + 4\,(L_{10} - L_{90}) - 30$$

Since, it was found annoyance was correlated with background noise, $L_{90}$. So, we have a factor of $L_{90}$ in TNI. $L_{10} - L_{90}$ is the range of fluctuation of noise. The wide variations of noise over the background noise are the prime cause for the fluctuation. The term-30 has no special significance; it is subtracted from the final value so that the value does not come very high.

**PERMISSIBLE AMBIENT NOISE LEVELS IN ACOUSTIC ZONE (AS PER CPCB STANDARD)**

| Acoustic Zones | Day (6.00-21.00 hr) | Night (21.00-6.00 hr) |
|---|---|---|
| Residential | 55 dB | 45 dB |
| Industrial | 75 dB | 70 dB |
| Commercial | 65 dB | 55 dB |
| Silent zone (school, hospital etc) | 50 dB | 40 dB |

# WASTE DISPOSAL

Waste disposal, the collection, processing, and recycling or deposition of the waste materials of human society. Waste is classified by source and composition. Broadly speaking, waste materials are either liquid or solid in form, and their components may be either hazardous or inert in their effects on health and the environment.

## Classification of Waste

We can classify waste as follows:

- **Solid waste:** Vegetable waste, kitchen waste, household waste etc.
- **E-waste:** Discarded electronic devices such as computer, TV, music systems etc.
- **Liquid waste:** Water used for different industries, tanneries, distilleries, thermal power plants
- **Plastic waste:** Plastic bags, bottles, bucket, etc.
- **Metal waste:** unused metal sheet, metal scraps etc.
- **Nuclear waste:** Unused materials from nuclear power plants

Further we can group all these types of waste into wet waste (Biodegradable) and dry waste (Non-Biodegradable).

**Wet waste (Biodegradable)** includes the following:

- Kitchen waste including food waste of all kinds, cooked and uncooked, including eggshells and bones
- Flower and fruit waste including juice peels and house-plant waste
- Garden sweeping of yard waste consisting of green dry leaves.
- Sanitary wastes
- Green waste from vegetable & fruit vendors/shops
- Waste from food & tea stalls/shops etc.

**Dry waste (Non-biodegradable)** includes the following:

- Paper and plastic, all kinds
- Cardboard and cartons
- Containers of all kinds excluding those containing hazardous material
- Packaging of all kinds
- Glass of all kinds
- Metals of all kinds
- Rags, rubber
- House sweeping (dust etc.)
- Ashes
- Foils, wrappings, pouches, sachets and tetra pack (rised)

- Discarded electronic items from offices, colonies viz. cassettes, computer diskettes, printer cartridges and electronic parts.
- Discarded clothing, furniture and equipment.

In addition to the above wastes, another type of waste d **"Domestic hazardous Waste"** may also be generated e household level. These include used aerosol cans, ies, and household kitchen and drain cleaning agents, tteries and car care products, cosmetic items, chemical- insecticides/pesticides, light bulbs, tube-lights and act fluorescent lamps (CFL), paint, oil, lubricant and empty containers. Waste that is considered hazardous t required by the EPA to meet the legal definition of waste. The EPA incorporates hazardous waste into ategories. The first category are source-specific wastes, scond category is nonspecific wastes, and third, ercial chemical products. Generally, hazardous waste ge that is dangerous or potentially harmful to our or the environment. Hazardous wastes can be liquids, gases, or sludge. They can be discarded commercial cts, like cleaning fluids or pesticides, or the by- cts of manufacturing processes.

nilarly there is **"Non Hazardous waste"**. There are definitions of hazardous and non-hazardous waste he US federal government, states and industry groups. partment of Defense (DOD) and The Environmental on Agency (EPA) define waste as "the extravagant, , or needless expenditure of DOD funds or the ption of DOD property that results from deficient s, systems, controls, or decisions. In addition, "abuse anner in which resources or programs are managed ues or perpetuates waste and it includes improper not involving prosecutable fraud".

Environmental Protection Agency (EPA) defines -hazardous waste as "any garbage or refuse, sludge astewater treatment plant, water supply treatment air pollution control facility and other discarded including solid, liquid, semi-solid, or contained material resulting from industrial, commercial, nd agricultural operations, and from community

## ls of Waste Disposal

ccumulation has never been much of a concern in but due to globalization and industrialization, need for a more efficient waste disposal method. are some of the methods that are used today.

**Landfill:** In landfill, the waste that cannot be reused recycled are

layer in low-lying areas across a city. A layer of soil is added after each layer of garbage. However, once this process is complete, the areas is declared unfit for construction of buildings for the next 20 years. Instead, it can only be used as a playground.

- **Incineration:** Incineration is the process of controlled combustion of garbage to reduce it to incombustible matter such as ash and waste gas. The exhaust gases from this process may be toxic, hence it is treated before being released into the environment. This process reduces the volume of waste by 90 per cent and is considered as one of the most hygienic methods of waste disposal. In some cases, the heat generated is used to produce electricty. However, some consider this process, not quite environmentally friendly due to the generation of greenhouse gases such as carbon dioxide ($CO_2$) and carbon monoxide (CO).
- **Waste Compaction:** The waste meterials such as cans and plastic bottles are compacted into blocks and sent for recycling. This process prevents the oxidation of metals and reduces airspace need, thus making transportation and positioning easy.
- **Biogas Generation:** Biodegradable waste, such as food items, animal waste or organic industrial waste from food packaging industries are sent to bio-degradation plants. In biodegradation plants, they are converted to biogas by degradation with the help of bacteria, fungi, or other microbes. Here, the organic matter serves as food for the micro-organisms. The degradation can happen aerobically (with oxygen) or anaerobically (without oxygen). Biogas is generated as a result of this process, which is used as fuel, and the residue is used as manure.
- **Composting:** All organic materials decompose with time. Food scraps, yard waste, etc., make up for one of the major organic wastes we throw everyday. The process of composting starts with these organic wastes being buried under layers of soil and then, are left to decay under the action of microorganism such as bacteria and fungi.
- **Vermicomposting:** Vermicomposting is the process of using worms for the degradation of organic matter into nutrient-rich manure. Worms consume and digest the organic matter. The by-products of digestion which are excreted out by the worms make the soil nutrient-rich, thus enhancing the

