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ENVIRONMENT CONCEPT

CONTENT

- Environment: Concept and Importance, Components of environment,
- Ecosystem: Definition, structure and function; producers, consumers and decomposesrs; food chains and webs; ecological pyramids and energy flow in ecosystem;
- Ecosystem services; ecological, economic, social, aesthetic and informational value.

"Environment is the study of structure and function of nature"

This definition of environment was given by **Eugine P. Odum in 1971.** Environment (en-in; viron-circle) literally means "surroundings", it is the immediate surrounding space encircling man. It includes abiotic (non-living physical) and biotic (living-plants, animals and man) components, it is connected with human activity and its impact on natural resources.

Biotic components: These are living objects which include green and non-green plants, animals, parasites and human beings etc. They undergo reactions, interactions and inter-related actions among them.

Abiotic components : These are non-living objects which include

(1) non-living materials like air, water and soil

(2) forces of nature like time, temperature, light.

Biosphere is a global ecosystem; it composed of two components *i.e.* biotic and abiotic.

1 Abiotic components: They include lithosphere, hydrosphere and atmosphere.

2. Biotic components: They include plant system and animal system.

Both these components act and react and their mutual interaction maintains the biospheric system. The upper limit of the biosphere is determined by moisture, temperature and availability of oxygen in the atmosphere. Most of the living organisms are found up to the altitude of 6000 meters though some birds and insects may be found at mountain tops above 7500 meters. The depth of biosphere on land is up to the depth of the deepest oceans; the biosphere extends up to which burrowing animals can live. In oceans, the biosphere extends up to greater depths. The life has been detected at the depth of 9000meters. In reality, biosphere covers most of the earth. Its total thickness is about 16 kms. The biosphere is almost absent over polar areas, highest mountains, ocean deeps and hot and cold deserts.

Thus environment can be defined as "the sum total of all species and conditions which influence the development of life or organisms".

Habitat

The place occupied by an organism, population or community, which is exposed to a particular combination of environmental factors is called habitat. Thus habitat is defined as:

"The sum total of environmental factors or conditions which determine the existence of an individual organism, population or community in a particular locality."

Habitat may be as small as bark of a tree or as large as ocean. The term habitat implies a particular set of environmental factors and is used in a more concrete sense than the environment.

Multidisciplinary Subject

Environment science is a multidisciplinary branch of science which obtains source material from several other branches of science.

Some of the branches of science related with environmental studies are given below:

(i) Life sciences (biological science) : For studying the biotic components i.e. living objects such as animals and plants and their interactions, environmental studies require the understanding of life sciences namely botany, zoology,

microbiology, biochemistry, biotechnology and genetic. Study and conservation of national parks, wildlife sanctuaries and biodiversity zones require a good knowledge of biological sciences cited above.

(ii) Physico-chemical sciences: To understand the physical and chemical structure of abiotic components and energy transfer between these components. We need the help of basic sciences such as physics, chemistry, geology, geography, oceanography, climatology, etc.

(iii) Basic sciences: For learning environmental management and modeling and for understanding ecological problems, we depend upon the basic knowledge of mathematics, statics and computer science.

(iv) Humanities: For dealing with the socio-economic aspects associated with various developmental activities concerning environment, subjects like sociology, economics, education and mass communication provide the required input.

(v) Engineering Branches: Various technologies dealing with the control of environmental pollution, treatment of industrial wastes and development of cleaner technologies require the basic knowledge of hydraulics, civil engineering and chemical engineering. These branches of engineering put together from the subject of environmental engineering.

(v) Instrumentation: The experimental study of the environment requires the use of latest instruments like spectrophotometer, calorimeter, flame photometer, pH meter, infrared analyzer, satellites etc. in addition to the use of radioactive isotopes in tracer technique.

(vi) Environmental sciences: For the effective management and protection of the environmental and natural resources, a sound knowledge of environmental laws concerning water, air and land pollution, forest conservation, wildlife act, motor vehicle act, factory act etc. is desired. Environmental studies, therefore, is a synthetic branch of science which requires knowledge of several disciplines cited above.

IMPORTANCE OF ENVIRONMENTAL:

1. To foster a clear awareness of, and concern about, economic, social, politic and ecological interdependence in urban and rural areas.
2. To provide every person with opportunities to acquire the knowled values, attitudes, Commitment and skills needed to protect and improve t environment.

3. To create new patterns of behavior of individuals, groups and society as a whole towards the environment.
4. **In solving global as well as local environmental problems:** issues like depletion of Ozone layer, global warming, deforestation, exhaustion of energy resource and loss of global biodiversity etc. are going to affect the whole world. These issues are not confined to any particular country or community but concern all the inmates on the globe. Environmental studies are helpful in reducing these problems at the global as well as local level.
5. **Environmental studies are helpful solving a number of problems:** Certain problems Related to pollution created by man himself by distributing the natural processes for his Comforts and luxuries can be solved to some extent through environment studies.

   Environmental studies are helpful in understanding the environment and planning of related environmental issues of immense importance such as:

   (a) Hygienic living surroundings

   (b) Provision of clean and safe drinking water

   (c) Public health

   (d) Town planning

   (e) Suitable location of industries
6. **In providing career opportunities:** To deal with the environmental issues of immense, there is a need for trained man power at every level.

Awareness: to help social groups and individuals acquire an awareness of and sensitivity to the total environment and its allied problems.

Knowledge: to help group and individuals gain a variety of experiences and acquire a basic understanding of the environment and its associated problems.

Attitudes: to help social groups and individuals acquire a set of values and feelings of concern for the environment and the motivation for actively participating in environmental improvement and protection.

Skills: to help social groups and individuals with an opportunity to be actively involved at all levels in working towards the resolution of environmental problems.

In conclusion, comprehension of the objectives of environmental education is very essential for the successful formulation, implementation and evaluation of its programme. However, these objectives can only be achieved and understood properly, if we know what our environment is, what is contained in it.

Components:

Biotic components: These are living objects which include green and non-green plants, animals, parasites and human beings etc. They undergo reactions, interactions and inter-related actions among them.

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Ecosystem:

The word ecology, derived from Greek word: Oikas meaning habitation, and logas meaning study, thus it is the study of the habitations of organisms. Ecology was first described as a separate science in 1866 by German zoologist, Ernest Haeckel, who invented the word oeckologi for the "the relation of the animal to its organic as well as its inorganic environment, particularly its friendly or hostile relations to those animals or plants with which it comes in contact.

Ecology has been by many as, "scientific natural history", "the study of biotic communities," or "the science of community population", probably the most often

given a study of animal and plants in their relationship to each other and to their environment.

Concept: The world ecosystem is now listed to describe ecology. The term ecosystem was first used by A.G. Tansley, a British ecologist, in 1935. Ecosystem stands for ecological system.

Tansley defined ecosystem as a "holistic concept that includes all living organisms, their physical environment and all their inter-relationships in particular unit of space."

According to him ecosystem is composed of two major parts i.e. biome (all the living animals and plants of a given area) and habitat (environment of a particular place).

Thus ecosystem is defined as a unit that includes all the organisms in a given area interacting with physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycles (exchange of material between living and non-living parts) within the system.

Ecosystem includes all the communities of an area functioning with their physical environment. A pond, lake, river, garden, crop field, forest, manned spaceship are common examples of ecosystem. The vast network of all interconnected ecosystem constitute the biosphere. Our planet, the earth represents a giant ecosystem called biosphere or ecosphere. All the ecosystems are linked with different biomes. A biome is a group of communities in different stages of succession under similar climatic conditions.

STRUCTURE OR COMPONENTS OF ECOSYSTEM

The ecosystem involves the circulation transformation and accumulation of energy and mater through the medium of living things and their activities. Environment, plants and animals keep modifying and changing each other as a result of reaction among themselves. This leads to the development of an ecosystem.

THE TWO COMPONENTS OF AN ECOSYSTEM:

Abiotic Substances:

These include air, water, soil, basic elements and compounds of the environment.

(a) Lithosphere: Various land forms provide a variety of habitat for plants and animals. Soil provides nutrients. Rocks and minerals are included in lithosphere.

(b) Hydrosphere: Oceanic water is source area for water through rain (water cycle). It provides life to all forms of life i.e. plants, animals and man.

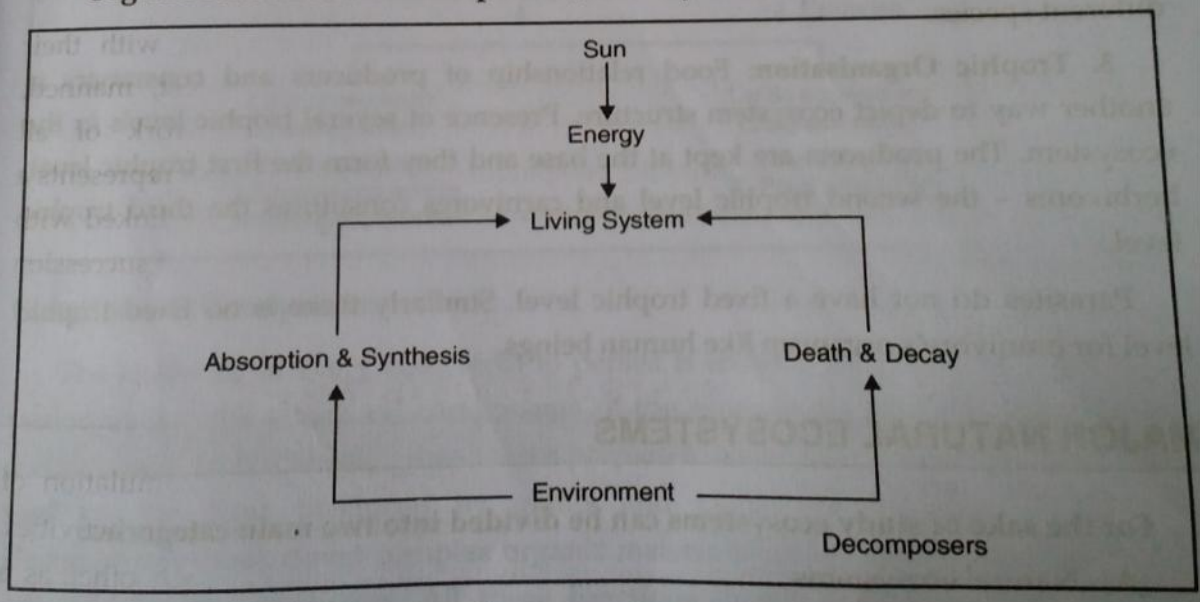
(c) Atmosphere: It provides a variety of gases necessary for animals and plants are the surface of the earth.

Abiotic portion of the ecosystem is divided into three parts for functional purposes :

(a) The physical factors: such as temperature, relative humidity precipitation light etc.

(b) Inorganic substances: Such as water, carbon, nitrogen, sulphur, phosphorous etc.

Organic substances: Such as protein, carbohydrates etc.



Cycle of material between living organism and non-living environment (Bio-Geochemical cycle)

These are the buildings blocks living body and the link between the biotic an Abiotic components. This cycle is known as bio- geochemical cycle. Solar energy i continuously trapped by the producers from the sun which is the ultimate source o

BIOTIC COMPONENTS

They include plant system and animal system.

The major structural features of an ecosystem are :

1. Species composition
2. Stratification
3. Trophic Organisation

1. Species Composition: It is different for each ecosystem. Various ecosystems have their own species composition e.g. pond ecosystem and marine ecosystem have different species in them. A desert ecosystem has only a few species where as a forest ecosystem contains a great variety of species.

2. Stratification: In an ecosystem, organisms may be arranged in one or many layers, called strata. This layer or strata formation is called stratification. Each stratum comprises the population of particular types of species e.g. in tropical rain forest there are three strata – trees, shrubs and herbs and these are occupied by different species.

3. Trophic Organisation: Food relationship of producers and consumers is another way to depict ecosystem structure. Presence of several trophic levels in the ecosystem. The producers are kept at the base and they form the first trophic level, herbivores – the second trophic level and carnivores constitutes the third trophic level.

Parasites do not have a fixed trophic level. Similarly there is no fixed trophic level for omnivore's organism like human beings.

MAJOR NATURAL ECOSYSTEMS

For the sake of study ecosystems can be divided into two main categories:

(A) Natural ecosystems

(B) Man made or artificial ecosystems.

Natural ecosystems are further of three types :

(i) Terrestrial ecosystems,

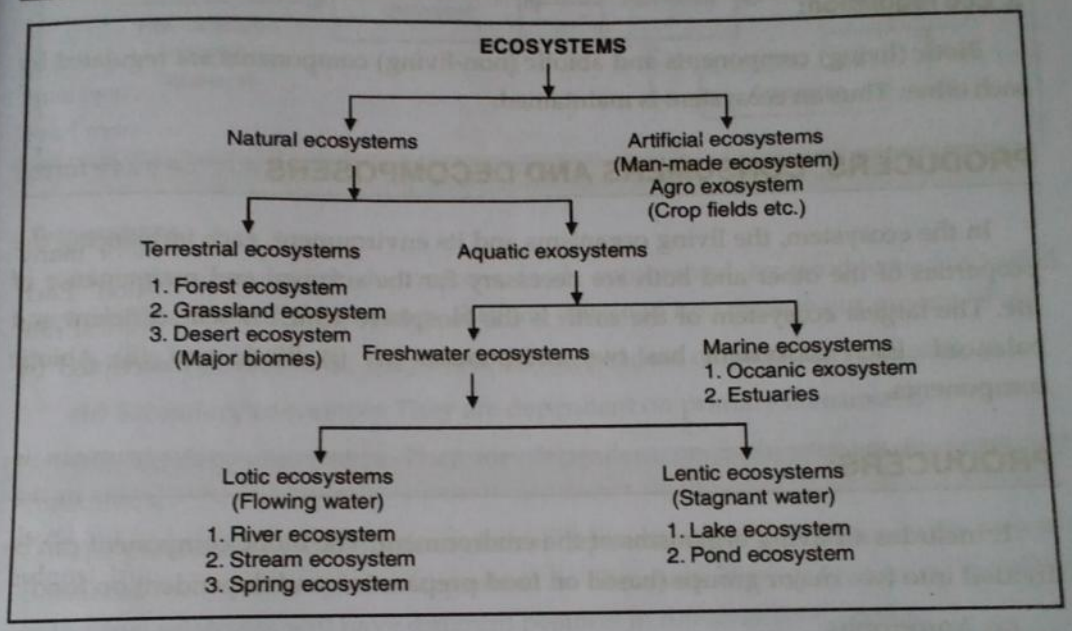
(ii) fresh-water ecosystems and

(iii) marine ecosystems.

A large geographical area with its specific and complex flora and associated

fauna is called a *biome*. The type of climax vegetation of a biome depends upon the physical factors like nature of soil, amount of rainfall, temperature variation, intensity and saturation of light, topography, etc.

ECOSYSTEMS:



Functions of Ecosystem:

The tendency of every ecosystem to persist is ensured by the various functions performed by the structural components of the ecosystem e.g. roots absorb water and nutrients from the soil, green leaves prepare food by photosynthesis. Herbivores feed on the food produced by plants and carnivores eat these herbivores. Decomposers break down complex organic materials into inorganic materials which are used by the producers. All these functions in the ecosystem occur through delicately balanced and controlled processes.

1. Energy Flow:

(a) From sun to producers

(b) Producers to consumers

(c) Consumers to decomposers

consumers to de...

3. Eco regulation:

Biotic (living) components and abiotic (non-living) components are regulated by each other. Thus an ecosystem is maintained.

PRODUCERS, CONSUMERS AND DECOMPOSERS

In the ecosystem, the living organisms and its environment, each influencing the properties of the other and both are necessary for the survival and maintenance of life. The largest ecosystem of the earth is the biosphere which is self sufficient and balanced. Each ecosystem has two components i.e. (i) Biotic and (ii) Abiotic components.

PRODUCERS:

It includes all living organisms of the environment. The biotic component can be divided into two major groups (based on food preparation and dependent on food):

(a) Autotrophs

(b) heterotrophs

(a) Autotrophs (auto = self; troph = nourishing) : Self food producing organisms are known as autotrophs. They depend on the environment for raw materials and utilize sun light for the production of their own food, hence, called as producers.

(b) Heterotrophs (Hetero = other; troph = nourishing) : The heterotrophs are the organisms mostly animals that cannot utilize sun light directly like autotrophs for their food preparation, because they do not have chlorophyll. Hence, they consume plants and plant products produced by the autotrophs. In this process, the complex organic substances (food) produced by green plants are broken down into simpler forms. Plants are considered as primary producers of food and supply food to the heterotrophs. Heterotrophs digest, absorb and assimilate food and store it. Hence, heterotrophs are also known as secondary producers. Very few plants, all animals,

and human beings are considered as heterotrophs are again divided into *consumers* and *decomposers*. (Fig.)

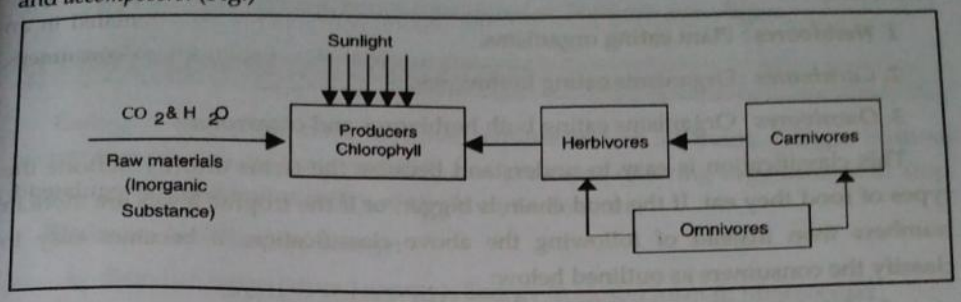


Fig. Food Chain based on the food.

Consumers

Living organisms which consume food, synthesized by producers are called consumers. Based on dependency, they are classified into three major groups. (Fig.)

(i) Primary consumers: They are totally dependent on producers (plants).

(ii) Secondary consumers: They are dependent on primary consumers.

(iii) Tertiary consumers: They are dependent on both primary & secondary consumers.

The placement of individual organism depends on the type of food they eat and positional occupation of the organism in the food chain. At times, the same individual organism will have different position in different food chains.

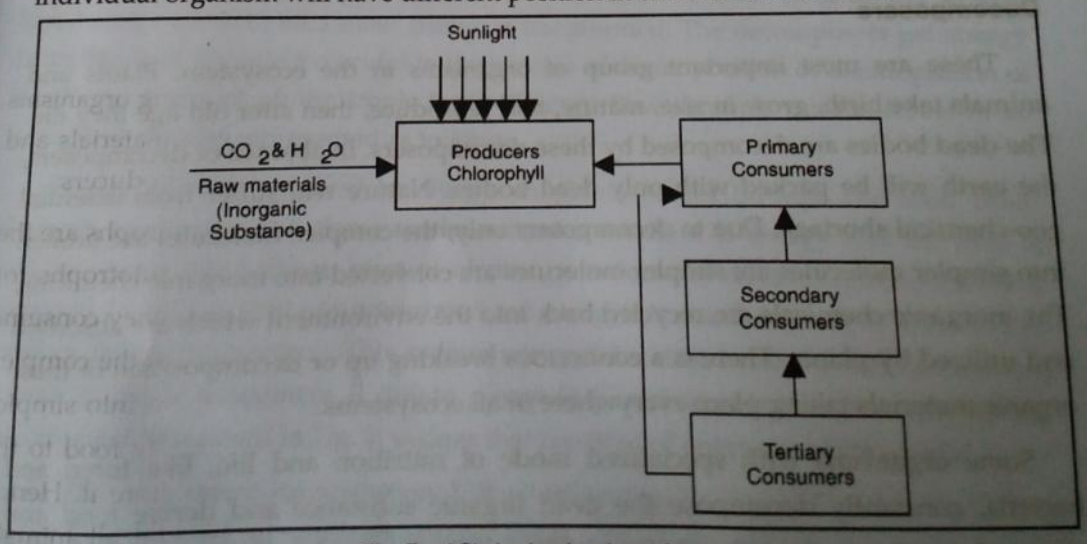


Fig. Food Chain showing dependency.

Based on the type of food they eat, consumers may be divided into three groups. These are:

1. ***Herbivores*** : Plant eating organisms.
2. ***Carnivores*** : Organisms eating herbivores.
3. ***Omnivores*** : Organisms eating both herbivores and carnivores.

This classification is easy to understand because the terms directly indicate the types of food they eat. If the food chain is bigger, or if the trophic levels are more in numbers then instead of following the above classification, it becomes easy to classify the consumers as outlined below:

1. 1st order of consumer.
2. *2nd order of consumer.*
3. *3rd order of consumer.*
4. *4th order of consumer and so on.*

Example: Suppose in a grassland ecosystem the trophic levels may be

Grass ⟶ GrassHopper ⟶ Frog ⟶ Snake ⟶ Hawk

Following the above classification, here grass is the producer, whereas grasshopper is the 1st order of consumer, frog is the 2nd order of consumer, snake is the 3rd order of consumer and hawk is the 4th order of consumer.

Decomposers

These are most important group of organisms in the ecosystem. Plants and animals take birth, grow in size, mature, and reproduce, then after old age they die. The dead bodies are decomposed by these decomposers. In absence of decomposers, the earth will be packed with only dead bodies. Nature will suffer from essential geo-chemical shortage. Due to decomposers only, the complex molecules are broken into simpler molecules are simpler molecules are converted into inorganic chemicals. The inorganic chemicals are recycled back into the environment which are absorbed and utilized by plants. There is a continuous breaking up or decomposition of these organic materials taking place everywhere in all ecosystems.