## DESERTIFICATION

Desertification is the degradation process by which fertile land changes itself into a desert by losing its flora and fauna, this can be caused by drought, deforestation, climate change, human activities or improper agriculture. It is a process of degradation of the land. Desertification takes place when a particular type of biome converts into a desert biome.

### Causes of Desertification

- **Deforestation:** Wood extraction, and infrastructure expansion such as road building and urbanization, then it contributing to problems related to desertification.
- **Overgrazing:** When there are too much animals that are overgrazing in certain spots it makes it difficult for the plant grow back, which hunts the biome and make it loss its former green glory.
- **Farming practice:** Some farmers may essentially strips the land of everything that it has before moving the another plot of land. By stripping the soil of its nutrients, desertification becomes more of a reality for the area that is being used for the farming.
- **Excessive use of fertilizers and pesticides:** Excessive use of fertilizer and pesticides to maximize to their crop yields in the short term often lead to significant damages for the soil. In the long run, this may turn from arable into arid land over time and not suitable for the farming.
- **Overdrafting of groundwater:** It is a process in which groundwater is extracted in excess of the equilibrium yield of the aquifer that is pumping or the excessive pulling up of groundwater from underground aquifers.
- **Climate change:** It plays a huge role in desertification. As the days get warmer and periods of drought become more frequent, desertification becomes more and more eminent. Unless climate change is slowed down, huge areas of land will become desert. There are also some reason such as natural disasters, soil pollution, overpopulation and excessive consump-tions, mining etc. causes desertification.
- **Effects of desertification:** Farming become next to impossible—an area become desert than it's impossible to grow sustainable crops there without special technologies. This can cost a lot of money to try and do, so many farmer will have to sell their desert land. Hunger is also a problem, without [illegible] in this area the food that this farm produce [illegible] become much scarcer, and people try and deal [illegible] hunger problems.
- **Flooding:** Without life in an area, flooding is a [illegible] more imminent. Not all desert are dry; those that [illegible] wet could experience a lot of flooding because [illegible] there is nothing to stop the water from gathering and going all over the place.
- **Biodiversity loss, endangerment and extinction of species:** The destruction of habitats and desertification may also contribute to a loss of biodiversity. Many species will not able to adjust to the changing environmental conditions and may suffer from serious decline in population.
- **Migration:** If large area of land that are currently used for farming will no longer be suitable for farming due to water triggered by global warming. This results in serious migration movements.

### Desertification Impacts

1. Farming becomes difficult or even impossible in the area
2. Flooding chances are more
3. Hunger – because of no farming
4. Poor quality of water
5. Overpopulation
6. Poverty as a result of the above

### Status of Desertification in India

- 96 million hectares or close to 29% of India's [illegible] is undergoing degradation.
- According to the Government's data recently presented to the United Nations Convention to Combat Desertification (UNCCD), India lost 31% or 5.65 million hectares (mha), of grassland area in a decade.
- The extent of degraded land in India is over [illegible] million hectares or about 32% of India's area.
- More than 80% of the country's degraded land [illegible] in just nine states.

### The Global Reach of Desertification

Slightly less than half of Earth's ice-free land surface—approximately 52 million square km (about 20 million square miles)–is drylands, and these drylands cover some of the world's poorest countries. The United Nations Environment Programme (UNEP) notes that desertification has affected

36 million square km (14 million square miles) of land and is a major international concern.

According to the United Nations Convention to Combat Desrtification, the lives of 250 million people are affected by desertification, and as many as 135 million people may be displaced by desertification by 2045, making it one of the most severe environmental challenges facing humanity.

## Solutions to Desertification

At local scales, however, desertification is often the result of unsustainable land and soil management. To maintain engineering projects, some of the techniques that may help ameliorate the consequences of desertification in irrigated croplands, rain-fed croplands, grazing lands, and dry woodlands include:

1. Salt traps, which involve the creation of so-called void layers of gravel and sand at certain depths in the soil. Salt traps prevent salts from reaching the surface of the soil and also help to inhibit water loss.
2. Irrigation improvements, which can inhibit water loss from evaporation and prevent salt accumulation. This technique involves changes in the design of irrigation systems to prevent water from pooling or evaporating easily from the soil.
3. Cover crops, which prevent soil erosion from wind and water. They can also reduce the local effects of drought. On larger scales, plant cover can help maintain normal rainfall patterns. Cover crops may be perennials or fast-growing annuals.
4. Crop rotation, which involves the alternation of different crops on the same plot of land over different growing seasons. This technique can help maintain the productivity of the soil by replenishing critical nutrients removed during harvesting.
5. Rotational grazing, which is the process of limiting the grazing pressure of livestock in a given area. Livestock are frequently moved to new grazing areas before they cause permanent damage to the plants and soil of any one area.
6. Terracing, which involves the creation of multiple levels of flat ground that appear as long steps cut into hillsides. The technique slows the pace of runoff, which reduces soil erosion and retards overall water loss.
7. Contour bunding which involves the placement of lines of stones along the natural rises of a landscape, and contour farming.
8. Windbreaks, which involve the establishment of lines of fast-growing trees planted at right angles to the prevailing surface winds. They are primarily used to slow wind-driven soil erosion but may be used to inhibit the encroachment of sand dunes.
9. Dune stabilization, which involves the conservation of the plant community living along the sides of dunes. The upper parts of plants help protect the soil from surface winds, whereas the root network below keeps the soil together.