Some organisms with specialized mode of nutrition and life, like fungi and bacteria, constantly decompose the dead organic substance and derive food and energy from them. the role of decomposers is very special and important in the

ecosystem. They are not only important for mineral cycling but also important for cleaning of the environment, hence considered as Nature's scavengers.

ENERGY FLOW IN THE ECOSYSTEM

Energy is the single most essential requirement of all living beings. Without energy to work can be done and different processes of living organisms will stop. Hence, it is defined as the ability of any body to do work.

There are two kinds of energy:

1. *Potential energy* (stored energy): Energy in stored form in bimolecular.
2. *Kinetic energy* (free energy): Energy in motion.

Conversion of potential energy into kinetic energy helps to drive the metabolic activities of living beings. In an ecosystem, producers (green plants) trap the radiant energy of the sun by chlorophyll pigment in a simple process of photosynthesis and store the energy in the bonds of organic molecules (carbohydrates).

$$\underset{\text{(Carbon dioxide)}}{6CO_2} + \underset{\text{(Water)}}{6H_2O} \xrightarrow[\text{Chlorophyll pigment}]{} \underset{\text{(Carbohydrate)}}{C_6H_{12}O_6} + \underset{\text{(oxygen)}}{6O_2}$$

This stored energy passes from producers to primary consumers (Herbivores), then from primary consumers to secondary consumers (primary carnivores) and finally from secondary consumers to tertiary consumers (Secondary carnivores). This link up constitutes a food chain in an ecosystem. At each level of the system (producer, consumer etc.) some energy is transformed. The decomposers get energy from the dead organic molecules in the process of decomposition or disintegration of dead organisms of all the tropic levels. Energy flow through various levels in an ecosystem may be represented as follows:

Energy of the sun fixed by the green plants passes through the food chain through food only. The above model indicates the flow of energy and the flow is unidirectional (Fig.). Huge amount of energy in form of electromagnetic waves is radiated from Sun, the ultimate source of energy. A small amount of this energy reaches the earth's surface. This radiant energy absorbed by the plants (producers) passes through consumers (Primary, Secondary and Tertiary) and finally to the decomposers as shown in Fig. It is clear that the flow of energy is *unidirectional*.

In any ecosystem, unidirectional flow of energy is normally observed. This energy flow is based on two laws of thermodynamics.

They are as follows:

1. First law of thermodynamics: It states that *"Energy can neither be created nor be destroyed, but can be converted from one form to the other."* A common household example of this law shows conversion of electric energy into light and heat energy.

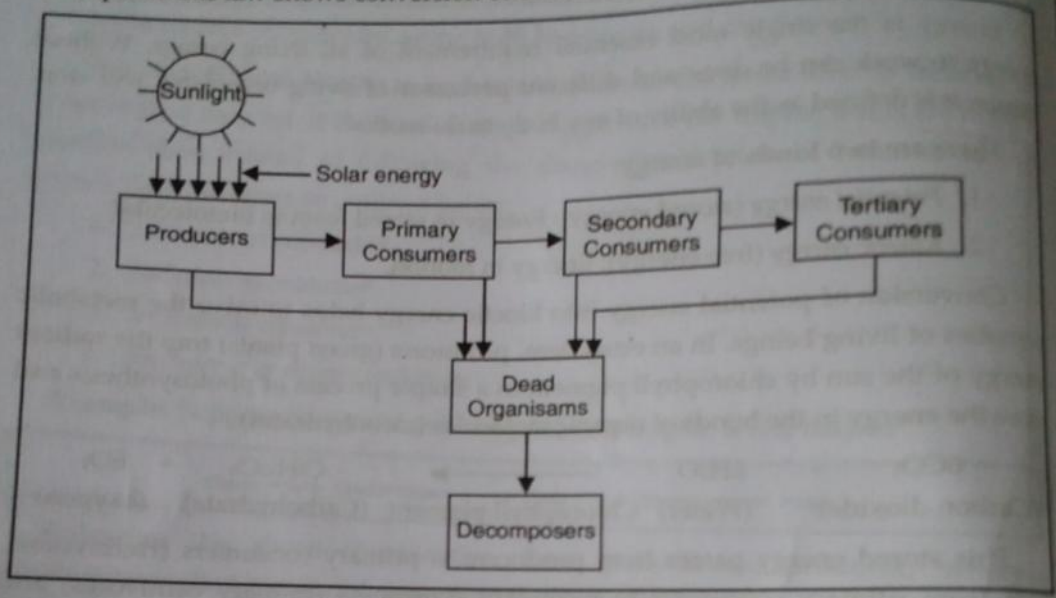


Fig. Unidirectional flow of energy

2. Second law of thermodynamics: According to the second law of thermodynamics, there can be no transformation of energy unless the energy change is from a concentrated to a dispersed form. In other words, "energy cannot flow from a cold body to a hot body by itself". One of the best examples of such a transformation is seen in the process of photosynthesis, where conversion of light energy into potential chemical energy is invariably accompanied with the dispersion of some energy as heat energy.

Growth, development and reproduction, etc. are accompanied with energy transfers only. In the process of respiration, breakdown of complex molecules takes place. Lesser amount of kinetic energy is again stored as potential energy and some amount of energy is lost in the process of respiration as heat energy. In each and every step of conversion, huge amount of energy is lost and a small amount of energy is again converted to potential energy. By this process, the system either gains energy or loses energy in different forms.

FOOD CHAIN

The transfer of food energy from the source in plants through a series of organisms with repeated eating and being eaten is referred to as a food chain.

OR

The transfer of energy from one tropic level (e.g. producers) to the next tropic level (e.g. consumers) is called food chain.

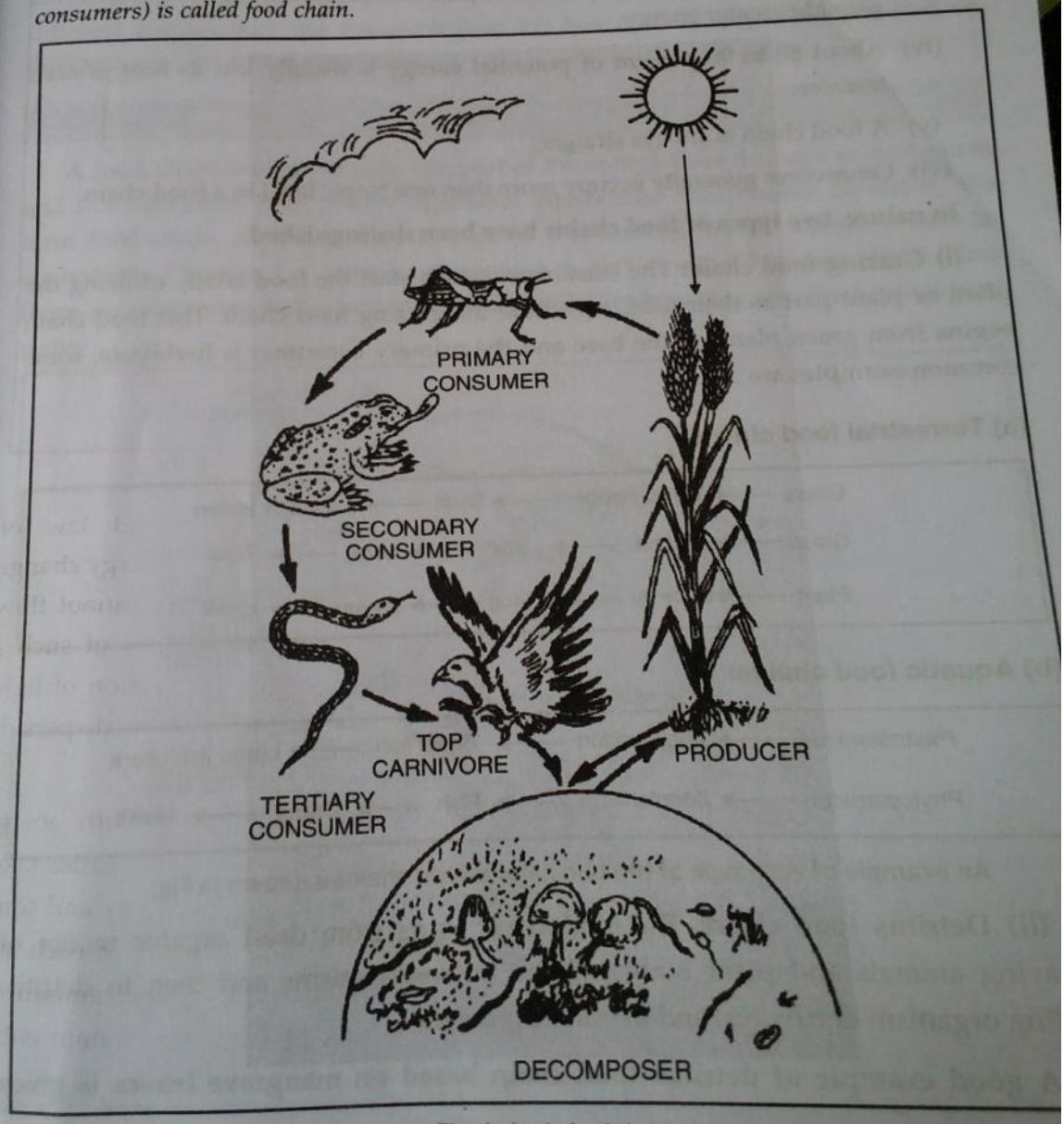


Fig: A simple food chain

Characteristics of a food chain:

(i) There is repeated eating in which each group in a food chain eats the smaller one and is eaten by the larger.

(ii) There is unidirectional flow of energy from sun to producers and then to a series of consumers.

(iii) There are four to five tropic levels in a food chain shorter, food chains will provide greater energy.

(iv) About 80 to 90 percent of potential energy is usually lost as heat at each transfer.

(v) A food chain is always straight.

(vi) Omnivores generally occupy more than one tropic level in a food chain.

In nature, two types of food chains have been distinguished:

(i) Grazing food chain: The consumers which start the food chain, utilizing the plant or plant part as their food, constitute the grazing food chain. This food chain begins from green plants at the base and the primary consumer is herbivore, some common examples are :

(a) Terrestrial food chains:

Grass → GrassHopper → Birds → Hawks or falcon

Grass → Rabbit → Fox → Wolf → Tiger

Plant → Butterfly → Frog → Snake → Hawk

(b) Aquatic food chains:

Phytoplankton → Zooplankton → Small fish → Large fish shark

Phytoplankton → Zooplankton → Fish → Crane → Hawk

An example of each type of the two natural food chains is shown in Fig.

(ii) Detritus food chain: The food chain starts from dead organic matter of decaying animals and plant bodies to the micro-organisms and then to detritus feeding organism detrivores, and to other predators.

A good example of detritus food chain based on mangrove leaves is given below:

Mangrove leaves → Detritus → Micro-organism → Crabs and shrimps → Small fishes → Large fishes

In a community of organisms in a shallow sea, about 30% of the total energy flows via detritus chains, but in a forest with large biomass of plants and a relatively small biomass of animals' even large portion of energy flow may be via detritus pathways.

Food chains are not always as simple as the one just described. Often, several different species may use the same item for food and one species may feed on different species of food organisms.

FOOD WEB

A food chain represents only one part of the energy flow through an ecosystem and our ecosystem may consist of several interrelated food chains. However, the term food chain implies a simple, isolated relationship, which seldom occurs in ecosystems. Usually, the same food resource is part of more than one chain. Thus there are interconnected networks of feeding relationships that take the form of food webs.

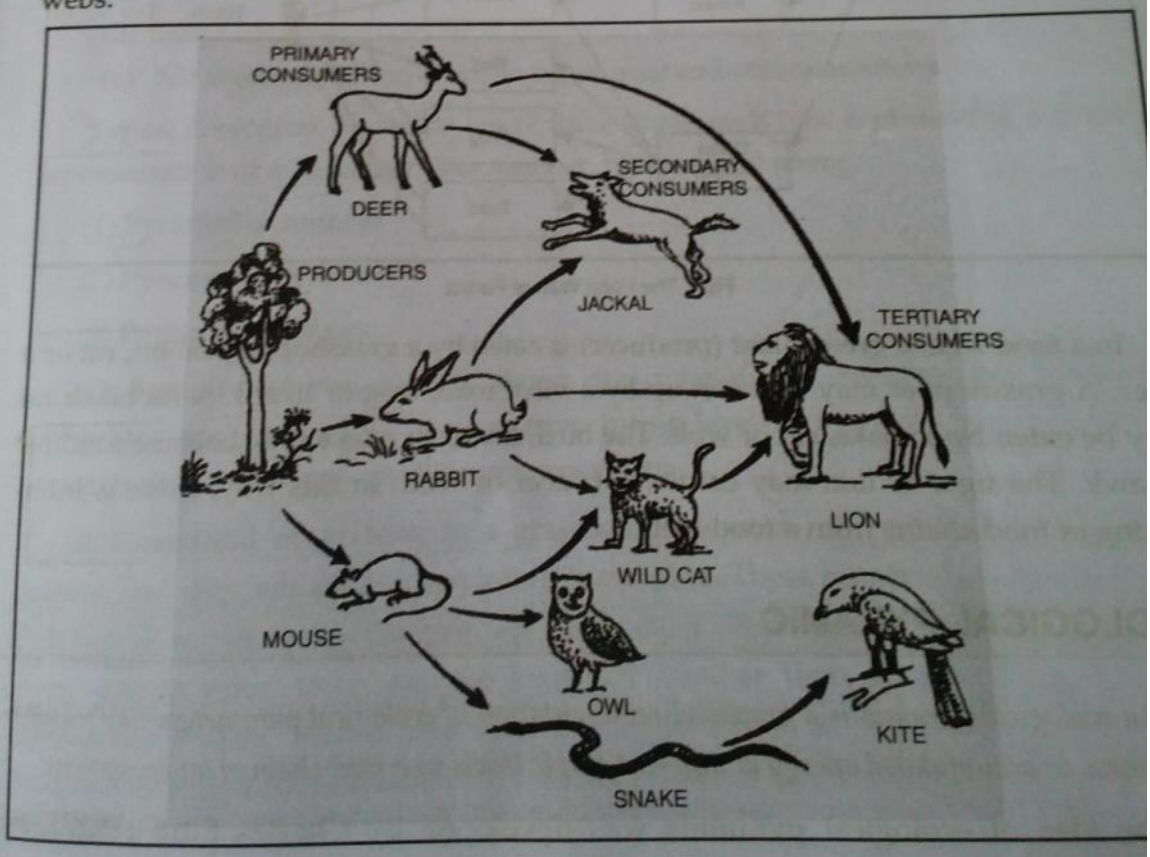


Fig. The food web of forest.

Mangrove leaves → Detritus → Micro-organism → Crabs and shrimps → Small fishes → Large fishes

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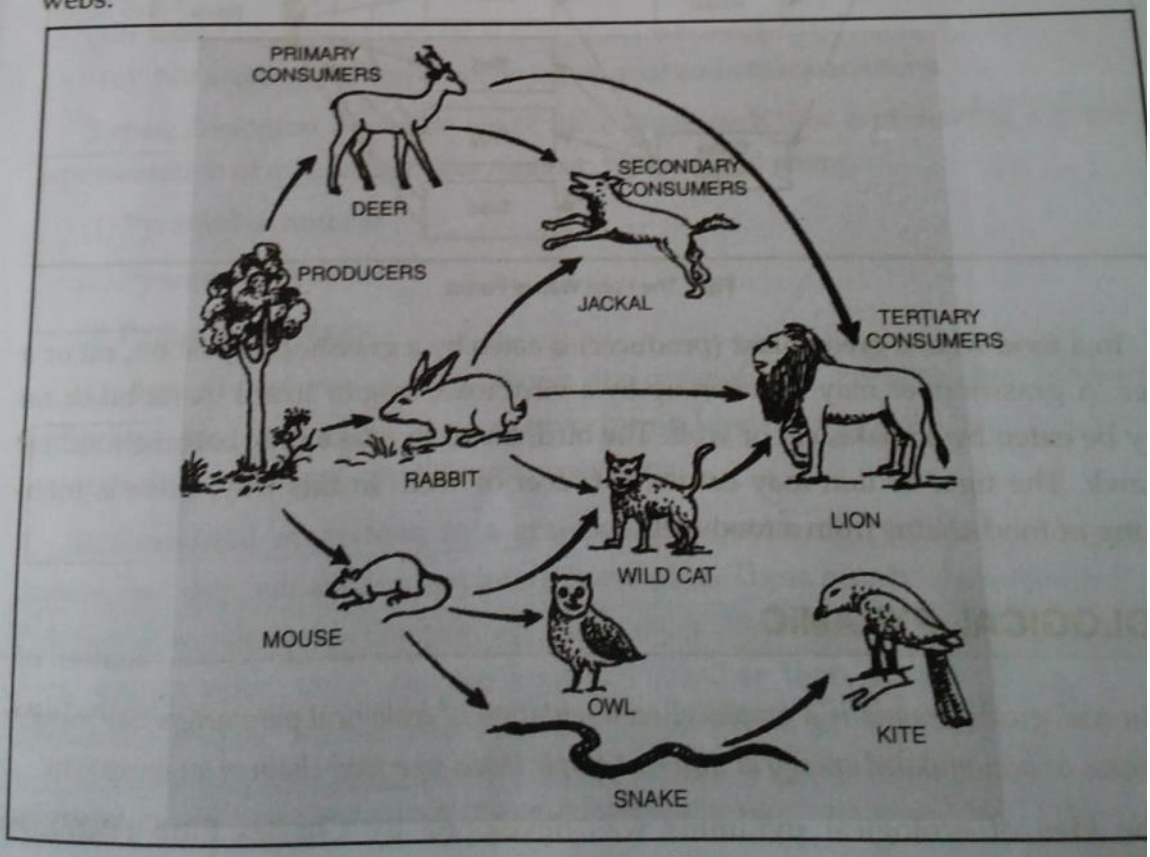

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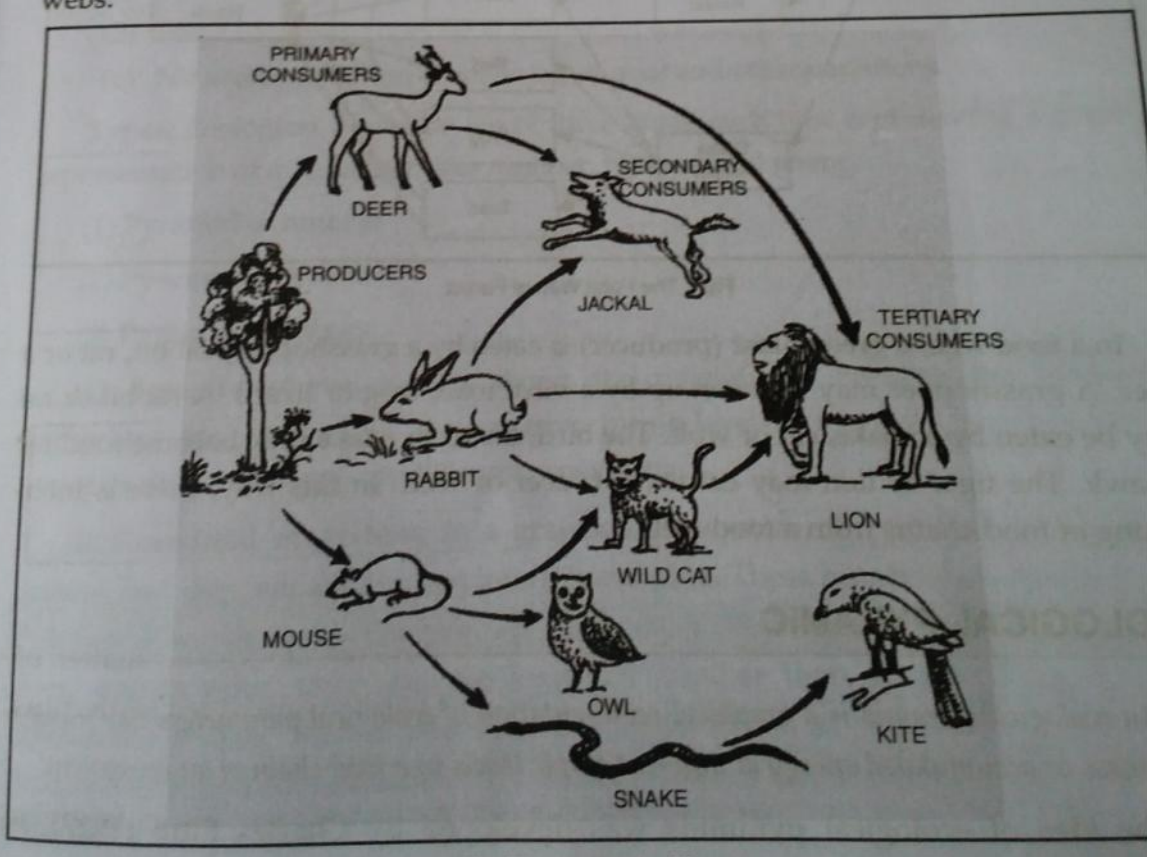

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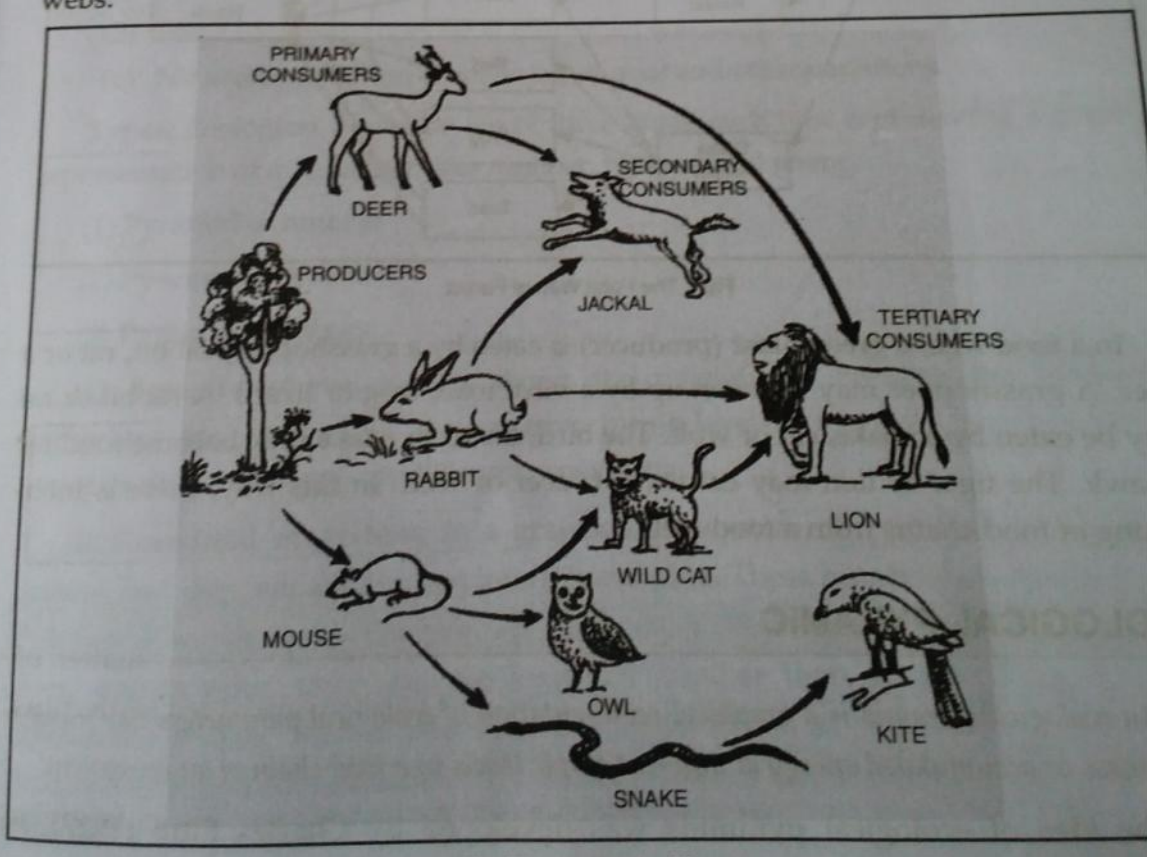

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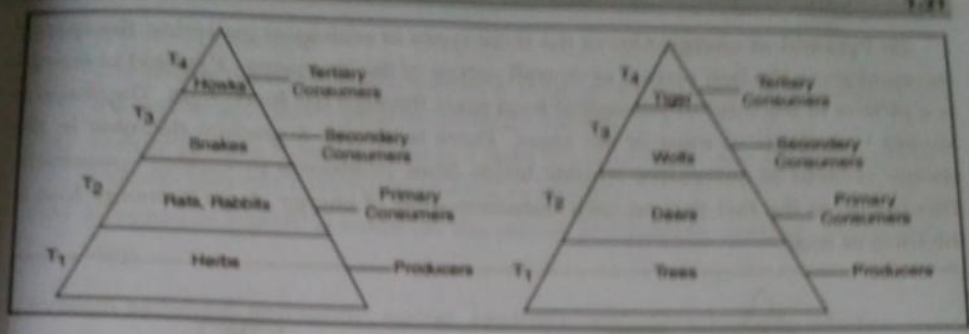


Fig. Grass land ecosystem

(ii) Forest ecosystem: In this ecosystem also, the biomass of producers (trees) (T_1) is minimum which reduces at herbivores (T_2) e.g. deer level and further at carnivore (T_3) e.g. wolf etc. level. The biomass of top carnivores is minimum and thus the pyramid is upright. (Fig.)

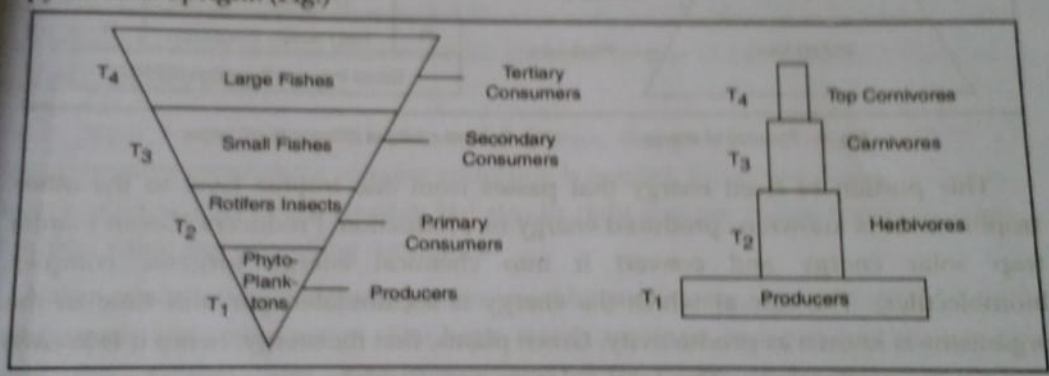


Fig. Pyramid of biomass in Pond ecosystem

(iii) Pond ecosystem: Here, the biomass of producers e.g. algae etc. are maximum which decreases at herbivore (rotifers, insects) level and further at carnivore (small fishes etc.) level. The biomass of top carnivore (large fishes) is maximum. Hence, pyramid of biomass is this ecosystem is inverted. (Fig.)

Limitations:

(1) Life span of individuals is not taken into account.

(2) The rate of accumulation or formation of biomass is not taken into consideration.

(3) In aquatic ecosystems, pyramid of biomass is often inverted in unfavorable period.

(4) Biomass may differ in its energy content in different organisms.

(3) Pyramid of energy: Out of the three types of ecological pyramids, the energy pyramid gives the best picture of overall nature of the ecosystem. Pyramid of energy is a picture of the rates of passage of food mass through the food chain. The shape is always upright as in most of the cases. There is always a gradual decrease in the energy content at successive trophic levels from producers to various consumers. This is due to the fact that on each transformation of energy, there is energy loss in the form of heat.

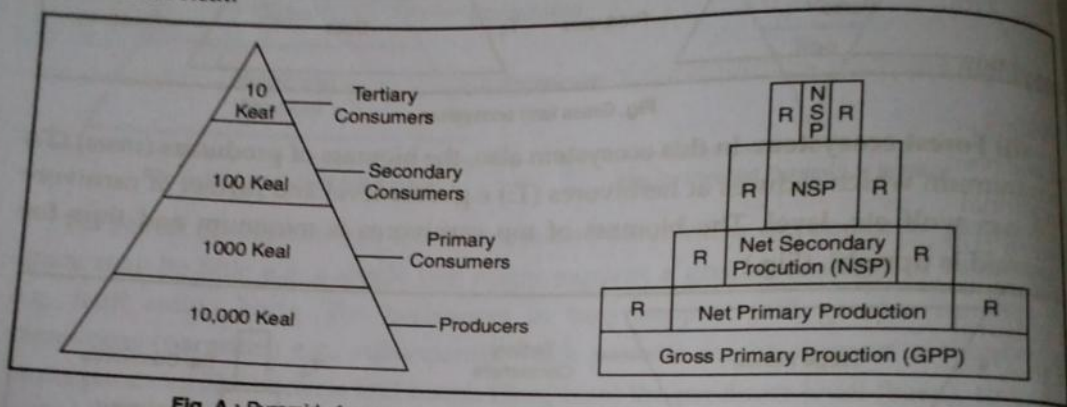


Fig. A : Pyramid of energy. **Fig. B:** Productivity at different tropic levels

This portion of fixed energy that passes from one trophic level to the other trophic level is known as produced energy or production. Producers (Green plants) trap solar energy and convert it into chemical energy (organic complex biomolecules). The rate at which the energy is accumulated per unit time in the organisms is known as productivity. Green plants, first fix energy, hence it is known as primary productivity. The total solar energy fixed by the green plants in the process of photosynthesis is known as Gross Primary Production (GPP). From the total food synthesized, some amount of energy is used in the process of respiration. The residual energy stored is known as Net Primary Production (NPP). (Fig. B)

GPP (Gross primary production) → R (Respiration) → NPP (Net primary production)

The conversion or resynthesis of complex organic molecules in heterotrophs is known as secondary productivity.

Advantages:

(1) It allows comparisons among different ecosystems and different populations in the same ecosystem.

4. Many organizations such as WHO, maintain their web sites with information about endemic, epidemic and communicable diseases to inform people.

Information Technology and Environment

Information technology helps in environmental protection. *Remote sensing and Geographical Information System (GIS)* are the areas of advance technology and are very useful in ecosystems environment management.

"Remote sensing" is a 'science of acquiring information about an object by measurement made at a distance without coming into physical contact with the object.

(i) Quantifying the environment.
(ii) Weather forecasting
(iii) Forest area cover
(iv) Inventory and mapping of resources.
(v) Describe the flow of energy and matter in ecosystem.

Remote sensing has proved to be very beneficial in soil and agriculture, town and city planning, geology and forest mapping etc.

Geographical Information System (GIS) is another effective tool in environment management. It is a technique of super imposing various thematic maps using digital data on a large number of inter-related or inter-dependent aspects. Different thematic maps, containing digital information on a number of aspects like water resources, soil type, forest land, crop land, human-settlement, road network etc. are superimposed in a layer formed in computer using software. It also helps in identifying various diseases infected areas which are prone to some vector borne diseases like malaria.

Information technology also plays an important role in environment management like biodiversity conservation, species monitoring, site selection, disaster management etc.

CONCEPT OF SUSTAINABLE DEVELOPMENT

The Steps for Attaining sustainable development are:

1. Inter-generation equity.
2. intra-generation equity.

- **Inter-generation equity:** Emphasizes that the adverse impact on environment should be minimized so that generations can get a clean and healthy environment. This can be achieved by reducing the exploitation resources.
- **Intra-generation equity:** This refers to minimizing the wealth gaps between the developed and the developing countries and also that the developed countries should help the developing countries.

Thus we have come to know that sustainable development is a necessity for us now. But the question is

"How can we achieve this type of development?"

This can be done by taking following steps:

- **Change the Technology:** The older techniques should be changed with new techniques and machines because advance technology help in many ways:
- Lesser waste production.
- Eco-friendly, as reduced rate of pollution.
- Higher efficiency.

(ii) 3-R Approach: Reduce, reuse and Recycle (3-R) of waste help in achieving sustainable development as it reduces pollution of environment by waste reduction and also reduces stress on natural resources.

(iii) Environmental education & awareness: The weaker sections of the society (i.e. the labour men, villages etc) have very low or no information related to what is happening to our environment & in what way this will affect us. Therefore, these people should be educated or made aware about environment related problems so that they can contribute their part for minimizing environment degradation.

(iv) Resource utilization: Over utilization of any resource can lead to the collapse of a system i.e. resources should be utilized only to their carrying capacity. In simpler words we can say that the consumption should not exceed regeneration.

(v) Use of Ecofriendly Technologies: The technologies used for the development should exploit the natural resources rationally and produce minimum waste products. The technologies used should be adaptable, echo-friendly, resource efficient and socially acceptable.

(vi) Population stabilization: Steps should be taken to stabilize our population. If population is more, then the consumption of resource will be more. As a result, it

2

NATURAL RESOURCES

CONTENT

- Land resources: land use pattern; land degradation and desertification;
- Forest resources: use and consequences of over-exploitation;
- Water resources: use and consequences of over-utilization; concept of water harvesting and water shed management; water conflicts;
- Energy resources: renewable and non-renewable energy sources; growing energy needs and alternate energy sources.

Natural Resources

The sum of all physical, chemical, biological and social factors which compose the surroundings of man is referred to as environment and each element of these surroundings constitutes a resource on which man draws in order to develop a better life. Thus land, water, air, minerals, forest, rangeland, wildlife, fish or each human population that man can utilize to promote his welfare may be regarded as natural resources.

Resources are defined as a source of supply or support that is usually held in reserve, it means support, it is something which meets the needs of man. 'Re' means again and source means the place from where something comes again and again. Natural resources are those resources which gifted by nature.

The reservoirs of natural resources are-

(a) The sun

(b) The atmosphere

(c) The lithosphere

(d) The hydrosphere

Natural resources include energy, air, water, soil, minerals, plants and animals. Substances present in the nature but not utilized, is not a natural resource. A substance becomes a resource when it is being utilized, e.g. once uranium was not a natural resource, after the discovery of nuclear energy and development of nuclear reactor plants, it has become an important natural resource..

Advancement in technology has led to increase in population, rise in standard of living and high expectations for better life. Man has come from the primitive hunting age and has gone to moon changing and increasing human needs give rise to new resources. Exploitation has increased with increasing demands. The resource creation is a continuous process.

Many needs have created and there is more exploitation of natural resources. Man's activities are often so extreme and so rapid that their effects are like those of a series of catastrophic natural events. Thus, not only he is responsible for destroying or modifying natural communities, but he may also frequently modify the environment. Deforestation has increased soil erosion, loss of soil fertility and recurring floods and draughts, the need of the hour is that we stop indiscriminate use and abuse of environment and evolve methods for keeping the pollution under control.

CLASSIFICATION OF NATURAL RESOURCES

On the basis of availability and abundance, natural resources are of two kinds:

1. Inexhaustible Resources:

These resources are present in unlimited quantity in the nature and they are not likely to be exhausted by human activities. Some of the inexhaustible resources remain unaffected by human activity in term of quality and quantity, while many other may undergo some changes in their quality. For example, solar energy, wind power, tidal energy, rainfall and even atomic energy are classified as inexhaustible resources. At the global level, these resources can not be exhausted significantly due to human activities. However, resources like air may be affected in quality at the local level due to discharge of poisonous gases from the industrial area. For example, the quality of air is changed due to human activities such as exhaust gases from

vehicles and industries due to burning of fuels. This is the cause of air pollution at the local level. The quality of air may be degraded by not its quantity.

2. Exhaustible Resources:

These resources are provided by nature in the limited quantity and their constant use indiscriminately is likely to exhaust them in near future. The exhaustible resources are further classified into two categories — renewable and non-renewable sources:

(a) Renewable sources: These resources have the tendency to regenerate themselves within a reasonable time by processes such as recycling, reproduction or replacement. Among living sources, micro-organisms, animals and plants are common examples. Among non-living sources, soil and water are the common examples of renewable resources. The living beings must die and decay after the lapse of some time. If the time period of the reproduction and growth is comparable with that of their death and decay, they will never be exhausted and are renewable resources. However if the rate of consumption of these sources is greater than their rate of reproduction, a time will come when they are completely exhausted.

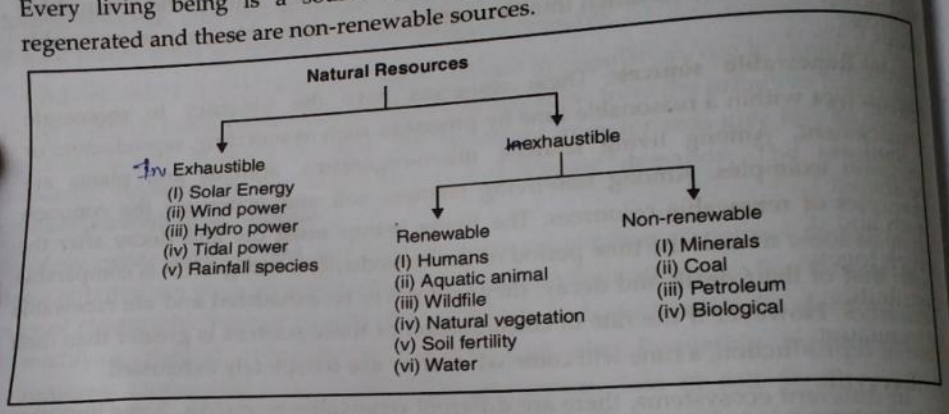
In different ecosystems, there are different renewable resources. Some important ecosystems along with their renewable products are listed in the table below:

Table: Important Ecosystems and their renewable products :

Sr.No.	Eco-systems	Renewable products
1.	Forests	Give timber and other plant products
2.	Grass lands	Sustain grazing animals for milk, meat and wood products.
3.	Wild life	Maintains food chain.
4.	Marine and Fresh water system	Gives various foods for animals and plants.
5.	Agricultural system	Gives food and fiber.

(b) Non-Renewable Resources: These resources cannot be regenerated or recycled or replaced after use. The sources with a very long time for recycling are also regarded as non-renewable sources. Some examples of abiotic resources which are non-renewable are coal, petroleum and minerals from which metals can be extracted. The rate at which fossil fuels like coal and petroleum are being used is very high in comparison to their rate of formation under earth. So, these resources of

energy must get exhausted in near future. Similarly metals like iron, copper and aluminum are extracted from their ores, but their corrosion back to minerals takes a very long time. Some biotic resources are also non-renewable. Countless biological species have been evolved in nature during the course of billions of years back since the creation of earth. But some of the species have become extinct from the earth. Every living being is a source of energy, but the extinct species cannot be regenerated and these are non-renewable sources.



NATURAL RESOURCES AND ASSOCIATED PROBLEMS

Land resources

Land is a major constituent of the life supporting system in the lithosphere. It forms about one fifth of the earth's surface, which is largely covered with natural forests, grasslands, wetlands, agricultural land and urban as well as rural settlements. In India, about 42 percent of land surface is covered by plains, 28 percent by plateaus and 30 percent comprises mountains and hills. Top layer of earth is called soil which is the main natural resource for survival of life. Terrestrial plants get water and nutrients required by them from the soil. These plants and animals decay and are released back to the soil.

Many micro-organisms and animals are involved in detritus pathway are present on the soil. The study of **soil** is called **pedology**. Land is a valuable resource upon which we depend for our food, fiber and fuel, the basic amenities of life. Soil, especially the top soil, is classified as a renewable resource because it is continuously regenerated by natural process, though at a very slow rate. About 200- I 000 years are needed for the formation of one inch of soil, depending upon the climate and the

type of soil. But, when rate of erosion is faster than rate of renewal, the soil becomes a non renewable resource.

Soil is formed due to interaction of rocks with rain, wind and temperature. This process is called weathering of rocks. It is outermost layer of earth on which we live. This solid crust is also called lithosphere (meaning 'Rock') or land; it is made of solid rocks. Its average thickness is about 20 km (8-40kms). It consists of all landmasses and ocean beds. It is thick in continents and thin below ocean beds. Crust forms about 0.4% of the total mass of earth. The lighter rocks are called Sial (Si=Silicon, al=Aluminium) which form the outermost layer and float. Under the Sial we find heavier rocks called Sima (Si=Silicon, ma – Magnesium).

Soil (L. Solum = earthy material in which plants grow) is the uppermost weathered layer of the earth's crust having mixed organisms and products of their death and decay. Soil is not a single factor but is a complex of several soil factors, which together constitute the soil complex. According to Schimper's second law, the distribution of plants in a region is determined chiefly by the nature of soil directly or in relation to other factors. Soil is *a renewable* resource.

Everything on land is useful to man. Man satisfies his need of food, fodder, shelter, clothing and articles of use of recreation from land. Soil supports plant life, which in turn supports life of animals and humans. 80% of land is covered by soil which is highly useful. Out of 13393 millions hectares of land of earth, 20% is covered by deserts. 14.4% by ice-caps and glaciers. 30% by forests, 2.6% by human establishments (residential, industrial, roads, etc.) and 11% of land is cultivated.

India's 43% of land surface is covered by plains. 28% of it is plateaus and less than 30% comprises mountains and hills. In all only 62% of our total land area is geographically usable. Out of total geographical area of 329 mha of our country, about 265 mha is suitable for crop production and about 175 mha is affected by soil related constraints and are classified as wastelands.

SOIL FORMATION

Soil formation occurs in two stages:

1. Weathering of Rocks: These processes are physical, chemical and biological.

(a) Physical Weathering: It occurs due to alternate heating and cooling, wetting and drying, freezing, glaciations, solution (movement of water) and wind activity.

(b) Chemical Weathering: It occurs due to hydration. Hydrolysis, oxidation, reduction, carbonation and chelating of rock material.

(c) Biological Weathering: Due to activity of bacteria, fungi, lichens, mosses, roots of higher plants, animals etc.

2. *Pedogenesis:* The weathered mineral matter gets mixed up with the decomposed organic matter and undergoes biochemical, biophysical and geochemical changes to form the fully developed true soil. This process of soil development is called Pedogenesis and its study is called pedology. Soil formation is affected by a number by a number of passive factors (parent material, topography, time) and active factors (rainfall, temperature, humidity of evaporation, wind and organisms i.e. plants, animals and microbes.)

LAND DEGRADATION

With increasing population growth, the demands for land for producing food, fiber and fuel wood is also increasing. Hence, there is more and more pressure on the limited land resources which are getting degraded due to over-exploitation. Soil degradation is a real cause of alarm because soil formation is an extremely slow process and the average annual erosion rate is 20-100 times more than the renewal rate.

To feed the teeming millions we can not reduce the share of cultivated land at same time our diminishing forest resources do not allow us to divert forest areas for crop cultivation. So, the only option available is reducing the process of land degradation.

A large portion of fertile land is degraded due to following reasons:

(i) Overgrazing: Overgrazing makes the soil prone to erosion and soil looses its fertility.

(ii) Wrong agricultural practices: They make land unfit for cultivation by excessive use of agrochemicals and over cropping.

(iii) Water logging: Water logging due to over irrigation or due to high water table makes the soil unfit for cultivation.

(iv) Mining and stone quarrying: It makes a large portion of land uninhabitable and generates a lot of waste that destroys vegetation and causes land slides in hills.