## WATER SCARCITY

Water scarcity involves water crisis, water shortage, water deficit or water stress. It can be due to physical water scarcity and economic water scarcity. Physical water scarcity refers to a situation where natural water resources are unable to meet a region's demand while economic water scarcity is a results of poor water management resources.

"Water scarcity is — the lack of sufficient available water resources to meet the demands of water usage within a region. It already 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water."

### Causes of Water Scarcity

- Overuse of water
- Pollution of water
- Global warming
- Illegal dumping
- Natural disasters
- Drought

### Solutions of Water Scarcity

1. **Sustainable water management:** Improving water infrastructure must be a priority, as water conservation and efficiency are key components of sustainable water management.

   Solar desalination and smart irrigation system are great examples of clean technology for water efficiency and control. That obviously applies even more to the agriculture and farming sector - the largest consumer of water.
2. **Reclaimed water:** Rainwater harvesting and recycled wastewater also allow to reduce scarcity and ease pressures on groundwater and other natural water bodies. Groundwater recharge, that allows water moving from surface water to groundwater, is a well-known process to prevent water scarcity.

3. **Pollution control & better sewage treatment:** Without proper sanitation, the water becomes full of disease and unsafe to drink. That is why addressing pollution, measuring and monitoring water quality is essential.
4. **Awareness & Education:** Education is critical to solve the water crisis. In fact, in order to cope with future water scarcity, it is necessary to radically reform all forms of consumption, from individual use to the supply chains of large companies.

## ENDANGERED SPECIES

Endangered species are those animals, birds and fish that are in immediate danger or becoming extinct. There may be many reasons like loss of habitat, pollution, natural disasters etc. that increases the risk of a particular species to become endangered.

### Examples of Endangered Species

1. **Giant Panda:** Scientific name of giant panda *Ailuropoda melanoleuca* that means "black and white cat footed animal." It is known as the bamboo bear, panda bear or in Chinese as Daxiongmao (large bear cat). Habitat destruction is the main reason of Panda's extinction. The panda is considered vulnerable of extinction by the IUCN. Due to the fact that pandas reproduce so infrequently, it is very difficult for their population to recover.
2. **Asiatic lion:** Scientific name of Asiatic lion *Panthera leo persica*. Asiatic Lions are found in Gir National Park (Gujarat).
3. **Sea turtles:** Scientific name of sea turtles *Chelonioidea*. The most endangered species of Sea Turtles in the world are the Hawksbill Turtle and the Leatherback Turtle.
4. **Rhino:** Scientific name of Rhinos is *Rhinocerotidae*. The Javan Rhino is the most threatened with extinction.
5. **Tiger:** Scientif name of tiger is *Panthera tigris*. Of the total nine tiger subspecies, three are already extinct, many are endangered.

### Causes of Endangered Animals

- Loss of natural habitat
- Environmental pollution
- Invasive species
- Overpopulation
- Hunting and poaching
- Fishing
- Natural disasters
- Genetics
- Disease

### Solutions to Save Endangered Species

1. Recycle and buy sustainable products
2. Protect wildlife habitat
3. Use less pesticides and herbicides
4. Raise awareness among people to save species
5. Reduce your carbon footprint
6. Avoid plastic products

## REGIONAL AND GLOBAL ENVIRONMENT ISSUES

Some regional and global environment issues are given below:

1. Global warming
2. Ocean Acidification
3. Acid Rain
4. Ozone Depletion

## GLOBAL WARMING

### The Greenhouse Effect

The basic idea behind the **greenhouse effect** is as follows: Short-wavelength, high-energy, **solar radiation** shines from the Sun onto the Earth. Some of this incoming solar radiation is reflected by the atmosphere back into space, some passes though the atmosphere and is absorbed and heats the air, and about half reaches the Earth's surface. The surface heats up and in the process given off long-wavelength, lower-energy **infrared**, or **heat** radiation. This infrared radiation passes up into the atmosphere, but instead of being radiated 100% back into space, much of it is absorbed by the atmosphere and reradiated to surface.

This phenomenon occurs because many trace gases (the **greenhouse gases**) in the atmosphere are relatively transparent to the higher-energy sunlight, but trap or reflect the lower-energy infrared radiation. Thus, the greenhouse gases act as a one-way filter, letting energy in the form of sunlight in but not allowing the infrared heat to escape.

the same rate. This process is crudely analogous to the way glass in a greenhouse allows sunlight to shine in, but stops much of the longer-wavelength heat from escaping. Even on a cold winter day, the ions of a green-house can become quite warm if the Sun is shining.

Likewise, the Earth's surface would be a frozen mass if it were not for the natural greenhouse effect of the atmosphere. Without this phenomenon, average global temperatures might be on the order of –17°C. Note, however, that with current levels of greenhouse gases, some infrared heat does continue to escape. In recent Earth history, a relative steady-state balance has been achieved that maintains the average global surface temperature at about 15°C.