(vi) Desertification: It leads to land degradation by increasing spread of desert like condition in nearby areas.

(v) Dams: They cause water logging, salinity, food shortage and large scale shifting of population to other areas.

(vi) Soil erosion: It leads to land degradation and deforestation in large areas.

(vii) Salinity and Alkalinity: Conditions like salinity and alkalinity render a large part of fertile land uncultivable.

(viii) Brick Kilns: The process removes top most fertile layer of soil and leave it uncultivable and barren.

(ix) Urbanization: Urbanization and shifting of large population from villages to towns and cities cause lot of land degradation.

(x) Floods: Floods spoil a large portion of our lands and impair their fertility.

(xi) Land fallowing: Fallow land which is devoid of plant cover deteriorate very fast.

(xii) Pollution: Land pollution and dumping of urban waste also play a vital role in land degradation.

Every human being has the right to live in a quality environment and his fundamental duty is to protect the environment and his surroundings.

DESERTIFICATION

Desertification is a process leading to desert formation. It is either due to a natural phenomenon linked with climatic changes or due to abusive land use. Removal of vegetal cover causes changes in the local climate. Excessive deforestation and overgrazing bring changes in rainfall, temperature and wind velocity which lead to soil erosion and ultimately desertification.

Desertification is a process whereby the productive potential of arid or semiarid lands falls. Desertification leads to the conversion of irrigated croplands to desert like conditions in which agricultural productivity falls. Desertification is characterized by de-vegetation and loss of vegetal cover, depletion of groundwater, Stalinization and severe soil erosion.

Causes of Desertification:

The major man-made activities responsible for desertification are as follows:

(a) Deforestation: The process of destruction of forests initiates a desert

producing cycle that continues of its own. Since there is no vegetation to hold back the surface run-off, water drains off quickly. It cannot be soaked into the soil to nourish the plants or to replenish the groundwater. This increases soil erosion, loss of fertility and loss of water.

(b) Overgrazing: The region's most seriously affected by desertification are the cattle producing areas of the world. Due to overgrazing of grass lands and forests by the cattle, the land is denuded i.e. its vegetation cover is removed. When the earth is denuded, the microclimate near the ground becomes unsuitable to seed germination. The dry barren land becomes loose and more prone to soil erosion. The top fertile layer is also lost and thus plant growth is badly hampered in such soils. The dry barren land reflects more of the sun's heat, changing wind patterns, driving away moisture laden clouds leading to further desertification.

(c) Mining and quarrying: These activities are also responsible for loss of vegetal cover and denudation of extensive land areas leading to desertification.

(d) Drought conditions: Desertification usually begins in areas made susceptible by drought or overuse by human population. Desserts are found to occur in the arid and semi-arid areas of all the continents. During the last 50 years about 900 million hectares of land have undergone desertification over the world. This problem is especially severe in Sahel region, just south of the Sahara in Africa.

FOREST RESOURCES:

Forests are major renewable natural resource. *A forest is a biotic community, mainly of trees, shrubs or any other woody vegetation usually with a closed canopy.* Forests not only produce innumerable material goods, but also provide many environmental benefits which are essential for life. About one third of the total land area of the earth is covered by forests. Forests play a great role in the economic development of a country.

Main Functions: Forests have the following three main functions to play besides many other uses:

(i) Production: The production of timber, bamboos, food, fruits and a wide variety of compounds such as resin, essential oils, latex, alkaloids and pharmaceuticals etc. is the productive function of forests.

(ii) Regulation: Forests regulate the release of O_2 and absorption of CO_2 through the process of photosynthesis. They regulate floods, draughts and biogeochemical

cycles particularly carbon cycle in nature. This function improves atmospheric and temperature conditions in addition to the rainfall which is vital importance for the maintenance of healthy environment.

(iii) Protection: Forests play a main role in the conservation of soil as well as water. They protect us against wind, cold, heat radiations, noise and irritating smells. They enhance agricultural products and prevent draughts.

USES & THEIR EXPLOITATION

Based upon the above main functions, the forests have very important role to play in providing us the basic necessities for living.

The following are some important advantages of forests:

(i) Food: Forests provide food in the form of roots, leaves, fruits and tubers not only to human beings but other animals also.

(ii) Fuel: Wood obtained from forests in used as a fuel for cooking and keeping us warm especially in villages even today. Around 80% of the total fuel used in the world is wood. The origin of fossil fuels (coal and petroleum) is from forests which were somehow buried under earth millions of years ago.

(iii) Timber : Timber obtained from forests is used for building houses, bridges, boats, ships, furniture, railway sleepers, poles, sport-goods, agricultural tools, toys and plywood for doors, windows etc.

(iv) Paper: Different kinds of papers such as stationery paper, newspaper, sanitary paper and packing paper are obtained from bamboos and eucalyptus trees.

(v) Commercial Products : Useful products such as essential oil (Khas, sandal) for cosmetics, camphor (from laurel tree); tannins, dyes, lac, gums and resins for individual uses, soap substitutes (ritha, shikakai), silk, honey (from forest insects), ivory, born and hides from forest animals, drugs, species, poisons, insecticides etc. and many other useful products are obtained from forests.

(vi) Production of oxygen: Green plants of the forest produce oxygen as a by-product of photosynthesis which is essential for the respiration of animals. They are rightly called as earth's lungs.

(vii) Environmental maintenance: Forests keep the environment cool by regulating transpiration of plants and by increasing the chances of rainfall. Humid conditions increase the chances of survival of plants in scorching heat of summer.

(viii) Shelter: A large variety of animals like insects, reptiles, birds and mammals live in forests which act as shelter for them. Forests are the homes for million of wild animals and plants. About seven million species are found in the tropical forests alone.

(ix) Soil conservation : Forests help in the conservation of soil due to following factors:

(a) The roots of trees and plants bind soil particles.

(b) The fallen leaves decrease the speed of rain water flow.

(c) They decrease the wind velocity which would otherwise erode the soil.

(x) Soil fertility: The fallen leaves of forest trees decay to form humus which increase the fertility of soil.

(xi) Control of hydrological cycle: The water in streams, springs, wells and rivers is regulated by humus of the decaying leaves. It absorb large amount of water which is released gradually maintaining the hydrological cycle in nature.

(xii) Pollution moderation: Air pollution is reduced due to absorption of $C0_2$ and other toxic gases by plants. It has also been reported that forests absorb noise. Forests are helpful in controlling air and noise pollution both.

(xiii) Reducing global warming: The forests act as a sink for $C0_2$ which is responsible for green house effect and global warming.

(xiv) Aesthetic importance: Greenery of the forests pleases humans due to their aesthetic sense. Forests stimulate the art of literature and music and thus have aesthetic importance.

WATER RESOURCES

Water is a renewable resource on this earth. It is indispensable natural resource on which life depends. Water is required for all physiological activities of plants and animals. Clean water is required to meet our domestic demands like drinking, cooking, washing, and bathing. Besides that it is required for irrigation, navigation, electricity production and industrial use. Most of the animals and plants contain 60.-65% of water in their bodies.

The water that we use keeps on circulating from sea to land and back, which is called hydrological cycle in nature (Fig.). Water passes into the atmosphere by evaporation from the surface of the moist earth, lakes, streams, rivers and oceans etc. Water vapours get condensed and return to the earth in the form of rain, hail and

snow. Thus, there is circulation of water from sea to land and back. Plants also play an important role by absorbing the ground water from the soil and releasing it into the atmosphere by the process of *transpiration*. So far as the main factor evaporation is concerned, global evaporation from the ocean surface contributes around 84 percent and the remaining 16 percent evaporation takes place from land surface. The water vapours in the atmosphere obtained due to evaporation from the water bodies on earth undergo condensation and fall back on earth in the form of rainfall. The excess water is returned to the ocean as surface run off through rivers and streams. The hydrological cycle is considered to be perfectly balanced cycle because the total annual evaporation matches with the annual condensation.

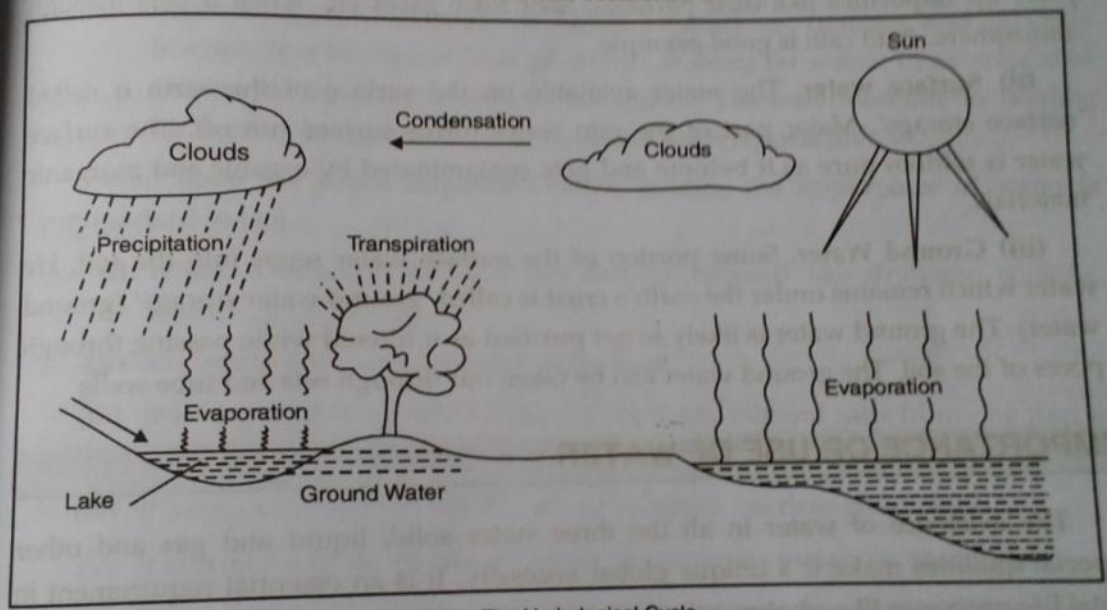


Fig : The Hydrological Cycle

Aquatic System

The natural aquatic ecosystem is of two parts.

They are:

1. Marine Ecosystem :

(i) Oceanic Ecosystem

(ii) Coastal Ecosystem

(iii) Tidal or Swamp Ecosystem

2. Fresh water Ecosystem:

(i) Running waster Ecosystem (rivers)

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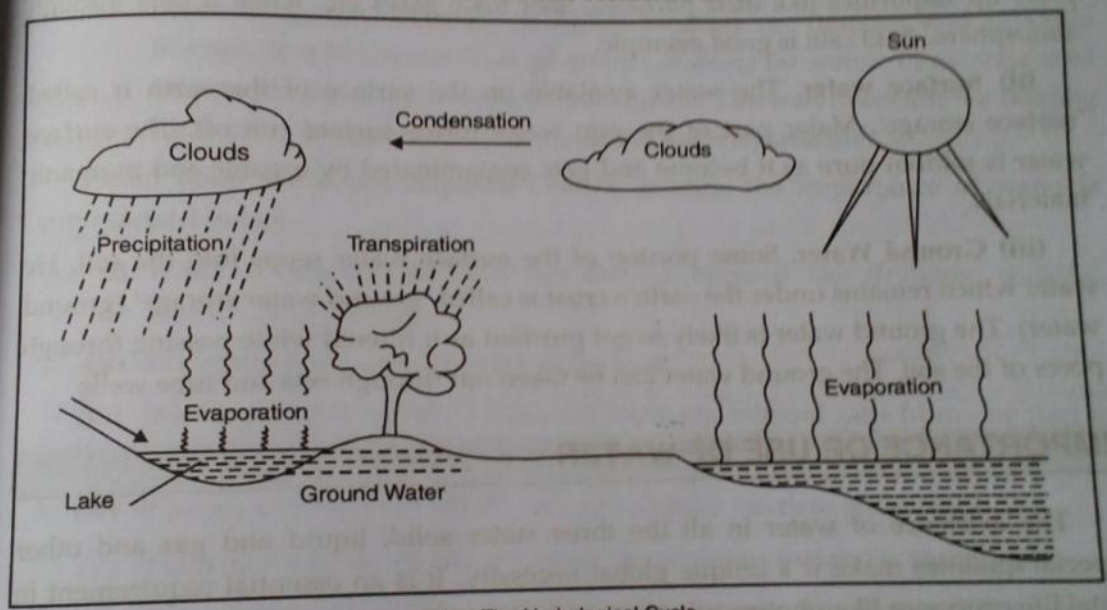

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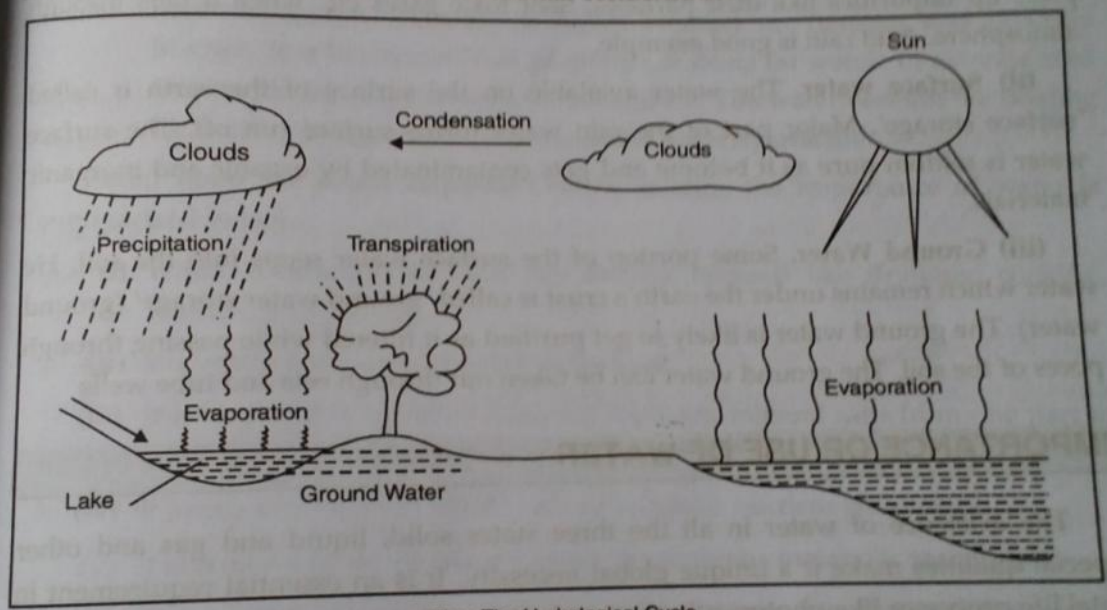

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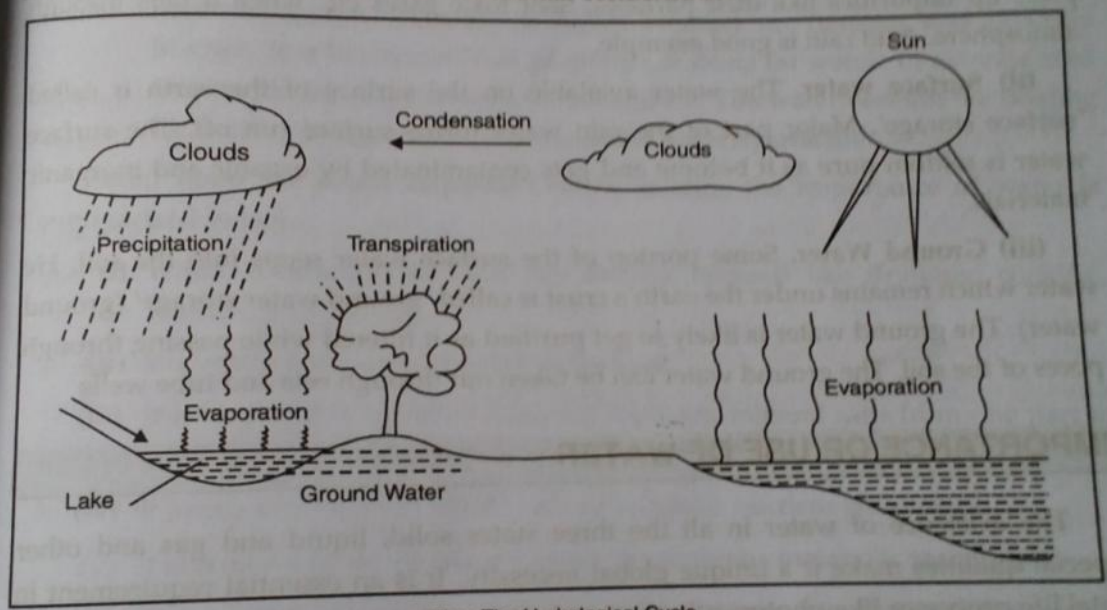

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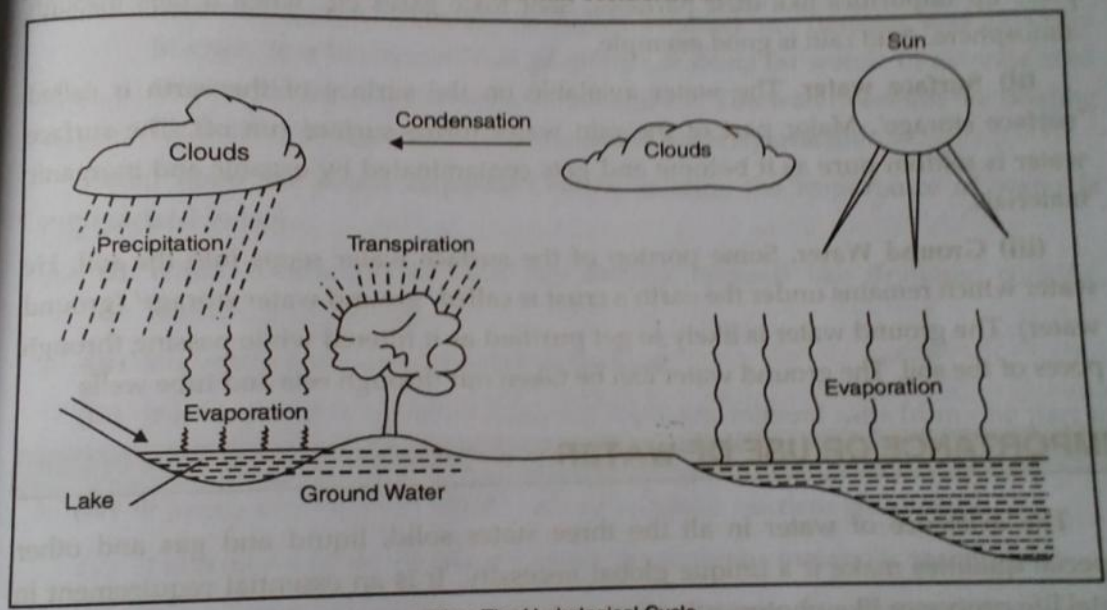

Fig : The Hydrological Cycle

Aquatic System

The natural aquatic ecosystem is of two parts.

They are:

1. Marine Ecosystem :

(i) Oceanic Ecosystem

(ii) Coastal Ecosystem

(iii) Tidal or Swamp Ecosystem

2. Fresh water Ecosystem:

(i) Running waster Ecosystem (rivers)

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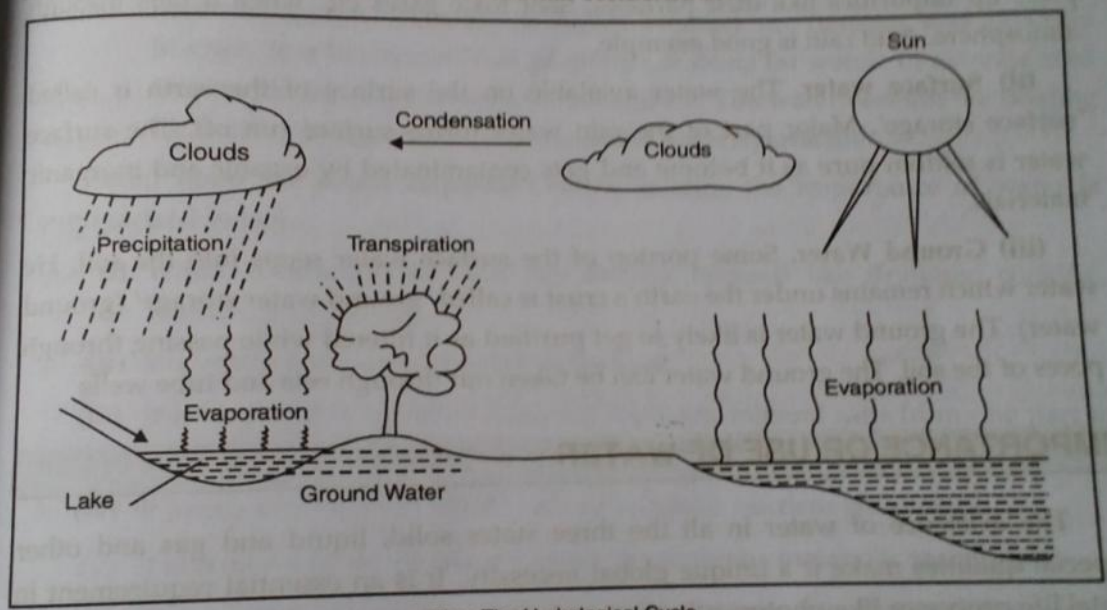

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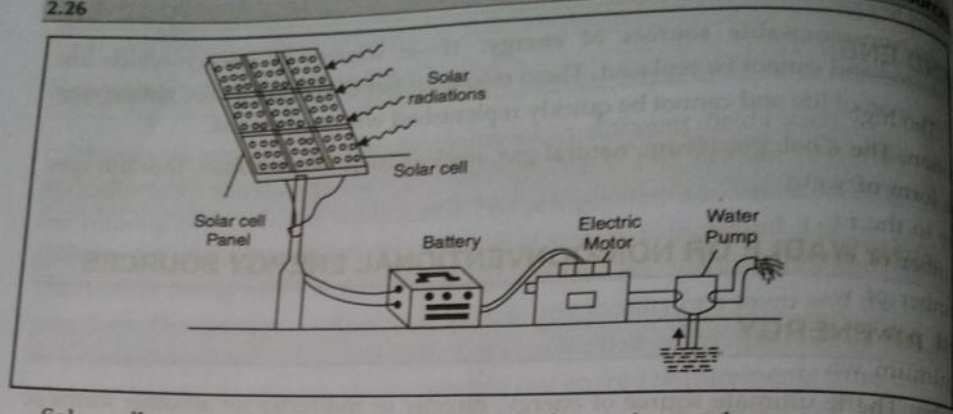

Solar cells are widely used in calculators, electronic watches, street lighting, traffic signals, radio and television, water pumps etc. They are also used in artificial satellites for electricity generation.

(ii) Solar cooker: Solar cookers (Fig.) makes use of solar heat by reflecting the solar radiations using a mirror directly on to a glass sheet which covers the black insulated box within which the raw food is kept. A new design of solar cooker is now available which involves a Plane Mirror spherical concave or (Reflector) parabolic reflector instead of plane mirror which has more heating effect and hence greater efficiency. The food cooked in solar cookers is more nutritious due to slow heating. However, it has the limitation that it cannot be used at night or one cloudy days. Moreover, the direction of the cooker has to be adjusted according to the direction of the sun rays.

(iii) Solar water heater: It consists of an : Insulated box painted black from inside and having a glass lid to receive and store solar heat. Inside the box it has black painted copper coil through which cold water is made to flow in, which gets heated and flows out into a storage tank. The hot water from the storage tank fitted on roof top is then supplied through pipes into the buildings.

(iv) Solar furnace: Here very large numbers of small plane mirrors are arranged in concave reflectors, all of which collect the solar heat and produce as high a temperature as 3000°C.

(v) Solar power plant: Solar energy is harnessed on a large scale by using concave reflectors which can boil water to produce steam. The steam turbine drives a generator to produce electricity. A solar power plant (50 K Watt capacity) has been installed at Gurgaon, Haryana.

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67% of the petroleum reserves which together from the OPEC (Organization of Petroleum Exporting Countries). About 1/4th of the oil reserves are in Saudi Arabia.

Petroleum is a cleaner fuel as compared to coal as it burns completely and leaves no residue. It is also easier to transport and use. That is the reason why petroleum is preferred amongst all the fossil fuels. Some other petroleum products are:

(i) Liquefied petroleum gas (LPG): The main component of LPG is butane, the other being propane and ethane. The petroleum gas is easily converted to liquid form under pressure as LPG. It is used as domestic fuel. It is odourless, but the LPG in our domestic gas cylinders gives a foul smell. This is, in fact, due to ethyl mercaptan, a foul smelling gas, added to LPG so that any leakage of LPG from the cylinder can be detected instantaneously.

(ii) Natural Gas: It is mainly composed of methane (95%) with small amounts of propane and ethane. It is a fossil fuel. Natural gas deposits mostly accompany oil deposits because it has been formed by decomposing remains of dead animals and plants buried under the earth. Natural gas is the cleanest fossil fuel. It can be easily transported through pipelines. It has a high calorific value and burns without any smoke.

Natural gas reserves are found in association with all the oil fields in India. Some new gas fields have been found in Tripura, Jaisalmer, Off-shore area of Mumbai and the Krishna Godavari Delta

Natural gas is used as a domestic and industrial fuel. It is used as a fuel in thermal power plants for generating electricity. It is used as a source of hydrogen gas in fertilizer industry and as a source of carbon in tyre industry.

(iii) Compressed natural gas (CNG): It is being used as an alternative to petrol and diesel for transport of vehicles. Delhi has totally switched over to CNG where buses and auto rickshaws run on this new fuel. CNG use has greatly reduced vehicular pollution in the city.

(iv) Synthetic natural gas (SNG): It is a mixture of carbon monoxide and hydrogen. It is a connecting link between a fossil fuel and substituted natural gas. Low grade coal is initially transformed into synthetic gas by gasification followed by catalytic conversion to methane.

(a) Nuclear Energy: Nuclear energy is known for its high de power as evidenced from nuclear weapons. The nuclear energy can also be harnessed for useful purposes. Nuclear energy can be generated by two types of reactions namely nuclear fission and nuclear fusion.

3

BIO-DIVERSITY AND ITS CONSERVATION

CONTENT

- **Bio-diversity: definition, levels and values;**
- **Threat to biodiversity, habitat loss;**
- **Concept of endemism;**
- **Hot-spots of biodiversity;**
- **Conservation of bio-diversity: In-situ and ex-situ concepts**

Biodiversity and Its Conservation

Man is surrounded by numerous organisms smaller or bigger, around him. We have number less species starting from small algae to the largest whale. This differentiation and variation is the base of life. To understand Bio-diversity we have to know the origin of life on earth *i.e.* when earth as a Planet took it's form, many chemical and organic changes took place. Non-living, organic and inorganic molecules have created living cell by their chemical reactions. The living cell later on became the 'basic unit' of life. Previously unicellular organisms came into existence. Then bicellular and with further complex developments, Multicellular organisms were formed. But this process was not so easy and fast rather it was very slow and difficult. Millions of years have been taken to bring about a single change in life and its form.

The word biodiversity was used for the first time in Washington in a symposium in 1986. it is in fact the shortened form of two words – 'biological' and 'diversity'.

Biodiversity refers to the number, variety and variability of all life forms on earth. For example, animals, micro-organisms, domesticated animals, cultivated plants, wild plants and even genetic materials like seeds and germs are a part of diverse fauna and flora. The variety and variability of organisms and ecosystems is called biological diversity. In simple form, *biodiversity is defined as the sum total of species richness.*

All the species do not occur at a single place. The occurrence of a species at a place is determined by the environmental conditions. Different kinds of communities have different types of plants and animals. Biodiversity includes varieties of plants and animals, micro-organisms of water, land and air in which they live and interact. Thus, biodiversity differs from place to place. Biodiversity is the result of the evolution of life on earth in past 3.5 billion years. The variability among living organisms from all sources including terrestrial, marine and other ecosystem and ecological complexes among which they occur gives rise to biodiversity.

Definition: The term 'Biodiversity' or biological diversity' refers to "the variety and variability of living organisms algae, fungi, plants and animals and the ecological complex in which they occur."

LEVELS OF BIODIVERSITY

There are about 30 million species present on planet earth. Out of which only 1.5 millions have been identified till now and the rest remain unidentified. There are about 259,000 green plants and 65,000 species of animals.

Biodiversity covers a wide range of species. It is said to have three levels or components:

1. Genetic Diversity: *Genetic diversity is related to the variation of genes within species.* Due to variations in genes, diversity in characters occurs within the same species and gives rise to varieties and races. For example, there are various varieties of mangoes, wheat, rice etc. Similarly there are various races of human beings such as *Mongoloid, Negrito and Nordic* etc.

It is the diversity of basic units of hereditary information (genes) which are passed from one generation to another. Genetic diversity within a species is expressed by many terms such as subspecies, breeds, races, variety and forms. Environment also plays an important role in imparting diversity of living organisms. Genetic changes due to mutations result in altered genotypes. Natural selection

favours the survival of those genotypes which are best suited to the prevailing environment. The results are in the formation of polymorphs (differently looking individuals of the same species). The genetic diversity provides the raw materials for adaptation to changing environment and for the evolution of new life forms (speciation).

2. **Species Diversity:** It is related to the variety in the number and richness of the species within a region and is measured at the level of 'species'. For example, Panthera leopersica (lion), Panthera tigris (big cat), Panthera uncial (snow leopard), all belong to the same genus (Panthera) but they all differ at the species level. Similarly, taking examples of plants, brinzal, potato and tomato belong to the same genus (solanum), but they all differ at the species level.

Species richness refers to the number of species per unit area. Species diversity is the product of species richness and species evenness. Thus, variations in the number of individuals per species lead to greater diversity.

Living World is most widely considered in term of species. The diversity is because of population of organisms which interbreed or are reproductively isolated from other such populations. *The richness of a species in an ecosystem is known as species diversity*. Species level is the most natural one to consider biodiversity. The ecological importance of a species lies in that it has direct effect on the structure of a community, which in turn affect the biodiversity, e.g. A species of Tropically Rain Forest tree that support hundreds of organism, is contributing more towards biodiversity than a European Alpine which may have no other species dependent on it.

3. **Ecosystem Diversity:** *It is related to the different types of ecosystems/ habitats* e.g. terrestrial (forests, grassland, desert etc.) and aquatic (fresh water and marine) ecosystems. Ecosystem differs from gene and species as it also includes abiotic components. This is the diversity of ecological complexity showing variation in trophic structure, food chain, food web and nutrient cycling. The ecosystem diversity is of great value. This diversity has developed over million of years of evolution. If we destroy this diversity, it would disturb the ecological balance. This diversity develops according to the variations in Environmental factors. Within a geographical area, there may be variable number of ecosystems/ habitats. The number of ecosystems/ habitat present in a region is also a measure of biodiversity.

THREAT TO BIODIVERSITY

Extinction is the complete elimination of a wild species. Extinction in biology refers to disappearance of a species from earth when its last member dies.

A number of species today are under threat of extinction due to both natural as well as man made factors:

(i) Natural factures like natural calamities, competition between species, biological imparity of a species etc. have contributed to some extent towards the extinction of various species. The process of extinction has become particularly fast in recent years of human civilization.

(ii) Man made threats like deforestation, clearance of forest for agriculture, mining, urbanization, industrialization, grazing, over exploitation of component of floristic diversity are responsible for the rapid extinction of species.

According to an estimate, about one third of species are likely to extinct in the next few years. Fossil records show that all species have a definite life span and are bound to extinct after that span i.e. extinction is a natural phenomenon. But the cause of concern is the rate at which species are extinction these days as compared to earlier days. It has been estimated that rate of extinction through natural processes was just one species after a spam of 60-70 years. But currently it has grown to about one species per day. If it goes on at the present rate, the rate of extinction may be as high as one hundred species per day by 2050 A.D.

There are a number of causes for extinction of biodiversity as given below:

1. Over Hunting: Over hunting has been a significant cause of extinction of hundred of species. Man has hunted for food from early days. But, nowadays people

are hunting animals for commercial purposes such as hide and skin, pharmaceuticals, cosmetics fur and so on.

Commercial hunting, both legal and illegal (Poaching), is the principal threat. The pet and decorative plant trade falls within this commercial hunting category. Despite international ban on trade in products from endangered species, smuggling of Wildlife items like furs, hides, horns, tusk and herbal products worth million of dollars per year continues.

Excessive hunting has caused following extinctions:

(a) Extinction of dodo bird of Mauritius: Extensively killed due to its beautiful feather.

(b) Extinction of Cheetah: The fastest Mammal of India.

(c) Many species of fishes, Molluscs, sea turtle, sea cow and whale are facing extinction.

In Africa, 95 percent of the black rhino has been poached for their horn. Africans have wiped out about 3000 times of ivory from elephants within a year. Several species of spotted cats, scarlet macaw have been eliminated from the range of central America. 70,000 whales were slaughtered in 1962. Therefore, International ban is put on the whale products. In India tigers are hunted for bones and skin, musk deer for musk, crocodile for their skin, elephant for ivory and desert lizard for oil.

2. Habitat Destruction: Habitat loss is the most serious threat to the biodiversity loss. Due to increase in population day by day, as it reaches to 6 billion now, we have destroyed roughly half of the world's forests. Deforestation is main reason of loss-of biodiversity. Forests are the habitat of animal species. Today forests are being eliminated for timber, minerals, agriculture and human settlement. The majority of forests are cut down for agricultural use such as grazing of cattle and planting of crops. If the habitat of species is cut down, they become extinct.

3. Invasion of Non-native Species (Exotic species): Exotic species are those that thrive in a region where they did not originate. Their site of origin geographically had been different but due to some reason they got shifted or introduced to the non-native area. Such species are known as *exotic species*. These species when introduced or invaded into other non-native area may cause disappearance of native species through changed biotic interaction.

Some examples of these exotic species are as given below:

(a) Periplaneta Americana (American Cockroach) is threatening the existence of many native oriental Cockroaches, *Blatta orientalis*.

(b) Parthenium hysterophorous (Congress Grass): It is native of South America, Argentina and came to India in 1951 along with contaminated wheat from USA and invaded Indian field. It shows the allelopathic effect (release the toxic chemical parthenin) which affect plants and animals.

(c) Lantana camara : It is native of Maxico and Central America, introduced in India as an ornamental plant. It escaped garden and acclimatized in forest rapidly as a naturalized exotic. Complete disappearance of native species occurred.

4. Climate change: The changing global climate is a threat to the species and Ecosystem. The distribution of species (biogeography) is largely determined by climate, as is the distribution of Ecosystem and plant vegetation zones. Climate change simply shift these distribution but, for a number of reasons, plants and animals may not be able to adjust.

5. Natural catastrophe: A natural catastrophe means a sudden change in the environment brought about by nature. It includes fire, storm, floods, earthquakes, volcanic eruptions, change in oceanic currents etc. Such a natural catastrophe may cause local extinction of many forms of life in that region.

6. Over exploitation: It not only leads to loss of economic species but also biological species such as insectivorous species for laboratory work. Examples are psilotum, Ghetum and Nepeuths. Besides biological species, medicinal, and horticulture plants are also under threat due to over exploitation. Excessive harvesting of marine animals such as whales, molluscus, sea turtles, sea cows results in the extinction of species.

7. Pollution: Pollution leads to changes in natural habitat. For example, water pollution is dangerous to biotic components of coastal ecosystem. The most common cause of pollution is pesticides, industrial effluents and emissions. Toxic pollutants can have disastrous emission. Toxic pollutions can have disastrous effects on local populations of organisms. Mysterious widespread deaths of thousands of seals on both sides of Atlantic and recent years are doe to accumulation of chemical such as DDT, PCB's and dioxins. Lead poisoning is another major cause of deaths of many species of wild life.

ENDANGERED AND ENDEMIC SPCIES OF INDIA

Endangered Species: These are species whose numbers have been reduced to a critical level or whose natural habitats have been reduced to such a level that these are in danger of extinction.

Their main characteristic are:

(i) Low reproductively rate

(ii) Narrow habitat requirements.

The International Union for Conservation of Nature and Natural Resources (IUCN) published Red Data Book, in which the list of endangered species is given. Concept of Red Data Book was developed by Sir Peter Scott (1960).

Threatened species occur in India by Taxonomic Groups

Taxonomic Group	Number of Threatened Species
Mammals	86
Birds	70
Reptiles	25
Amphibians	3
Fish	3
Molluces	2
Invertebrates	21
Plants	244
Total	459

According to Groombridge (1993), India contains about 3% of the world's total number of threatened species. India ranks second in terms of the number of threatened mammals, while sixth in terms of countries with the most threatened birds. The number of threatened species of India by Taxonomic groups is shown below. According to the red list of Threatened Animals, 18 animals species are critically endangered, 54 endangered and 143 are vulnerable. Amongst plants, 44 are critically endangered, 113 endangered and 87 are vulnerable i.e. likely to be endangered.

Some of the animals, which have been identified as endangered are Lion tailed Macaque, Golden Monkey, Himalayan Brown Bear, Tiger, Indian Lion, Great-Indian one homed Rhinoceros, Indian Antelope, Kashmir Hangul, Swamp deer, Great-Indian Bustard, Indian Pied Hornbull and Gharyal.

Endemic Species:

Species that are found in a single locality are and no where else in the world. In other words, these species are confined to a small area or a specific region. *Endemism* is the phenomenon of restriction of species in small region.

4

ENVIRONMENTAL ISSUES, POLICIES AND PRACTICES

CONTENT

- Causes, effects and control measures of: air, water, soil, noise and solid waste pollution
- Concept of natural disasters;
- Global environmental issues: increases in green house gasses, climate change, acid rain and ozone layer depletion;
- Salient features of : Water Act, 1974; Air Act 1981 and environment Act 1986;
- Environmental education;
- Environmental movements; chipko and silent valley and
- Environmental ethics.

Environmental Issues, Policies and Practices:

Causes, effects and controlmeasures of : air, water, soil, noise and solid waste pollution:

Air Pollution

Air pollution is basically the presence of foreign substances in air.

It can be defined as:-

The excessive concentration of foreign matter in the air, which adversely affects the well being of the individual or causes damage to property.

It has different meaning to different people, to house holder it may be an eye irritation and soiled clothing, to the farmer damaged vegetation, to industries problems of process control and public relations.

Pollutants of air can be of three types: solid, liquid and gas.

Primary pollutants:

Carbon monoxide, nitrogen oxide, sulphur oxide, hydrocarbons are chemical substances and dust, soot, cosmic dust, mineral particles are particulate matter. These are produced directly and enter the air as a result of human activities or natural event.

(a) Organic particulates are released by burning of vegetation and fuels—smoke, soot, flyash, fumes etc.

(b) Inorganic particulates are produced by industries, mining, smelting etc—lead, asbestos etc.

Secondary Pollutants :

They are all formed in the air either from the chemical reaction of one or more primary pollutants among them selves or due to reaction between primary pollutants and components of atmosphere. E.g.—sulphur trioxide (reaction of sulphur dioxide with oxygen), ozone (reaction of UV rays with oxygen), aldehydes, phenol etc.

Non criterion pollutants:

They are all man made e.g. asbestos, mercury, benzene etc.

Some major air pollutants are:

1. Carbon monoxide: Automobile engines and defective furnaces are the main source of CO. It is the most dangerous air pollutant. Its concentration in the atmosphere means less oxygen. It leads to headache, dizziness, reduced awareness etc. High concentration of CO may lead to unconsciousness or even death. It has adverse effects on plant life also. It decreases the nitrogen fixing ability, leaf drop and leaf curling is other results.

The remedy is to change the internal combustion system.

2. Carbon dioxide: It constitutes only .03% of the atmosphere. It is not harmful as

natural component. But its increased concentration in atmosphere is harmful and dangerous. It increase through burning of coal combustion of oil etc. its increased concentration affects global temperature.

3. **Nitrogen Oxide**: It is another harmful pollutant. Oxides of nitrogen are formed when combustion take place at high temperature in auto mobile engine or diesel operated engines.

Natural resources are forest fires and lightning. Fire wood burning produces nitric oxides in villages.

It can cause Gum inflammation of lung tissues Bronchitis internal bleeding Pneumonia or lung cancer. It forms photo chemical smog.

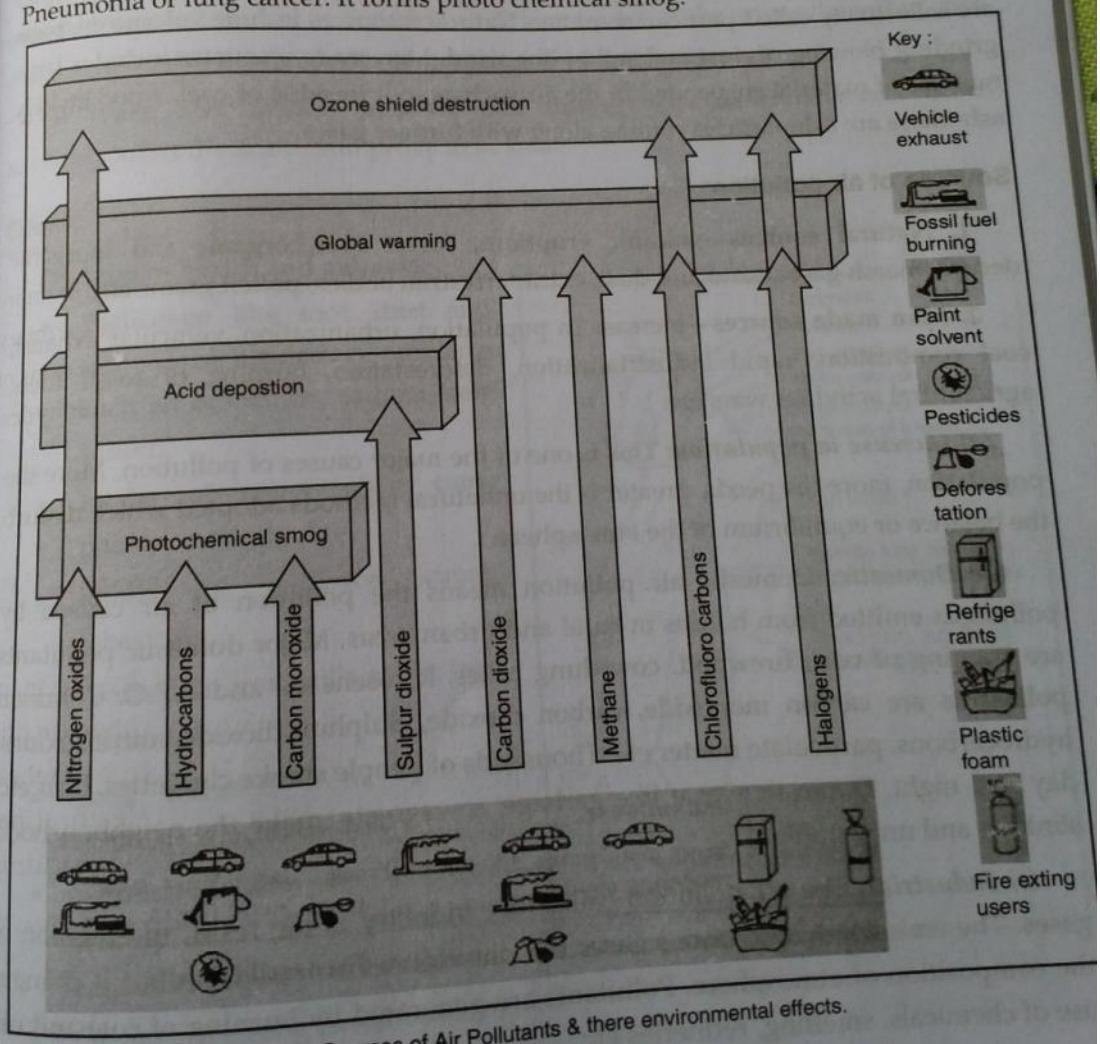


Fig: Sources of Air Pollutants & there environmental effects.