If no heat escaped, the surface would continue to heat up to unbearable temperatures. The perceived problem is that, due to inadvertent human intervention, greenhouse gases are accumulating very quickly in the atmosphere, and some predict this will lead to catastrophic global warming.

## OCEAN ACIDIFICATION

The Earth is watery planet because about 71 percent of the Earth's surface is water-covered, and the ocean hold about 96.5 per cent of all Earth's water.

Ocean acidification can be defined as the ongoing consistent decrease in the pH of the ocean water. When carbon dioxide ($CO_2$) dissolved in the Ocean water, it creates carbonic acid ($H_2CO_3$) and increases the hydrogen ion ($H^+$) concentration in the ocean. The absorption of the carbon dioxide by ocean helps in mitigating the climatic effects of carbon dioxide emissions, but at the same time it also has negatively impacted the pH value of ocean water.

### Causes

The ocean chemistry is changing continuously due to following causes given below:

1. The industrial revolution
2. High concentration of carbon dioxide
3. Burning of fossil fuels
4. Cement manufacturing
5. Changes of land use
6. Raising of carbon dioxide levels in the ocean
7. Raising of carbon dioxide in the atmosphere
8. Chemical reactions causing high concentration of hydrogen ions
9. Decrease in carbonate ions
10. Loss of biodiversity
11. Production alterations of biogas
12. Lack of environmentally friendly laws and regulation

### Effect on Marine Ecosystems

1. It reduces the concentration of carbonate, which is important for building block in seawater.
2. Marine animals interact in complex food webs that may be disrupted by ocean acidification due to losses in key species that will have trouble creating calcium carbonate shells in acidified waters.
3. It has a huge impact on commerical fisheries, shell-fisheries, aquaculture, recreational fisheries, subsistences, traditional shellfisheries and fisheries.

### Solution of Ocean Acidification

- Reducting the use of fossil fuels
- Increasing the use of eco-friently fuels
- Use of technology for reducing pollution
- Making strict regulations
- Spreading the awareness to the masses
- Promotion of environmentally friendly initiatives
- Use of Geo-engineering.

## ACID RAIN

Acid rain is an environmental problem that knows no boundaries. Increasing acidity in natural waters and soil has become a global concern. Acidification and climate change are interrelated, as the sources responsible for acidification of environment and green house gases are same. Normally unpolluted rain water is always slightly acidic, because $CO_2$ in atmosphere dissolve in it forming carbonic acid $H_2CO_3$. The pH of unpolluted rain water is about 5.5–5.7. But due to presence of $SO_2$ and $NO_2$ gases as pollutants in the atmosphere, the pH of rain is further lowered. Often as low as 2.4 and this type of precipitation is generally referred to as acid rain.

The term *acid rain* was first used by Robert Angus in 1872. Literally it means presence of excessive acids in rain water. Acid rain is in fact a cocktail of mainly $H_2SO_4$, $HNO_3$ and HCl. $H_2SO_4$ is the major contributor (60–70%), $HNO_3$ (30–40%) and HCl is the third contributor. These oxides may travel long distances in the atmosphere and under go several physical and chemical transformations to produce more hazardous substances, which may fall on earth with rain. Once these oxide have fallen on earth it is difficult to remove them. There has always been some acid in rain,

coming from volcanoes, swamps and planktons in the oceans. But acidic conc. has increased many folds during the last 200 years. And there is no doubt that this increase is due to human activities, such as burning of fossil fuel, automobile exhaust, domestic fires and power plants emissions.

### Types of Acid Rain

1. **Wet Acid Rain:** Acid rain in the form of snow, dew, fog, mist, frost represent the wet form of deposition.
2. **Dry Acid Rain:** Dust particles containing sulphates and nitrates settled on earth is called dry deposition. However wet acid rain is much more common. Every source of energy that we use be it coal, wood, petroleum products has sulphur and nitrogen. Those two elements when burnt in atmospheric oxygen are converted into their respective oxides ($SO_2$ and $NO_x$), which are highly soluble in water.

### Adverse Effects of Acid Rain

1. Acid rain causes extensive damage to buildings and structural materials such as marble, lime stone, motar & slate. Lime stone is attacked rapidly for e.g. Taj Mahal in Agra has suffered a lot due to $SO_2$ and Sulphuric acid or other pollutants from Mathura Refinery.
2. Acid rain is contaminating portable ground water with toxic compounds present in it. These toxic compounds enter into the man's body and play Havoc with human respiratory, nervous and digestive system.
3. Acid rain produces the acidity of the lakes and rivers which kill fishes, algae, bacteria and aquatic system gets collapsed.
4. Acid rain has become a great threat to British Environment. Much of the falling snow in the Britain is now highly acidic and if it does not melt it may turn into a pollution time bomb. The acid rain in a nut shell effects aquatic as well as terrestrial eco-system.

### Control of Acid Rain

We have to adopt and enforce some strict measures to reduce vehicular emissions containing nitrogen oxide and emissions from power stations containing $SO_2$. Short term control of acid deposition problem can be achieved by using lime. New York has been liming it's lakes, ponds since 1959 but liming is possible only for a few lakes by observing that whether it is economically feasible to lime the whole lake. It takes around 40 dollars per acre if done manually but if done through helicopters the cost comes out to be about 200 dollars per acre. People should be made more aware about the harmful effects, causes and preventive measures of controlling acid rain.

## OZONE DEPLETION

### Ozone in Nature

**Ozone ($O_3$)** is an important component of the **stratosphere.** Ozone occurs in scant amounts between about 10 and 50 km above sea level and is most strongly concentrated at an altitude of 20-25 km the **ozone layer**. Ozone is formed in the stratosphere (See Fig.) when high-energy **ultraviolet (UV) radiation** splits normal oxygen molecules $O_2$ into atomic oxygen (O). The atomic oxygen may then combine with a standards diatomic oxygen molecule ($O_2$) to form triatomic ozone ($O_3$). Under natural conditions, ozone is not only formed in the atmosphere, but it is also removed by various reactions. An ozone molecule can absorb UV radiation and split into $O_2$ and O. The atomic oxygen can then either recombine with an $O_2$ molecule to form ozone once again, combine with another atomic oxygen to form diatomic oxygen, or combine with some other substance in the stratosphere. In nature, excluding human interference, a dynamic equilibrium exists between ozone production and ozone destruction, such that the stratosphere always contains a small amount of ozone. The amount of stratospheric ozone is so small that if it were all brought down to sea level, it would form a blanket over the surface of Earth only 0.118 inch thick.

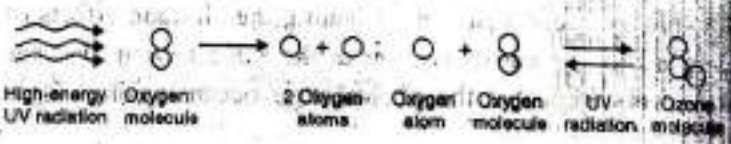


**Fig.** *Schematic representation of the formation of stratospheric ozone*

Nevertheless, this stratospheric ozone is essential to the preservation of current forms of life on the Earth's surface. The ozone layer acts as a shield that absorbs biologically dangerous UV-B radiation (See Fig.). Ultraviolet radiation is commonly divided into two bands: UV-A has wavelengths 320 to 400 nm [nm = nanometers; 1 nm = $10^{-9}$ m, or one billionth of a meter or approximately $3.937 \times 10^{-8}$ inch] and the higher- energy UV-A has wavelengths less than 320 nm [sometimes the very shortest wavelength UV, applied "UV-C" as in Fig.]. When an ozone molecule is hit by UV-B wavelengths, it absorbs the radiant energy and photodissociates into $O_2$ and O while giving off heat. This

keeps the UV-B radiation from reaching Earth's surface and also causes a temperature inversion in the stratosphere that helps to maintain relatively stable climatic conditions on and near the ground.

## Waste

Although the words **trash, garbage, rubbish** and **refuse**— are often used as synonyms in casual discussions, each has a different and specific technical meaning. *Trash* refers to things like old paper, newspaper, boxes, cans, containers, and so on— generally, objects that are "dry" and nonedible. *Garbage* refers to "wet" discarded matter, such as old food remains, yard waste like grass clippings, dead animals, leftovers from meat packing operations and butcher shops (such as the viscera of slaughtered animals), and so on. Generally, garbage is edible and was often kept separate from trash in the past so that it could be fed to pigs. Today some types of garbage are useful for composting. *Refuse* technically refers to both trash and garbage, while *rubbish* includes not only refuse but also construction and demolition debris, such as old boards, bricks, cinderblocks, beams, tar paper, shingles, and so on. Ultimately, all of these sorts of rubbish are finding their way into our modern landfills.

## Solid Waste

**Solid waste**, "Materials (non liquid or gaseous) which are mainly generated through anthropogenic activities and are discarded as useless or unwanted are called solid wastes." Certainly, household garbage, trash, refuse, and rubbish are all solid waste, but so too are solids, various semi-solids, liquids, and even gases that result from mining, agricultural, commercial, and industrial activities. Often substance such as liquids and gases are confined in solid containers and disposed of with more conventional solid wastes. Sewage effluent, and wastewater from commercial enterprises, organizations, and private homes are not solid waste, but once wastewater is treated and various residues are removed from the water to form sludge, the sludge is usually treated as a form of solid waste. Solid waste may be divided into two broad categories depending on its origination : municipal solid waste (produced by various institutions, businesses, and private homes) and industrial solid waste.

## Liquid Waste

Liquid waste can be defined as such Liquids as wastewater, fats, oils or grease (FOG), used oil, liquids, solids, gases or sludges and hazardous household liquids. These liquids that are hazardous or potentially harmful to human health or the environment. They can also be discarded commerical products classified as "Liquid Industrial Waste" such as cleaning fluids or pesticides, or the by-products of manufacturing processes.

The improper disposal of waste water play a role in the contamination of surface water, ground water, and the soil thereby posing health problems. These phenomena persists on developing countries and affect almost every one.

In our country, today, all wastes even in large cities like are drained to the side of roads to ultimately join small streams or rivers to flow down stream causing water pollution. All the wastes drained in water ways depends on the winter rains for cleaning.

There are some household sewage (liquid dung, domestic wastewater, etc.) generated from kitchens, toilets, barns, and other domestic areas.

If household, industrial, or commercial wastes are not properly disposed, then the disease problems caused by pollution will still remain to be persistent in the environment.

The disease commonly transmitted through water such, as Cholera, dysentery and typhoid are waste related. If waste was safely deposited, or treated and disposed most of the water born diseases would have not been a problem.

### *Classifications of Liquid Waste*

Waste water or sewage that are generated from a home or community including toilet, bath, laundry, lavatory, and kitchen-sink wastes, and surface run off may be classified into four. These are :

**Sanitary sewage** also called domestic sewave contains human wastes and wash water from homes, public building or commerical and industrial establishments.