4. Sulphur dioxide: This harmful pollutant which is added to atmosphere by the burning of sulphur containing substances like coal, other sources are manufactures of fertilizers and sulphuric acid, rubber industries, refineries smelting and roasting industries and those industries which converts metallic ores in to metal. Largest contributed are thermal power plants. It has sharp odour it irritates nose, eyes and lungs, its higher concentration can block, respiratory system and cause death. It causes lung cancer. It is the most dangerous single pollutant which can cause health hazard. It causes acid rain and smog. In plants it destroys the chlorophyll. It even affects the marble.

5. Particulate matter: Small solid particle and liquid droplets suspended in air are collectively called particulate matter. Natural resources include volcano eruption grinding blowing of dust and soil by the wind. Man made resources includes large number of material suspended in the air such as soot (residue of coal, wood etc) Fly ash- these are ash particles coming along with furnace gases.

Sources of air pollution:

1. Natural sources—volcanic eruptions, forest fires, organic and inorganic decays, marsh gases, sand and dust, extra-terrestrial bodies, pollen grains etc

2. Man made sources—increase in population, urbanization, vehicular exhaust, coal combustion, rapid industrialization, deforestation, burning of fossil fuels, agricultural activities wars etc.

(a) Increase in population: This is one of the major causes of pollution. More the population, more the needs, greater is the unnatural methods adopted which disturb the balance or equilibrium of the atmosphere.

(b) Domestic: Domestic air pollution means the pollution of air caused by pollutants emitted from houses in rural and urban areas. Major domestic pollutants are burning of coal, firewood, cow-dung cakes, kerosene oil and L.P.G. Common pollutants are carbon monoxide, carbon dioxide, Sulphur dioxide, nitric oxides, hydrocarbons, particulate matter etc. Thousands of people smoke cigarettes, biris etc. day and night. Domestic waste like garbage, sewage etc. make the neighbourhood stinking and unbearable.

(c) Industrial: The air pollution caused by industry is the result of emission of gases. The emission of poisonous gases not only causes air pollution but it changes the composition of atmosphere. Pollutants are generated by burning of coal and oil, use of chemicals, smelting, refineries etc.

(d) Vehicular: Automobile revolution has contributed more than its share to air pollution. Millions of vehicles produce poisonous gases through combustion of oil. Incomplete combustion produces hydrocarbons. A survey conducted on the eve of World Environment Day, 1997 revealed that in Delhi 1400 tons of pollutants are generated every day out of which 1025 tons are contributed by 28 lakh vehicles.

(e) Deforestation: Man has been cutting trees indiscriminately to meet his needs. This has resulted in increase in the percentage of Carbon oxide and decrease in the percentage of oxygen in the air.

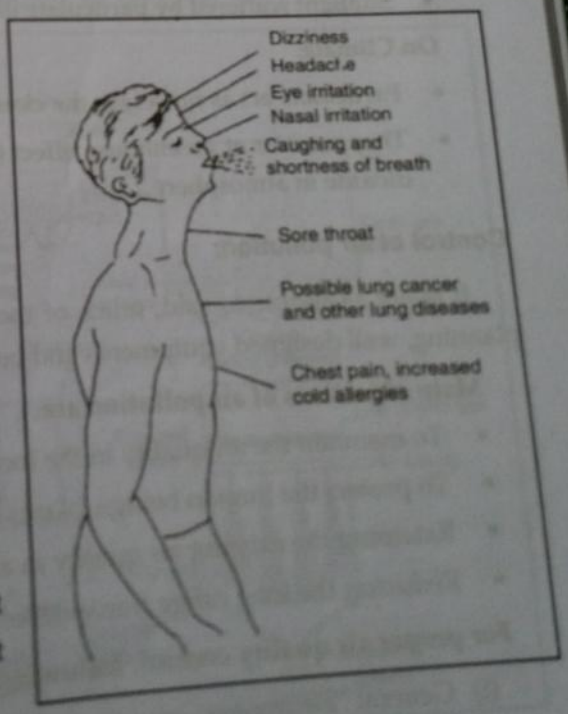
(f) Agricultural activities: The pesticides added to the soil or the sprays done over the crops are carried by the wind to different parts of the town where they give a foul smell and affect the health of animals and human beings.

(g) Wars: The nuclear weapons used during wars emit radiations which adversely affect the health and prove to be fatal.

Effects

On human health and animals:

- Particulate like soot, dust and smog cause respiratory problems such as bronchitis, asthma lung cancer.
- Intake of cotton dust cause pneumoconiosis
- Intake of asbestos causes asbestosis
- Workers in iron mills suffer from siberosis
- Lead released from vehicular exhaust, affects children's brain
- Sulphur-dioxide is the most widespread air pollutants-it causes irritation to eyes , throat
- Ozone is a strong irritant to lungs



Health Hazards caused by Air Pollution.

On plants:

- Suppression of growth
- Abscission- dropping of leaves etc.
- Acid rain affects aquatic life – most planktons, molluses and fishes
- Acid rain affects the building and other materials
- Hydrogen sulphide discolors silver and lead paints
- Ozone results in rubber cracking.
- Carbon dioxide is the major culprit for climate change

On Materials:

- Particulate damages a large number of materials for eg. Clothes, building, monuments (Taj damaged by Mathura oil Refinery). They also accelerate corrosion of metals.

On Visibility:

- Light scatter by particular matter results in poor visibility.
- Sunlight scattered by particulate illuminates the air and reduces visibility.

On Climate:

- Particulate act as nuclei for the cloud formation.
- They counter at greenhouse effect (global warming due to increase of carbon dioxide in atmosphere.

Control of air pollution:

It is not as simple as said; much of the pollution could be prevented by careful planning, well designed equipments and better operation of the equipments.

Main objectives of air pollution are:

- To maintain the air quality in the long term
- To protect the human beings, plants and animals from harmful effects
- Retaining the existing air quality in areas currently less polluted
- Reducing the long range transport of air pollutants

For proper air quality control, following steps are recommended.

(i) General awareness among society and government bodies should be created.

(ii) Regular monitoring should be done to assess the concentration or degree of pollutants.

(iii) All out efforts should be made to reduce the contribution of pollutants.

(iv) Existing devices should be improved.

Remedial & Control Measures:

The following remedial measures can improve the air quality.

(i) Enforcement of Air (Prevention and Control of Pollution) Act, 1981.

(ii) Purified fuel like lead-free petrol should be used.

(iii) Obsolete machinery should be replaced. There should be modernization of old machinery.

(iv) Air treatment plants should be installed.

(v) The exploitation and utilization of energy resources should be restricted and regulated.

(vi) More importance should be given to alternative energy resources. Wind , Water and Solar energy resources should be exploited.

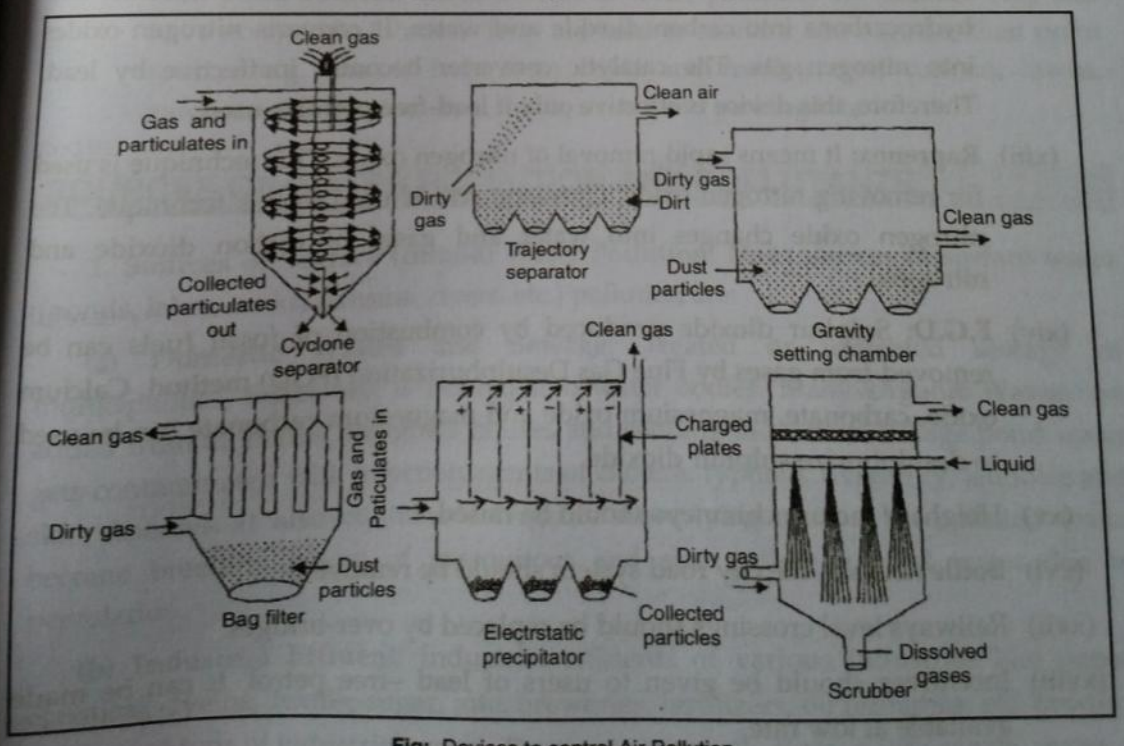


Fig: Devices to control Air Pollution.

... should be put into service (as in Delhi, Chandigarh etc)

(xxi) More trees should be planted within the city, broad leaved trees, ornamental trees, fruit trees etc. keep large amount of gases and dust on their leaves, twigs, stems and these parts of trees adsorb pollutants.

(xxii) Sewer system should be improved. Garbage should be collected regularly. It should not be set on fire in streets.

SOURCES OF WATER POLLUTION

- **Point sources**: Sources which discharge pollutants from specific locations, such as drain pipes, ditches or sewer out fall point sources are factories, power plants, sewage treatment plants, under ground coal mines and oil wells.
- **Non point sources**: These sources of water pollution are diffused one, and have no specific location. They are hard to monitor and regulate than point sources e.g. run-off from farm fields and feedlots, golf courses, lawns, gardens, construction sites, roads, streets and parking lots.

SOURCES OF WATER POLLUTION AND POLLUTANTS

1. **Sources of Surface (Inland) Water Pollution**: Main sources of surface water (ponds, lakes, tanks, streams, rivers, etc.) pollution are:

(a) Domestic Wastes and Sewage: Treated or untreated sewage of municipalities, boats, etc. is poured into water bodies. Many Organic Wastes are added from tanneries, slaughter houses and canning industries. Village pond water gets contaminated with infection agents of cholera, typhoid, dysentery, jaundice and skin diseases. It also contains detergents. Low lying areas with polluted water become breeding places of mosquitoes and also pollute ground water due to percolation.

(b) Industrial Effluent: Industrial effluents of various industries like paper, chemical, dyeing, textile, sugar, jute, breweries, fertilizers, oil refineries, etc. produce millions of tons of industrial waste. The waste is usually thrown into canals, rivers or

other water bodies or it gets collected in low lying areas. It percolates to contaminate ground water. The effluents contain : *(a)* heavy metals (mercury, lead, cadmium, copper, zinc, nickel), *(b)* other inorganic pollutants (cyanides, acids, alkalis, bleaching liquids, etc.) and *(c)* many organic pollutants (oil, phenol, naphtha, fats, fatty acids, sulphonated hydrocarbons, cellulose fibers, bark, wood, sugars, organic acids, etc.).

(c) Surface Run-off (Farm Run-off): It brings fertilizers (urea, potassium, phosphates, nitrate), insecticides (DDT, B.H.C, copper sulphate, aldrin, endrin, etc.), fungicides, nematicides, soil fumigants, 2, 4-D, and other herbicides.

(d) Solid Particles (Silt): Wrong agricultural and forestry practices cause soil erosion during rain and make the water muddy. Silt and mud may choke water courses, cause turbidity (reduce light to aquatic plants) and suffocate the organisms living at the bottom.

(e) Oil: Effluents of refineries discharge a lot of oil in the rivers that destroys the aquatic life.

(f) Thermal Pollution (Heat): It is caused by addition of hot effluents into water bodies from thermal power plants, refineries, etc. Warmer water contains less oxygen that harms aquatic life.

(g) Radio-active Wastes: Radioactive Wastes are dumped into the sea in thick resistant containers. After long time these containers liberate these wastes by wear and tear causing dreadful effects on living flora and fauna.

2. Sources of Underground Water Pollution:

The common sources of pollution are :

(a) Sewage and industrial effluents spilled over the ground.

(b) Fertilizers and pesticides used in fields percolate.

(c) Refuse dumps, septic tanks, seepage pits, mining activities, etc.

The pollutants filter through the soil to enter the underground water.

3. Sources of Marine Water Pollution: Sea is today the sewer of the world.

The main sources of pollution are:

(a) Dumping of industrial wastes directly by coastal industries or indirectly through river by inland industries.

(b) Discharge of fertilizers and pesticides from in land farm run-off through rivers.

(i) Iodine-131 (^{131}I) Damages while blood corpucles, bone marrow, spleen, lymph nodes, skin cancer, defective eye right, lung tumors etc.

(ii) Strontium-90 accumulates in the bones and may cause bone cancer and tissue degeneration in most animals and man.

CONSEQUENCES OF MARINE POLLUTION

1. Oil pollution inhibits plankton growth and photosynthetic activity of other aquatic plants.
2. Animal life is destroyed due to decrease of oxygen, food and toxic effects of oil.
3. Oil spreads over the water surface, may catch fire and hence kill all organic life.
4. Detergents used to clean oil spill are equally harmful.
5. Oil smeared sea birds fall sick and die. Every year about 50,000 to 250,000 birds are killed by oil.

6. South pacific islanders, who live largely on sea food, suffer frequently from cholera, gastroenterisus and infectious hepatitis.
7. Biomagnifications of polychlorinated biphenyls (PCBs) causes thinning of egg shells in the birds.
8. Consuming fish poisoned by hydrocarbons and benzene due to bio-concentration may cause cancer.
9. Huge quantity of plastic is being added to sea and oceans, e.g. 50 million *lb* plastic packing material is being dumped in sea of commercial fleets, whereas ever 300 million *lb* entering through inland waterways in U.S.A. Many marine birds ingest plastic that causes gastro-intestinal disorders.

Water Pollution Control

Water pollution control means quality control strategies. The quality of water has been degraded by our activities. There is a strong need of pollution control.

The major objectives are as follows:

(i) The supply of usable water for various purposes should be ensured.

(ii) Surface and ground water should be pollution free.

Various measures are recommended for the control of water quality. The remedial measures are as follows:

(i) To control quality at point sources. Various source points should be identified. Different source points are domestic sewage, industrial effluents, industrial waste, sewer system etc. Every effort should be made to check the discharge of polluted water from these source points into usable water bodies. Measures should be adopted to collect at various fixed centers.

(ii) To control quality of non-point sources. Non-point sources are generalized locations. Various measures should be adopted to check pollution at sources like forest, agricultural fields, mines, construction sites etc. Measures recommended are change in cropping pattern, farm management, structural measures etc.

Different methods which can be used for making the water usable are given below:

(i) Sedimentation. This method is used to separate insoluble material. The insoluble or suspended material in water is allowed to settle down under the influence of gravity. Sedimentation tanks are prepared. They are circular in shape.

The floor has a very gentle sloe of 2.5° - 7.5°. The heavy material settles down due to gravity. The layers which are formed at the bottom of tank are called sludge.

(ii) **Filtration.** In this method about 2 meters deep rectangular beds of coarse material like sand or crushed stone are prepared. The water filters through the beds and trickles down. Suspended and insoluble material is separated. A microbial film can also be sued. The filters can remove phosphorous also if the process in combined with chemical treatment.

(iii) **Chemical treatment.** This method is used to remove very fine suspended particles which do not settle down in sedimentation method. The treatment involves adding lime, alum or ferric chloride.

(iv) **Disinfection.** It means to destroy any infectious substance. This method is used to destroy the pathogenic germs or to inactivate them. It is done in the following manner.

The simplest method is *to boil* the water before using it.

(i) ***Chlorination.*** Chlorine is added in water for killing germs. It prevents the spread of waterborne diseases.

(ii) *Ozone* gas is a good disinfectant.

(iii) ***Ultraviolet Radiation.*** Ultraviolet rays can be used to disinfect water. The rays make the germs inactive. This is used in water purifiers. Iodine resin, used in water purifiers, kills the germs.

(iv) ***Dissolved Air Floatation.*** This method is used to treat oily water. In this method, gas is dissolved at elevated pressure. When small bubbles are formed, the pressure is reduced to atmospheric level.

(v) ***Activated Process.*** In this method oxygen is mixed with water by mechanical agitator. This aeration separates nitrates and water.

(vi) ***Activated Carbon Absorption.*** Most forms of organics can be effectively removed by activated carbon (obtained from coal).

- Government of India enacted 'The Water (Prevention and Control of Pollution) Act in 1974 to check water pollution. It was amended in 1978 to strengthen the hands of Pollution Control Board for effective implementation.

2 young children die every minute in India from dirty water.

- About 25,000 people die every day in world by consuming contaminated water.
- About 20 million children suffer from water borne diseases and 4.5 million children die from diarrhea alone in the world every year.
- Every day about 4,000 children die in India from contaminated water.
- Clean and safe drinking water can eliminate: 50% diarrhea, 90% cholera and 100% infection of guinea worm.
- Water contained no chloride is non-potable.
- Deficiency of iodine can cause thyroid and goiter.
- Excessive fluorides can cause bone disease.
- 500 million people in world suffer from trachoma (main cause of blindness) as they have no clean water to wash.
- 200 million people develop skin disease due to infected water.

CAUSES OR SOURCES OF SOIL POLLUTION & THEIR EFFECTS

Some of the main causes of soil pollution are briefly described below:

1. Industrial wastes: It has been estimated that about 50% of the raw material used by most of the industries become waste product which is either thrown into water or dumped into the soil nearby. This industrial waste contains huge amounts of toxic and disastrous chemicals, many of which are non-biodegradable.

2. Urban wastes: Urban waste consists of soil refuse containing garbage and rubbish material like paper pieces, glass, plastics, used cans, leaves, polythene bags, peelings of vegetables and fruits, food wastes etc. These wastes emit out poisonous gases, toxic hydrocarbons and pathogenic microbes (bacteria) which cause disease.

3. Agricultural pollutants: No doubt, the use of fertilizers, pesticides, soil conditioners etc. has increased the yield of the crops but they have polluted the soil. There entry into food chain has adversely affected the health of human being and led to a number of diseases.

Some of the agricultural pollutants are briefly described below:

(i) Fertilizers: Fertilizers act as nutrients for plant but it nitrates and phosphates are present in excess, they have hazardous effect.

(ii) Pesticides: These are the chemicals that are used to kill or stop the growth of unwanted organisms. However, their entry into food or drinking water adversely affects the health of human beings.

(a) **Insecticides:** These are the chemicals that are used to kill the insects which destroy the crop. The most common insecticides in use are DDT, BHC, aldrin etc. As they are not much soluble in water, they stay in the soil for long time and show their adverse activity.

(b) **Herbicides:** These are the compounds used to kill weeds. Earlier inorganic compounds, namely sodium chlorate ($NaClO_3$) and sodium arsenide (Na_3AsO_3) were commonly used as herbicides but arsenic compounds being toxic to mammals are no longer preferred. Instead, organic compounds such as triazines are now considered as better herbicides especially for the corn-fields.

(c) **Fungicides:** These are the chemicals used to stop the growth of fungi and check plant diseases. As fungi are the plants which do not contain chlorophyll, therefore they cannot use solar energy for the synthesis of their food (carbohydrates). Hence they depend upon other plants and living organisms. As a result, the growth of the main plant is retarded. Methyl-mercury is the most common fungicides. However, its dissociation in the soil produces mercury which is highly toxic and proves fatal if it enters into grain.

(iii) **Soil Conditioners:** These are used to protect the soil fertility but contain several toxic metals like Pb, As, Hg, Cd, Co etc. which may enter into the food chain.

(iv) **Farm wastes:** These are one of the biggest sources of soil pollution. In small towns and rural areas, there has been increase in dairies, poultries and piggery farms. Their washings collect as wet *slurry* on the land. This may seep through the soil and pollute the ground water. If their waste (faecal matter) is dumped, it may become a breeding place for insects. Moreover, their waste may contain pathogenic bacteria and viruses which may enter the plant and then pass on to humans.

- **Radioactive pollutants:** Dumping of the nuclear wastes from the nuclear power plants into the soil has been one of the greatest sources of radioactive pollution of the soil. Nuclear tests produce nuclear dust in the atmosphere which ultimately falls into the soil and pollutes it. The use of atomic and hydrogen bombs in the wars produces radioactive nuclides as the by-products. All the radioactive wastes thus produced emit radiations which are disastrous for the life on the earth.