**Industrial sewage** is the used water from manufacturing processes, usually carrying a variety of chemical compounds.

**Storm sewage, or storm water,** is the surface run off caused by rainfall, it carries organics, suspended and dissolved solids, and other substances picked up as it travels over the ground.

## Biomedical Waste

Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biologicals. It may include wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be a serious threat

to human health if not managed in a scientific and discriminate manner. Most biomedical waste generated from health care facilities are at present, collected without segregation into infectious and non-infectious categories and are disposed in municipal bins located either inside or outside the facility premises. Sanitary workers pick this waste from here along with MSW and transport and dispose it at municipal dumpsites. Since the infectious waste gets mixed with municipal solid waste, it has potential to make the whole lot infectious in adverse environmental conditions.

Moreover, biomedical waste also contains sharp objects (scalpets, needles, broken glasses/ampoules, etc.,) the disposal of which poses a risk of injury and exposure to infection to sanitary workers and rag pickers working at these dumpsites. Since most of these dumpsites are unscientifically managed, the chances of pathogens contained in infectious waste becoming airborne and getting released to nearby water bodies or affecting the local resident population. Biomedical waste management are

- Take immediate action for the segregation of the biomedical wastes at source.
- To go for advanced alternate technology like autoclaving for the treatment of biomedical wastes at source.
- To incinerate the pathological waste alone.
- *To go in for a common treatment and disposal facility for the biomedical wastes that must be* located away from any habitation and water bodies.

## Hazardous Waste

The term *hazardous waste* does not have an exact scientific definition because of the wide range of properties that can make a chemical, a threat to public health on the environment. Some of the hazardous effects of chemicals include short-term toxicity to humans, long-term toxicity to humans, eco-toxicity, flammability, explosivity and corrosivity. Further more, each of the thousands of chemicals used by industry is characterized by a different degree of hazard for any one of these characteristics consider one of these, short term toxically to humans. For thousand of chemicals that are potential hazardous wastes, a range of short-term toxicities may be found. For example, exposure to a few mm of one chemical may cause death of the average adult. At the other end of spectrum, adult may survive after ingesting Kg of a different chemical. Between these two extremes lies a gradient of toxicities for each of the thousands of different chemicals. If the definition of hazardous waste is based on acute toxicity, would of dose of 1 mg provide the definition of hazardous? Should 5 mg be the standard? The same case may be made for other characteristics and effects, such as chronic toxicity or explosively.

Due to difficulty of quantifying the detrimental characteristics of chemicals, hazardous wastes are typically defined by government regulations – a procedure that is by no means perfection without controversy. Nonetheless, a commonly used general definition of hazardous waste is "A waste that, due to its chemical activity or flammable, explosive, toxic or corrosive properties, is likely to result in danger to human health or the environment."

## Electronic Waste

Electornic waste (E-waste) means discarded electronic devices. Televisions, telephones, airconditioners, toys, microwave ovens and computers etc. are included in E-waste. The E-waste is often hazardous.

Electronic waste is toxic in nature as it contains some metals such as lead, beryllium, mercury and cadmium. In the circuit broad of computer, lead and cadmium is used, lead oxide and cadmium in cathode ray tube (CRT) monitors, mercury in switches and flat screen monitors, cadmium in computer batteries is used.

At present, Indian use about 57 million PCs, 684 million mobile phones and 289.5 million televisions. Soon these goods will enter waste streams. Already about 1.98 million PCs become obsolete in India annually, and manufacturers and assemblers alone are creating about 1050 tonnes of electronic scrap every year. Secondly, most PCs trashed in the industrialised world find their way into our backyards, as recycling or donation.

E-waste is a problem both at the manufacturers end, and at the user level. Computers are not designed for recycling. For instance, the new PCs have most operations in-built, which means that the hard discs can not be upgraded. As new technologically improved models hit the market, more E-waste is generated. Manufacturers also fail to take responsibility for their product. Once the product is sold, disposal becomes the headache of the customer or user. In some industrialized countries, manufacturers run recycling programmes, but in fact, 80 percent of what is diverted to recycling in US is actually exported to Asia.

E-waste management is poor while most of it is recycled, the rest ends up in landfills, where it becomes a heap of plastic and steel casings, circuit boards, glass tubes, wires, resisters, capacitors, and other assorted parts. The heavy metal dumped in landfills contaminate the ground water,

## CLIMATE CHANGE AND ITS SOCIO-ECONOMIC AND POLITICAL DIMENSION

Climate change occurs when changes in Earth's climate system result in new weather patterns that last for few decades, and millions of years. Over time with rising levels of pollution, a stratosphere layer around the earth which protects the earth from ultraviolet rays from the sun bears the consequences. But due to pollution, the ozone layer has started depleting.

Through black holes in the ozone layer, UV rays reach the surface of the earth resulting in many health-related skin problems. Ozone depletion has also affected the Arctic and Antarctic regions resulting in large-scale melting of glaciers.

There has been increase in the temperature; our seasons have been altered due to pollution and ozone layer depletion. Infrared rays (IR) from the earth get trapped into carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$) water vapour, and chlorofluorocarbons (CFCs), it then increases the heat and thereby the temperature of atmosphere are known as Greenhouse gases.

Greenhouse effect is rise in temperature caused by these gases. It is leading to the global warming, it will have serious implications on both terrestial and aquatic life.

The causes of climate change and global warming can be natural like volcanic eruptions which releases gases into the atmosphere or human activities like industrialization, urbanization, deforestation, overutilization of resources, and so on. The climate change can be the outcome of the prosperity and progress of the developed nations.