7. Recovery of metals from scraps is economical and is helpful in conservation of natural resources.

NOISE POLLUTION ITS CAUSES AND CONTROL

With progress in industrial growth, the level of noise has been increasing continuously. The development of the steam engine, petrol engine and technological machineries in industry in the nineteenth century resulted in increasingly noisy environment. In the twentieth century this has been further accelerated by introduction of the diesel engine, turbo-prop and jet engines, high tech. machineries, construction site machineries and increased road traffic. *Noise is a by product of industrialization and modern civilization and has become a part of our environment.*

Sound waves travel through the medium from the source to the listener. The rate of oscillations of the medium i.e. the number of waves passing, through a point per second is known as *frequency* of the sound. The frequency is a measure of the pitch of the sound received by the listener. High frequencies imply high pitched sounds which are more irritating to an individual than low frequencies. The second parameters of sound is *sound pressure,* which is measured in Newton's per sq. meter (Nm^{-2}). The third parameter of sound is its *intensity,* expressed in watts per sq. meter (Wm^{-2}) i.e. the quantum of sound energy that flows through unit area of the medium in unit time. Sound is also sometimes expressed in terms of loudness which can not be measured like the above three parameters but is a matter of personal judgment. The common scientific unit of sound is the Decibel (dB), which is a ratio expressed as a logarithmic scale relative to a reference sound pressure level.

$$1 \text{ decibel (dB)} = 10 \log \frac{\text{Intensity measured}}{\text{Reference intensity}}$$

Thus, the pollution caused by a kind of harsh, loud and confused sound called noise is known as noise pollution.

Sources of Noise Pollution:

The sources of noise pollution may be stationary or mobile.

Stationary Sources : They includes industries, printing presses, domestic gadgets like mixers, exhaust fans, desert coolers, vacuum cleaners, entertainment equipments such as radio, television etc.

Fig: Sources of Noise Pollution

Mobile Sources: They includes road traffic, railway, air traffic etc.

1. Transportation:

(a) Road Traffic is the most prevalent and perhaps the most damaging source of noise pollution. More people are exposed to noise from motor vehicles than any other single source of noise.

(b) **Aircraft noise:** In this case, noise is maximum during take off and landing. During landing aircraft fly closer to ground for larger period than take off, hence this produces more sustained environmental nuisance. That's why most of the international airports have prescribed noise limits during day and night period.

(c) **Rail Traffic noise:** The noise pollution by rail traffic is not as serious as compared to road and airport traffic. The introduction of electric locomotives has greatly helped to check this kind noise pollution.

2. **Industry Noise:** The various types of industrial activities such as production of electromechanical machines, combustion process as etc., where heavy machines are working day and night is responsible for industrial noise and needs immediate attention.

3. **Other Sources:** Household appliances, social functions, music systems, harvesters, thrasher, sirens, barking dogs, military noise, human noise etc.

Noise Pollution Hazards

1. ***It can cause partial or permanent hearing loss:*** The human ear is susceptible to damage if it receives high intensity noise. For example, the noise level is 65 dB heard at a distance of one meter. A noise level of 125 dB gives the sensation of pain in the ear and 150 dB might kill a human being.

2. ***It can also cause pathological or psychological disorders:*** High frequencies or ultrasonic sound above the normal audible range can affect the semi-circular canals of the inner ear and make one suffer from nausea and dizziness. Very low frequency sound noise can produce resonance in the body organs giving the effects of reduced heart beat, variation in blood pressure in the skull and hence affect the brain and nervous system.

3. ***Even a low frequency noise of 50–60 dB affects*** the higher centres of the brain and *disturbs the normal sleep pattern of old people in particular*. A minimum period of regular sound sleep is required for maintaining healthy body and mind.

4. ***Noise can disturb our verbal communication*** upon which we all depend for our domestic and social life.

5. ***Excessive noise is also one of the major factors for tension in our lives today*** and this tension does not allow enjoying ourselves. It partly explains why people are taking recourse to artificial stimulants such as alcohol, tobacco and drugs.

6. ***The impact of noise pollution on migratory birds is significant.*** It discourages the annual visit of these birds to the lakes surrounded by industrial units causing noise pollution.

Effects of Noise

Noise is very harmful and a serious health hazard. Sometimes the effects are

serious and have far reaching consequences. Noise pollution affects the man in the following ways.

I. General Effects. Annoyance, irritation and disturbance in sleep are its simple effects. Prolonged disturbance is sleep has serious consequences. Noisy environment increases the time of light sleep and decreases the time of deep sleep. Deep sleep or sound sleep recharges the mind and body. The individuals who are deprived of deep sleep can suffer mental confusion and mental derangement in severe cases. Adults (especially old aged) are more sensitive than children. Continuous disturbance in sleep can cause mental and physical illness.

II. Auditory Effects. A constant exposure to noise can impair our hearing. Sudden and severe exposure can cause deafness. Hearing loss from noise is called 'Sociocusis' (loss of hearing with age is called Presbycusis). Considerable hearing loss is suffered by truck and bus drivers.

III. Psychological Effects. Noise can cause psychological effects also. High level noise can cause many behavioral changes among men and animals. It often causes irritation and fatigue which results in low efficiency and frequent errors. It distracts our mind. Exposure to continuous high level noise may cause tension in muscles, nervous irritability and neurotic mental disorders. Frequent use of loudspeakers in religious places during festival days and fairs (Diwali, Dusehra, Baisakhi etc.) and use of crackers are health hazards.

IV. Physiological Effects. Recent research has found a nexus between noise level and heart disease. German doctors say that noise causes narrowing of arteries. According to Russian doctors, exposure to continuous noise at a certain level (100dB) causes pain in heart. Noise pollution of different types caused by varying level of noise may cause peptic ulcers, allergy, nervousness etc. Exposure to continuous noise can affect our respiration, digestion and nervous system. Sudden high level noise caused by sonic booms or explosion can lead to termination of pregnancy in early stages. Many cases of birth defects (defect in newly born babies) have been reported in areas close to high noise regions. Some of the well known effects are given below in Table.

Table: Noise and its harmful effects

Noise (dB)	Effects
Upto 23	No disturbance
30 – 60	Stress, tension, psychological effects (illness, heart attack) at upper range

60 – 90	Damage to health, psychological, disturbance in sleep, disturbance in stomach functioning, pain in muscles, high blood pressure
90 – 120	Damage of health, psychological and auditory effects
Above 120	Painful effects on long-run.

Control of Noise Pollution:

The above discussion makes it clear that noise pollution is a serious environmental problem. There is a need to prevent and control noise pollution. There is also a need to develop methods for the evaluation of damage caused. Preventive measures should be adopted to maintain the acceptable level of noise. Central Pollution Control Board has recommended permissible noise levels for different areas. These recommended noise levels are given below in Table.

Table: Permissible noise levels in different areas.

Area	Noise level (dB)	
	Day Time	Night Time
	06 A.M. – 09 P.M.	09 P.M. – 06 A.M.
Industrial area	75	65
Commercial area	65	55
Residential area	55	45
Silence zone	50	45

Three components of noise pollution viz. source of noise, medium of noise and objects affected by noise must be taken into consideration when measures are to be adopted. The most important medium is individual, society and government level. People must be educated about the ill effects of noise pollution.

Noise pollution abatement programmes involve two types of measures:

A. Engineering Measures

(i) Noise reduction

(ii) Noise control

B. Legislative Measures

Engineering Measures

Noise Reduction: It can be achieved through various techniques. Several devices can be used to reduce the intensity of noise.

(iii) [illegible] used.

(iv) The noise can be effectively reduced by using sound absorbing material (acoustic) in community halls, cinema halls, temples, mosques, churches etc.

SOURCES OF SOLID WASTE POLLUTION AND CONTROL:

(i) Domestic waste contains polyethylene bags, empty metal cans, scrap metals, glass bottles, waste paper, cloth/rags, food waste etc.

(ii) Combustible waste includes leaves, grasses, and plants from the garden.

(iii) Biomedical waste includes anatomical wastes, pathological wastes and infectious wastes etc.

(iv) Industrial waste consists of a large number of materials including packaging material, organic wastes, acids, alkalies and metals etc. Solid wastes from other type of industries include scrap metal, rubber, plastic, paper, glass, wood, oils, paints, asphalt, tars, dyes, scrap leather, ceramics, abrasives, slag, and heavy metals, asbestos.

(v) Construction/demolition waste include debris and rubbles, furniture, bricks, concrete etc.

(vi) Horticulture waste and waste from slaughter houses includes vegetable parts, and remains of slaughtered animals, respectively.

(vii) Sewage waste: Sludge, settled solid components of sewage wastes.

(viii) Power plant waste: Radioactive wastes are generated by nuclear power plants. Thermal power plants produce fly ash in large quantities.

(ix) Mining waste, such as waste from coal mines, mica, and metal ergs, marble and stone mines.

The urban solid waste materials that can be degraded by microorganisms are called biodegradable wastes. Vegetable wastes, stale food, tea leaves, egg shells, peanut shells, dry leaves etc. Wastes that cannot be degraded by micro-organisms are called non-biodegradable wastes. For example, polyethylene bags, scrap metal, glass bottles etc.

The amount and nature of wastes depend upon the population, economic status and life style of the people. Heaps of solid wastes are thrown on vacant unused lands in residential areas which cause unhygienic conditions and result into out break of diseases like cholera, gastroenteritis, dengue etc. Management of solid

wastes has, therefore, become very important in order to minimize the adverse effects.

Effects of Solid Wastes

(i) Solid waste pile at public places due to improper disposal system and cause destruction in daily life.

(ii) The biodegradable materials decompose under uncontrolled and unhygienic conditions. This produces foul smell and breeds various types of insects and infectious organisms.

(iii) Industrial solid wastes consist of variety of chemicals which are toxic to living beings. The toxics are transferred to organisms through food chains causing undesirable side effects.

(iv) Industrial waste products on subjecting to incineration give toxic vapours injuries to health.

(v) Metallic contaminants destroy bacteria and beneficial soil micro-organisms.

(vi) Dumping of solid wastes may pollute ground water and also water sources present in the vicinity.

(vii) Dumping of bio-wastes on empty plots in urban areas can turn the area into breeding ground of mosquitoes, flies and insects. Diseases like diarrhea, dysentery are caused by water and food infected by flies.

(viii) Burning of wastes like pesticides, cleaning solvents, batteries (zinc, lead or mercury) produce dioxins, furans and polychlorinated biphenyls, which have the potential to cause various types of ailments including cancer.

(ix) The solid waste, in general, causes a lot of air, soil, land and water pollution.

Management of Solid Waste

The collection of rubbish and trash and their safe disposal on suitable sites needs proper planning and management. Solid waste management involves activities associated with collection, transfer and transport and safe disposal ofv wastes which are environmentally compatible. It also includes adoptiong principles of economy, aesthetic and conservation.

Collection:

Collection of garbage is the first step in waste management. In developed

countries, there are automatic machines which collect waste. In poor countries collection methods are poor and in some cases absent. Most of it remains near the place of source. In countries like India, the domestic garbage is generallythrown in the streets or dumped on any available vacant land. Proper planning demands the clearance of waste atleast twice a dayfrom industrial and commercial areas and once a day from residential.

Transfer:

The next step in waste management involves the transfer of heaps of garbage from street corners, or municipal dustbins to places of processing or disposal sites. This needs a fleet of vehicals. Only rich countries are able to provide large number of vehicles while in poor countries few vehicles can be seen in very big cities.

Disposal

For solid waste management we should remember the principle of "three R's" which stand for Reduce, Reuse and Recycle before destruction and safe storage of wastes.

(i) Reduction: Reduction in the use of raw materials will correspondingly decrease the production of waste. For reducing the use of raw materials, the following points should be kept in mind.

(a) Unnecessary heavy packaging should be avoided by making the consumers product in concentrated form. The concentrated form of the product requires lesser material and volume for packing.

(b) One should bring one's own bag while shopping rather than getting bags for every item purchased from different shops.

(c) Unwanted catalogs, junks, mails etc. should be avoided.

(d) Kitchen, garden, lawns etc. should be reshaped to reduce the use of yard waste, water and fertilizers.

(ii) Reuse: Reuse of waste materials not only saves money but it is helpful in the disposal of waste as is clear from the following:

(a) One should purchase and use durable tea cups, plates and other utensils instead of disposable plastic and paper items, cloth napkins instead of paper, reusable containers instead of plastic bags, wraps or foils.

(b) Refillable lighters, writing pens and non-disposable razors should be used instead of disposable one.

(c) Clothing, furniture and other reusable material should be maintained and rather than throwing them.

(d) Donate or sell the items which can be used by other instead of throwing them out.

(e) Items which are used rarely can be borrowed or acquired on rent.

(iii) Recycling of materials: Recycling is the reprocessing of discarded materials into new useful products, for example:

(a) Old aluminum cans and glass bottles are melted and recast into new cans and bottles.

(b) Formation of new products, such as of cellulose insulation from paper, fuel pellets from kitchen waste, automobiles and construction materials from steel cans and compost manure from yard trimmings and agricultural wastes.

(c) Used newspapers, books, note books can be reprocessed to get fresh paper again.

The process of reducing, reusing and recycling saves money, energy, raw materials, and also reduce pollution. Recycling of paper will reduce cutting of trees for making fresh paper. Reuse of metals will reduce mining for recovery of metals from ores and prevent pollution.

(i) Land Filling: In this method, the solid waste are carried and dumped into the low lying areas. The refuse is spread out into thin layers of 1.5m or so and each layer is covered by good earth of at least 20cm, so that refuse is not directly exposed. Each layer is left out for at least seven days and compaction is carried out for its settlement, before starting filling the next layer. Insecticides like D.D.T. should be sprayed on top to prevent breeding of mosquitoes and flies.

The solid wastes get stabilized with the passage of time due to the decomposition of organic matter which gets converted into stable compounds. The organic matter gets hydrolysed under anaerobic conditions to give gases like CH_4, H_2S, CO_2 etc. and water soluble organic acids which diffuse through the soil.

The disadvantages of the methods are:

(a) Continuous evolution of foul smell near the site of disposal.

(b) To cover the top layer good earth is required which may be difficult to procure.

NATURAL DISASTER

The term disaster is derived from the French word 'Desastre' meaning bad or an evil star. Disaster is commonly used to denote an extreme event, be it natural or man made, which brings about loss of life, property, infrastructure, essential services and means of livelihood to an extent that it becomes difficult to cope with the situation.

The United Nation defines it as the occurrence of a sudden or major misfortune which disrupt the basic fabric and normal functioning of a society. Natural disaster are often sudden and intense, result in considerable, destruction, injuries and deaths, disrupting normal life as well as the process of development.

Types of Natural Disaster

Natural disaster can be classified as follows:

(i) Wind/Water natural disaster: Floods, Droughts, Cyclones and Tsunami.

(ii) Climate Related: Hot and cold waves, Ozone depletion and Global Warming.

(iii) Mountains area disaster: Landslide, Snow avalanches.

(iv) Geological disasters: Earthquakes, Volcanic eruption

Earthquake

A sudden geological event below the surface of the earth results in generation of waves that travel far and wide and cause vertical and horizontal vibration. It is shaking of earth caused by vibrations. It is shaking of earth caused by earth's crust that suddenly shifts its position. They are one of the most dangerous and destructive natural hazards.

Earth shakes due to various reasons. Earthquake can occur due to a geological event inside the earth which would result in release of energy. They can occur due to collision or undercutting between different plates in the earth's crust. Earthquakes can also be originated due to activation of volcano. Underground explosion of nuclear devices can also give the impression of minor earthquakes.

Hazards and impacts Associated with Earthquake:

Earthquake cause a variety of impacts on the crust of earth

Primary Hazard: These are the effects, which occur simultaneously along with the natural phenomenon of the earthquake.

Secondary Hazard: Which occur at the end or after the earthquake phenomenon:

(i) Land and slides (ii) Soil liquefaction

(iii) Snow Avalanches (iv) Tsunamis

Due to these hazards associated with an earthquake, a number of impacts occur.

1. Primary Impacts:

(i) Building and bridge collapse.

(ii) Rupture of water and gas pipelines.

(iii) Changes in underground water sources.

(iv) Change in the course of river.

(v) Disappearance/creation of new courses of rivers.

2. Secondary Impacts:

(i) Death and damage due to collapse of infrastructure including buildings.

(ii) Fire and explosions.

(iii) Diseases and Epidemics.

(iv) Flood from dam failure.

(v) Flood from Tsunami.

Mitigation Measures:

Some inferences may be drawn by studying the statistical patterns of past records of earthquakes about events which commonly occur just before an earthquake. These are called pre-cursors and may give some indication but only rarely and not surely.

These events include:

(i) Strange animal behavior and large number of small earth tremors called foreshocks and aftershocks.

(ii) Unusual sounds inside the earth and audible on the surface.

(iii) Water in the well may increase or decrease; it may turn brackish/normal.

(iv) Ground may swell or subside.

(v) Ground may emit radon gas.

The following **do's and don'ts**, if observed before, during and after an earthquake, will definitely help in mitigation of the consequences of earthquake disaster.

Before an Earthquake

(i) Build earthquake resistant buildings and infrastructure.
(ii) Learn first aid.
(iii) Encourage and participate in earthquake drills or training sessions.
(iv) Prepare family disaster mitigation plan for every household.

During an Earthquake

(i) Remain calm and reassure others.
(ii) Check house for damage-evacuate if necessary.
(iii) If indoors, don't run outside in panic.
(iv) Stay away from glass windows, mirrors, chimneys etc.
(v) If in an automobile, stop away from bridges, flyovers, poles, trees etc.

After an Earthquake

(i) Check for firs.
(ii) Check house for damage-evacuate if necessary.
(iii) Check for injuries.
(iv) Never touch fallen power lines.
(v) Don't spread rumors.
(vi) Check for persons not yet accounted for.

Cyclone

Among the extreme weather events, cyclones also termed as tropical cyclones (TCs) are by far the most devastating, both by causing loss of human lives as well as economic losses. The name 'cyclone' which mean 'coil of snake' in Greek was given to the revolving storm in North Indian Ocean, those occurring in the Philippines and China sea are called typhoons and those occurring in Caribbean area are called hurricanes. A cyclone is an area of low pressure in the centre and high pressure outside. The cyclone thus can be defined as traveling low pressure areas, roughly circular or oval in shape, which originate as a wave along the front separating two air masses of different temperature, density and direction. They produce clouds and rain because a warm moist air made to rise over a mass of cold air.

Severe cyclones are responsible for large causality and considerable damage to life, property and agricultural crops. The destruction is mostly confined to the coastal districts.

Principal dangers from a cyclone are:

(i) Very strong winds

(ii) Torrential rain

(iii) High storms tides technically known as stream surges.

Before the Cyclone Season:

(i) Check the house, secure lose tiles, carry out repair works.

(ii) Remove dead wood/dying trees.

(iii) Keep a lantern filled with kerosene.

(iv) Keep a first aid box handy.

(v) Keep some extra batteries for transistor radio.

(vi) Keep some non-perishable food ready.

When cyclone alert and warning are on:

(i) Listen to Radio and TV

(ii) Pass on information to others.

(iii) Do not spread rumors.

(iv) Do not delay and run the risk of being marooned.

(v) Board up glass windows.

(vi) Make provision for children and adults requiring special duties.

(vii) Remain calm.

When evacuation is inducted:

(i) Head for the proper shelter indicated for your area.

(ii) Don't worry about left over property.

(iii) Follow instructions of in charge at the shelter or relief camp.

(iv) Remain in shelter/relief camp, until informed to leave.

Post-Cyclone Measures

(i) One should remain in shelter until informed to return home.

(ii) Get inoculated against infections diseases immediately.

(iii) Strictly avoid any loose and dangling wire from the lamp post.

(iv) Clear debris from your premises immediately.

Floods

Flood denotes accumulation of water. It results from an imbalance between inflow and outflow of water. Flood can occur through heavy outflow of water. Flood can occur through heavy rains, dam failures, rapid snow melts, river blockages or even bursting of water mains.

There are three **types** of floods:

(1) Flash Flood (2) River Flood (3) Coastal Flood

(1) Flash Flood: It occurs when a temporary blockage in hilly area impounds water, which is released suddenly. It can occur due to sudden heavy rain over a limited area.

(2) River Flood: It occurs due to heavy inflow of water from heavy rainfalls, snowmelt and short intense storms.

(3) Coastal Flood: They are caused due to Tsunami or heavy rainfall from cyclone and the storm surge associated with a cyclone.

Inputs:

The serious consequences of flood are as follow:

(i) Floods are the most frequent and most wide spread of all the natural disasters.

(ii) They result in death, destruction, degradation, disease and displacement.

(iii) Economically and socially disadvantaged section of the community suffers the most.

(iv) Recurrent nature of floods aggravates the disaster.

(v) The natural hazard of flood turns into a long persisting socio-economic disaster.

Mitigation:

In case an impending flood disaster is imminent, the following DO's and DON'Ts should be followed:

DO's :

(i) Do listen to radio for appropriate advices.

(ii) Do unplug all electrical gadgets and move them to safer places, switch off the electric mains.

(iii) Do move all movable goods to safer place or leave them united.

(iv) Do remove all insecticides and pesticides along with other toxic goods to safer and isolated places.

(v) Do lock all doors and windows before leaving the house.

DON'Ts :

(i) Don't wander around in the inmate area.

(ii) Don't enter the flood water or foot unnecessarily.

(iii) Don't allow children to stay out in the flood waters.

(iv) Don't spread rumors.

Landslides

Landslides are defined as the mass movement of rock debris or mud down on slopes under the influence of gravity. In almost all cases, landslides occur as a consequence of changes in the composition and structure of rocks or vegetation on a slope, which loosens the soil or rocks which slide due to heavy rain or vibrations in the earth's surface. They are common in mountainous area such as Himalayas and the Western Ghats. Landslides are a major threat to the environment, human settlements and infrastructure. Landslides cause extensive damage to houses, roads, buildings, forest, plantations and agricultural fields. The debris originating from landslides results in siltation of streams and rivers, inducing further problem of erosion and floods. Damages to structures, loss of lives as well as properties occur extensively every year as a result of landslides.