### Initiatives by Indian Government to Combat Climate Change

A number of new policies and initiatives in various sectors like e-mobility, waste management, renewable energy, green transportation, water, afforestation, etc. have also been introduced to minimise the impact of climate change.

In the recent past the Indian Government has taken number of initiatives to combat the challenge of climate change. Some of initiatives of Government of India include :.

1. National Action programme to Combat Desertification
2. National Electric Mobility Mission Plan 2020 – for promoting use of hybrid and electric vehicle
3. India's National Solar Mission – for reducing carbon dioxide emissions
4. National Action Plan on Climate Change (NAPCC) comprising the following eight plans.
   - (*i*) National Solar Mission
   - (*ii*) National Mission for Enhanced Energy Efficiency
     - (*a*) Perform, Achieve and Trade Scheme
     - (*b*) Market Transformation for Energy Efficiency
       - Bachat Lamp Yojana
       - Super-Efficient Equipment Programme
     - (*c*) Framework for Energy Efficient Economic Development
     - (*d*) Energy Efficiency Financing Platform
   - (*iii*) National Mission for Green India
   - (*iv*) National Mission on Sustainable Habitat
   - (*v*) National Water Mission
   - (*vi*) National Mission for Sustaining the Himalayan Ecosystem
   - (*vii*) National Mission on Strategic Knowledge for Climate Change
   - (*viii*) National Mission for Sustainable Agriculture
5. Launch of Indian Satellite to Monitor Greenhouse Gases by ISRO
6. Indian Network for Climate Change Assessment (INCCA) – a network of research institutions and scientists
7. State Action Plan on Climate Changes (SAPCC)
8. Development of Solar Parks on canals
9. Himalayan Glaciers Monitoring Programme – to monitor the Himalayan glaciers
10. Clean Energy Fund promoting clean technologies
11. Intensive Afforestation for using as Carbon sink *i.e.*, to suck and store carbon dioxide from atmosphere
12. Doubled the Clean Energy Cess on Coal
13. Using renewable sources of energy more than non-renewable sources
14. Swacch Bharat Mission
15. FAME Scheme for E-mobility
16. Teaching students about the Environmental Issues in schools
17. UJALA Scheme for embracing energy efficient LED bulbs
18. Pradhan Mantri Ujjwala Yojana – for access to clean cooking fuel

19. Star Rating Programme for Buildings
20. Launch of National Air Quality Index
21. Labelling equipment with their energy saving efficiency (star rating)
22. Ultra Mega Solar Projects – to promote use of renewable energy
23. Use of Ultra-Modern Super Critical Coal Based Thermal Power Technology
24. Cleaning of Rivers
25. Atal Mission for Rejuvenation & Urban Transformation (AMRUT) – for Smart Cities
26. International Solar Alliances (ISA).

## IMPACTS OF POLLUTANTS ON HUMAN HEALTH

We know that pollution is the addition of unwanted substances in a concentration that has an adverse effect on organisms and the environment and the unwanted substances in a concentration is called Pollutants.

All pollutants have an adverse effect on human health. The impacts of air and water pollutants alongwith radiation, soil and noise pollution are given below:

### Major Air Pollutants

- **Carbon Dioxide ($CO_2$):** Carbon dioxide is one of the major gases which contributes to air pollution. It is mainly produced during the combustion of fuel in power stations, factories and household. The increasing $CO_2$ in the atmosphere is likely to have the following effects :
  - A rise in atmospheric temperature of global warming due to the greenhouse effect. Also causes climate change.
  - **Reduced productivity of the marine ecosystem:** Water in the oceans would be more acidic due to increased concentration of $CO_2$ in the air, which dissolves in the water.
  - **Due to Global warming:** Increased surface temperature would cause melting of continental and mountain glaciers and thus would cause flooding of coastal areas of some countries.
- **Sulphur Dioxide ($SO_2$):** Sulphur dioxide $SO_2$ is produced by the burning of coal in powerhouses and automobiles. It causes chlorosis and necrosis of plants, irritation in eyes and injury to the respiratory tract in humans, responsible for discolouration and deterioration of buildings. A high concentration of sulphur dioxide in the atmosphere dissolves in raindrops to form sulphuric acid which causes **acid rain.**
- **Carbon Monoxide (CO):** Carbon monoxide (CO) is produced as a result of incomplete combustion of fossil fuels like coal, petroleum and wood charcoal. Automobiles using diesel and petroleum are the major sources of CO which get added to the atmosphere. Carbon monoxide is more dangerous than carbon dioxide ($CO_2$). It is a poisonous gas which causes respiratory problems. When it reaches the blood-stream, it replaces oxygen due to its high affinity for haemoglobin. It also causes headache, giddiness and interferes with the normal functioning of the heart.
- **Fluorides (F):** Upon heating, rocks, soils and minerals that contain fluorides, give out hydrogen fluoride gas. This is an extremely toxic gas, which causes serious injury to livestock and cattle.
- **Oxides of Nitrogen:** A few oxides of nitrogen such as nitric oxide (NO), nitrous oxide ($N_2O$) and nitrogen dioxide ($NO_2$) are produced by natural processes as well as from thermal power stations, automobiles, factories and aircraft. They reduce the oxygen-carrying capacity of blood, may cause eye irritation and skin cancer in human beings.
- **Smog:** Somg is a mixture of smoke, dust particles and small drops of fog. It may cause necrosis and develop a white coating on the leaves (silvering) of plants. In human beings and animals, smog may cause asthma and allergies.
- **Aerosol Spray Propellants:** The fine particles suspended in the air are called aerosols. Aerosols contain chlorofluorocarbons (CFCs) and fluorocarbons used in refrigerants and aerosol cans. They cause depletion of the ozone layer.
- **Domestic Air Pollutants:** Smoke from cigarettes, Biri, cigar and other such objects using burning tobacco, burning of coal, firewood, cow dung cakes and kerosene are major domestic pollutants. The common pollutant gases emitted during the domestic burning of coal, kerosene, firewood, cow dung cakes etc. are carbon monoxide (CO), carbon dioxide ($CO_2$) and sulphur dioxide ($SO_2$). The pollution due to these pollutants causes suffocation, eye and lung diseases and low visibility.

## npacts of Air Pollutants

ajor effects of air pollutants on human health, plants, animals are given in table below.

**Some major air pollutants, their sources and effects**

| Pollutant | Sources | Harmful effect |
|---|---|---|
| Carbon compounds (CO and $CO_2$) | Automobile exhaust, burning of coal and wood | Respiratory problem Greenhouse effect global warming and climate change |
| Sulphur compounds ($SO_2$ and $H_2S$) | Power plants and refineries, volcanic eruptions | Respiratory problems in humans Loss of chlorophyll in plant (chlorosis) Acid rain |
| Nitrogen compounds (NO and $N_2O$) | Automobiles exhaust, atmospheric reaction | Irritation in eyes and lungs Low productivity in plants Acid rain damages material (metals and non-metals) |
| Hydrocarbons (benzene, ethylene) | Motor vehicles and petroleum industries | Respiratory problem Cancer-causing properties |
| SPM (Suspended particulate matter) (Any solid or liquid particles suspended in the air. (fly ash, dust, lead) | Thermal power plants, construction activities, metallurgical processes and automobiles | Poor visibility, breathing problems Lead interferes with the development of red blood cells and causes lung disease and cancer Smog (smoke + fog) formation leads to poor visibility and aggravates asthma in patients |
| Fibres (Cotton, wool) | Textile and carpet weaving industries | Lung disorders |

## pacts of Water Pollutants

ver, lake and seawater may be polluted in many ways:

- Industrial wastes effluents from urban areas containing a high concentration of oil, heavy metals and detergents.
- Domestic sewage discharged into rivers from areas located on its banks.
- Minerals, organic wastes and crop dusting from agricultural fields with phosphate and nitrogen fertilizers that reach lakes, rivers and sea (water becomes deoxygenated and poisonous, thus, cannot support aquatic life).
- Industrial wastewater containing several chemical pollutants, such as calcium, magnesium, chlorides, sulphide, carbonates, nitrates, nitrites, heavy metals and radioactive waste from the nuclear reactor.
- Chemical fertilizers, pesticides, insecticides, herbicides and plant remains.
- Excretory wastes of humans and animals in water boides. Disposal of urban and industrial waste matter into water bodies.

**Some major disturbances in the ecosystem due to water pollution**

| Pollutants | Sources | Causes | Effects |
|---|---|---|---|
| Nitrates, phosphates, ammonium salts | Agricultural fertilizers, sewage manure | Plant nutrients | Eutrophication |
| Animal manure and plant residues | Sewage, paper mills, food processing wastes | Oxygen deficiency | Death of aquatic animals |
| Heat | Power plants and industrial cooling | Thermal discharge | Death of fish |
| Oil slick | Leakage from oil ships | Petroleum | Death of marine life due to non-availability of oxygen dissolved in water |

In agriculture fertilizers and pesticides are widely used. Their excessive use for increasing agricultural yield has to the phenomenon of eutrophication and bio-magnification.

**Some water pollutants, their sources and effect on human health**

| ollutants | Sources | Diseases in human beings |
|---|---|---|
| ead | Industrial waste | Nervous disorders, kidney failure, blood poisoning |
| in | Industrial dust | Affects central nervous system (CNS). Affects vision |
| ercury | Industrial discharge | Affects central nervous system and peripheral nervous system, kidney failure, muscles and limbs, blurred vision |
| rsenic | Industrial discharge | Respiratory and skin cancer, nervous disorder |
| ickel, Cadmium | Aerosols, Industrial dust Industrial discharge | Pulmonary disorder, dermatitis kidney disorders, pulmonary and skeletal diseases |
| ranium, Thorium, Cesium | Radioactive wastes | Skin cancer, Leucoderma. |

## Impacts of Pollutants (Nuclear Radiation)

Radiations emitted by nuclear substances of wastes or from atomic power plant or an atomic explosion cause nuclear radiation. Nuclear wastes continue to emit radiation for a very long period. Radioactive Iodine (I-131) and strontium (Sr-90) are nuclear wastes from an atomic explosion and may cause cancer of thyroid and cancer of bone narrow respecticely. But entering the food chain, they also get accumulated in high concentration in the body of the top consumer causing a harmful effect on the health of both humans and animals.

## Harmful effects of Soil Pollution

- Decrease in soil productivity.
- Decrease in irrigated land thereby reduction in agricultural production.
- Carrvover of pollutants into food chain.
- Damage to landscape

## Effects of Noise Pollution

- Temporary loss of hearing, earache, sometimes even leading to permanent deafness.
- Inability to sleep, slow recovery from sickness.
- Irritability and interference in communication.
- Inability to concentrate, headache.
- Increased blood pressure, irregular heartbeat.
- Ringing of ears (a feeling, sound coming from within the ear in a very quiet environment).