Mitigatory Measures:

The main mitigatory measures adopted to landslide prone area are as follow:

(i) Proper land use

(ii) Drainage correction

(iii) Reforestation of the area occupied by degraded vegetation

(iv) Awareness among local people

(v) Human activities that might activate a landslide should be restricted.

(vi) Implementation of risk reduction measures must be preceded by locating areas that are prone to slope failure.

(vii) Houses and roads in vulnerable area should be avoided or built only according to prescribed building codes.

Rapid growth of human population over past two centuries has been the most spectacular phenomenon in human history. It is growing at the rate of two percent a year and becomes double after every 35 years. It has already crossed 6 billions marks and it will be around 8 billions in 30 more years. It is not only the number of humans that makes the major impact on biosphere. To meet the demand of rapidly growing human population, tremendous progress has been made in the field of agriculture, industry, transport etc. This, however, has resulted in the unlimited exploitation of limited natural resources, urbanization, contamination of the environment, increased desertification, increased soil eruption, irregular rainfall, more floods etc. High rate of consumption of non-renewable fossil fuels is adding harmful gases and other chemical into the atmosphere resulting in *acid rain, global warming, ozone depletion* etc.

GREEN HOUSE EFFECT (GLOBAL WARMING)

Building up of CO_2 in the atmosphere is a major challenge facing mankind today. In atmosphere, CO_2 is a natural constituent. It has concentration over 0.033% by volume having a ratio of 1 : 450 with oxygen. The green house effect is in fact normal to earth and essential to life. Without it, the earth would be over 300°C cooler and life as we known would not exist. It is the additional greenhouse effect under way since the industrial revolution began. It is the main threat to global climate change. An increase in global average temperature would result in melting of glaciers such as Antarctica caps, therefore a rise in ocean level followed by other climatic changes.

As we know that there are about 4 layers of atmosphere – Troposphere, Stratosphere, Mesosphere and Thermosphere. In the lowermost layer (troposphere) of the earth, there is a blanket of carbon dioxide (CO_2) gas. When the sunlight consisting of UV rays, visible and Infra-red rays falls on the top of atmosphere, then first of all the harmful UV rays are absorbed by the ozone layer which is present in stratosphere. The visible and Infra-red rays pass through the layer of CO_2 and fall on the surface of the earth. Infrared rays are of short wavelength and they pass through layer of CO_2 easily. When these rays strike on the earth, they become hot and earth starts emitting long wave length rays. These rays can't pass through the CO_2 blanket

easily and CO_2 traps all the hot rays (long wave length rays) and atmosphere of earth gets heated up. Green House effect is the warming up of earth surface due to absorption of heat by CO_2. The average temperature of earth is 15°C. In absence of green house gases, this temperature would have been 18°C. The gases which contribute Green House effect are as follows:

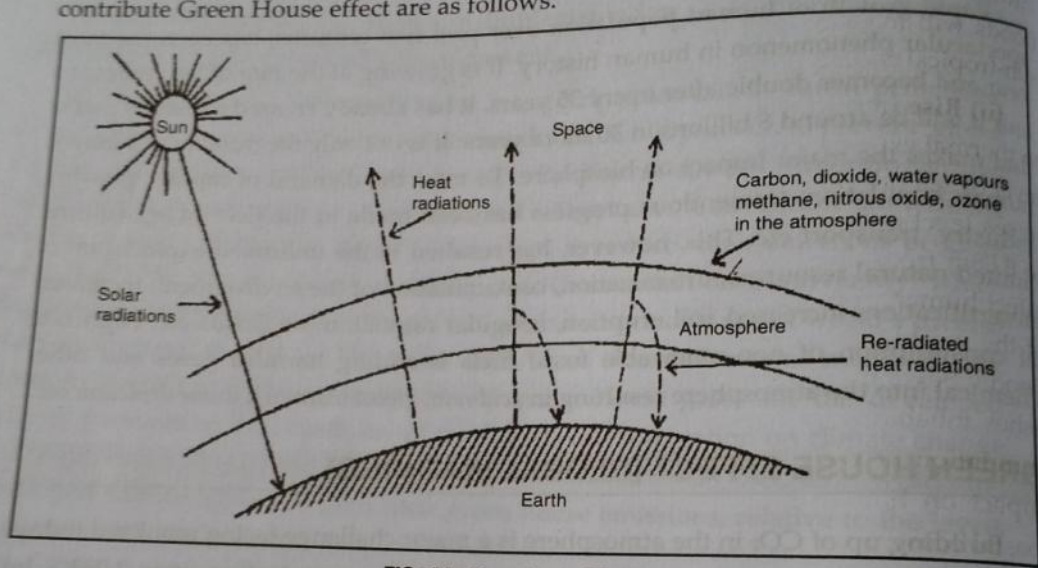


FIG : The Greenhouse Effect

Those gases which can trap the Infra-red rays to produce green house effect leading to heating up the Environment are called Green House Gases (GHGs). We have already stated that basically it is the CO_2 alone which is responsible for causing Green House effect. In addition to CO_2, water vapour, methane gas, nitrous oxide and ozone also have the ability to trap the hot rays.

GLOBAL WARMING

The increasing concentration of greenhouse gases in the atmosphere leads to global warming.

Some of the predicted effects of global warming are described below:

(i) Effects on weather and climate: In the 20th century, the global mean temperature has increased by about 0.6°C. The average temperature of the earth may increase by 1.4° to 5.8°C by the year 2100 from year 1990. It is expected that the rise in temperature will be more marked in the regions of middle and higher latitudes.

The moisture carrying capacity of the atmosphere is also expected to increase due to warming of the atmosphere. The troposphere will warm up and the stratosphere will cool down. This would cause a wide-spread change in precipitation patterns due to changed pattern of air mass movements. The precipitation will increase at higher latitudes but will decrease at lower latitudes. The frequency of extreme drought and floods will increase. The human disease will increase, particularly in tropical and sub-tropical countries due to increase of disease vectors, water borne pathogens etc.

(ii) Rise in sea level: The global warming also contributes to rise in sea level due to thermal expansion of ocean and melting of glaciers and Greenland ice sheets. The level of sea has been rising by 1 to 2 mm per year during the 20th century. If the rise in sea level goes on with the present rate, the global mean sea level will increase up to 0.88m from the year 1990 level. A rise of even half of a meter in sea level would affect human population, one-third of which lives within 60km of a coast line. Many of the world's important cities and coastal areas will likely to be hit by storms and floods. Several low lying islands may be submerged. Many important birds and fishes inhabiting in coastal salt marshes and estuaries, will become extinct due to inundation of their breeding grounds. Thus, rise in sea level will have a negative impact on human settlements, tourism, fisheries, agriculture, water supplies and coastal ecosystems.

(iii) Effect on range of species distribution: Each plant and animal species occurs within a specific range of temperature. The global warming will shift the temperature ranges, which would affect altitudinal and latitudinal distribution pattern of organisms. Many species may shift slowly poleward high elevations of mountain areas. It is predicted that the temperature region vegetation may extend 250-600km poleward with the rise in global temperature by 2 to 50°C during the 21st century. Rapid rise in temperature may cause large scale death of many trees, as they are sensitive to temperature stress, and the area may be occupied by scrub vegetation. Many species may disappear, as they are unable to migrate fast enough to track temperature change.

(iv) Food production: Global warming will reduce crop production due to increased incidence of plant diseases and pests, explosive growth of weeds and enhanced basal rate of respiration of plants. In temperature regions, small rise in temperature may enhance the crop productivity slightly but larger temperature change will decrease the crop productivity there. However, in tropical and subtropical regions, even a small rise in temperature, has a detrimental effect on crop

productivity. It is estimated that the yield of rise along in South East Asia will decrease by 5 per cent for each 1°C rise in temperature. Thus, the overall world's crop productivity will decrease due to global warming despite of beneficial CO_2 fertilization effect.

Approaches to Deal with Global Warming:

Some of the strategies, which could reduce global warming, are given below:

(i) Reduction in greenhouse gas emission by reducing the use of fossil fuels and by developing alternative renewable sources of energy like solar energy, wind energy etc.

(ii) Increase of the vegetation cover, particularly forest for photosynthetic utilization of CO_2.

(iii) Reduction in N_2O emission by minimizing the use of nitrogen fertilizers in agriculture and

(iv) Development of substitutes for chlorofluorocarbons.

Sources of Green House Gases (GHG's)

1. CO_2: The main sources of CO2 are fossil fuel emission by burning of coal, wood etc. CO_2 is also released by vehicles.

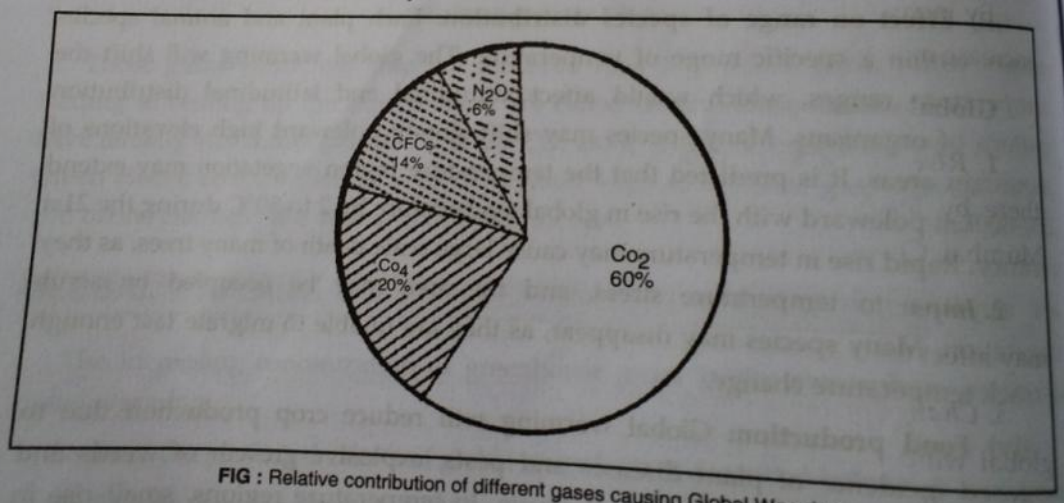


FIG : Relative contribution of different gases causing Global Warming

2. CFC (Chlorofluorocarbon): The main sources of CFC are from air conditioners, refrigerators, aerosols etc.

3. Methane (CH_4): Methane is produced by degradation of dead organic matter

by bacteria called *methanogens* under anaerobic conditions. Incomplete burning of organic materials is also the source of methane.

4. Nitrous Oxide (N_2O): The main source of N_2O is from burning of biomass and break down of nitrogen fertilizer in soil.

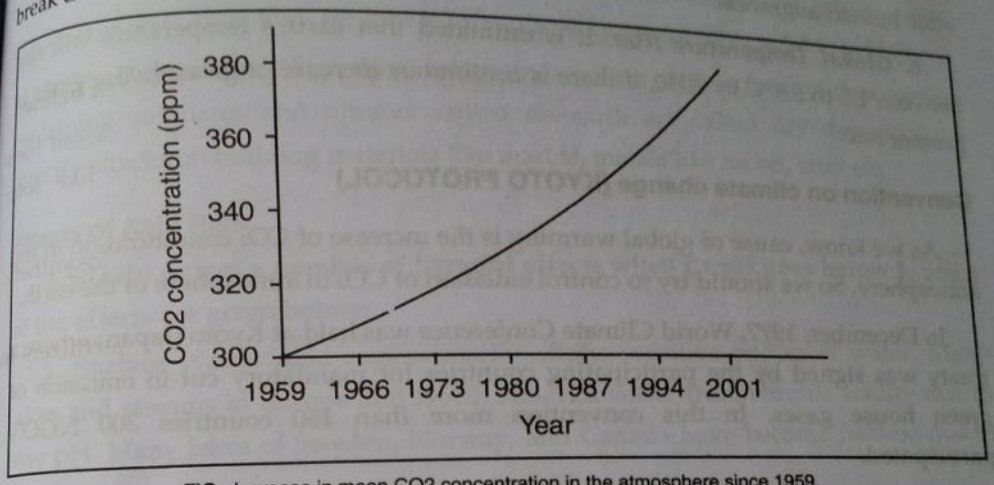


FIG. Increase in mean CO2 concentration in the atmosphere since 1959.

Impact of Green House Effect

By increase in the amount of green house gases, there is change in climate due to increase in temperature of earth.

Global warming has following effects:

1. ***Rise in sea level:*** Global warming can lead to the melting of ice peaks and there by leading to rise in sea water level. There is threat to coastal cities like Mumbai, Chennai, and Kolkata etc. of being immersed under water.

2. ***Impact on Agriculture:*** Global warming may change the rainfall pattern, which may affect the agricultural output in the various regions of the world.

3. ***Change in Wind Pattern:*** Other effect of global warming will be the change of global wind pattern due to more energy being pumped into the atmosphere. This will turn the climate, extremely.

4. ***Rise in Temperature:*** Rise in expenditure due to global warming may lead to death of micro organisms like phytoplanktons, zooplanktons, bacteria and thus ecosystem will be disturbed.

5. *Socio-Economic Impact:* Global warming will have also socio-economic impact. Many economical sectors, particularly physical infrastructure, will be affected by the climate change. The flooding and land slide will result into a large scale human migration.

6. *Global Temperature Rise:* It is estimated that earth's temperature will rise between 1.5 to 5.5°C by 2050, if there is continuous increase of green house gases at present rate.

Convention on climate change (KYOTO PROTOCOL)

As we know, cause of global warming is the increase of CO_2 concentration in the atmosphere. So we should try to control emission of CO_2 in atmosphere of the earth.

In December, 1977, World Climate Conference was held at Kyoto (Japan) where a treaty was signed by the participating countries for mandatory cut in emission of green house gases. In this convention more than 160 countries 300 NGO's participated.

Objective: The main objectives of the protocol were:

1. Stabilization of Green House Gases concentration in the atmosphere.
2. To ensure that food production is not threatened.
3. To enable economic development to proceed in a sustainable manner.

ACID RAIN

The term "Acid Rain" was first coined by Robert Aungus Smith (1852). Acid Rain means mixing of acid into rain water. Oxides of sulphur and nitrogen originating from industrial operations like burning of coal in which high amount of sulphur is present, Thermal power plants and automobiles exhaust oxides of sulphur and nitrogen which come into contact with rain water and they form acids like sulphuric acid and nitric acid. Hydrogen chloride emission form hydrochloric acid. Sulphuric acid (H_2SO_4) is the major contributor (60 – 70%) in acid rain. Nitric acid contributes (30 – 40%) and HCl contribute (5 – 10%). Natural Rain water a pH of 5.6 due to formation of carbonic acid by mixing of CO_2, Rain water become acidic when its pH gets lower than 5.6.

Types of Acid Rain: Acid rain can be of two types:

1. Wet Acid Rain 2. Dry Acid Rain

1. **Wet Acid Rain:** The acid mixtures when fall on the earth form of rain, snow, fog, mist or frost, then they are in wet form, these forms are more soluble in H_2O.

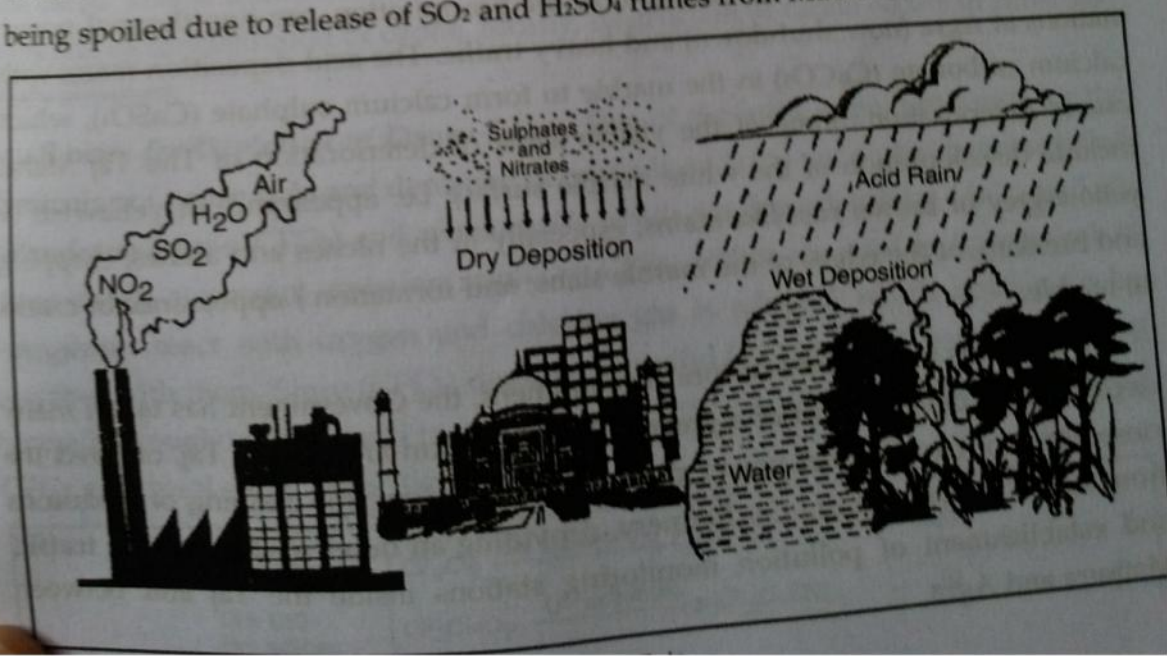
2. **Dry Deposition:** When these compounds fall on earth in form of dust particle containing sulphates and nitrates settled on earth are called dry deposition. It directly attacks on building materials like marble, metals like nickel, steel etc.

Effects of Acid Rain

Acid rain causes a number of harmful effects when its pH goes below 5. Some of the effects are given below:

1. **Surface Water:** Acid rain primarily affects sensitive bodies of water. Many lakes and streams in Europe and North America suffer from chronic acidity due to low pH. Many lakes of Sweden, Norway, and Canada have become fishless due to acid rain.

2. **Materials:** Acid rain and dry deposition of acidic particles are known to contribute to the corrosion of metals. Acid rain causes extensive damage to the building and structural materials of marble, limestone, slate etc. The attack on marble is known as stone leprosy. A good example is Taj Mahal in Agra, which is being spoiled due to release of SO_2 and H_2SO_4 fumes from Mathura refinery.



Ozone (O_3) is a form of oxygen (O_2) present in stratosphere. The ozone formation occurs 16 km above the surface of the earth by the action of ultraviolet radiations on atmospheric oxygen.

$$O_2 \xrightarrow{U.V.} O + O$$

$$O_2 + O \longrightarrow O_3$$

It is mainly found in stratosphere which is extends from 12 km to 35 km. This part of stratosphere which is rich in Ozone is called Ozonosphere or Ozone umbrella.

Ozone layer as protective umbrella: The presence of ozone layer in the stratosphere forms a protective umbrella around the earth. It absorbs the harmful ultraviolet (UV) radiation coming from the sum and thus prevents them from reaching the surface of the earth. The Ultraviolet radiation (UV) is very harmful and if all the UV radiation reaches the surface of the earth, then it will cause skin cancer in human beings.

Depletion of Ozone layer and Ozone Hole: In the year 1985, Ferman and his team of scientist noted that a gap or hole in ozone layer exists over the Antarctica region of the earth. This is called Ozone hole. In fact, there is no Hole in ozone layer. It is the thinning of concentration of ozone. Mostly, destruction of ozone occurs in spirit and early summer.

Causes for Depletion of Ozone Layer: One of the most important cause for the formation of ozone hole and depletion of ozone layer is the use of the chemical called *chlorofluorocarbons* (CFCs) and *nitrous oxide* which are depleting it by 146° and 3.5% respectively at current emission rate. The CFCs, which are used in sprays and as refrigerant react with oxygen and chlorine gas is released which destroy O_3 by reacting with them. Since (CFCs) deplete the useful O_3 layer, their use is now being banned throughout the world to protect ozone layer. In 1978, USA banned the use of CFCs as aerosol spray propellants.

Formation of Cl & ClO free radicals

$$CF_2Cl_2 \xrightarrow{\text{UV radiations}} Cl + CF_2Cl \quad \text{....(i)}$$

$$CF_2Cl + O_2 \xrightarrow{\text{UV radiations}} CF_2O + ClO \quad \text{....(ii)}$$

Ozone Formation

$$O_2 + O_2 \xrightarrow{\text{UV radiations}} O_3 + O \quad \text{....(iii)}$$

$$O_2 + O \xrightarrow{\text{UV radiations}} O_3 \quad \text{....(iv)}$$

Ozone Depletion

$$Cl + O_3 \xrightarrow{\text{UV radiations}} ClO + O_2 \quad \text{....(v)}$$

$$ClO + O \xrightarrow{\text{UV radiations}} Cl + O_2 \quad \text{....(vi)}$$

The combined effect of reaction (v) and (vi) is the removal of ozone in the form of oxygen.

$$O_3 + O \text{ ------> } 2O_2$$

The regenerated chlorine free radical (•Cl) by equation (vi) catalyse the degradation of several thousand molecules of ozone. It is because of the chain reaction set up as represented by reactions (v) and (vi). Only one •Cl atom free radical can decompose upto 100,000 molecules of O_3 before it is removed by some reaction.

Harmful Effects of Depletion of Ozone Layer

Due to the depletion of the ozone layer, more ultraviolet radiation (UV) will fall on the surface of the earth and it will cause following harmful effects:

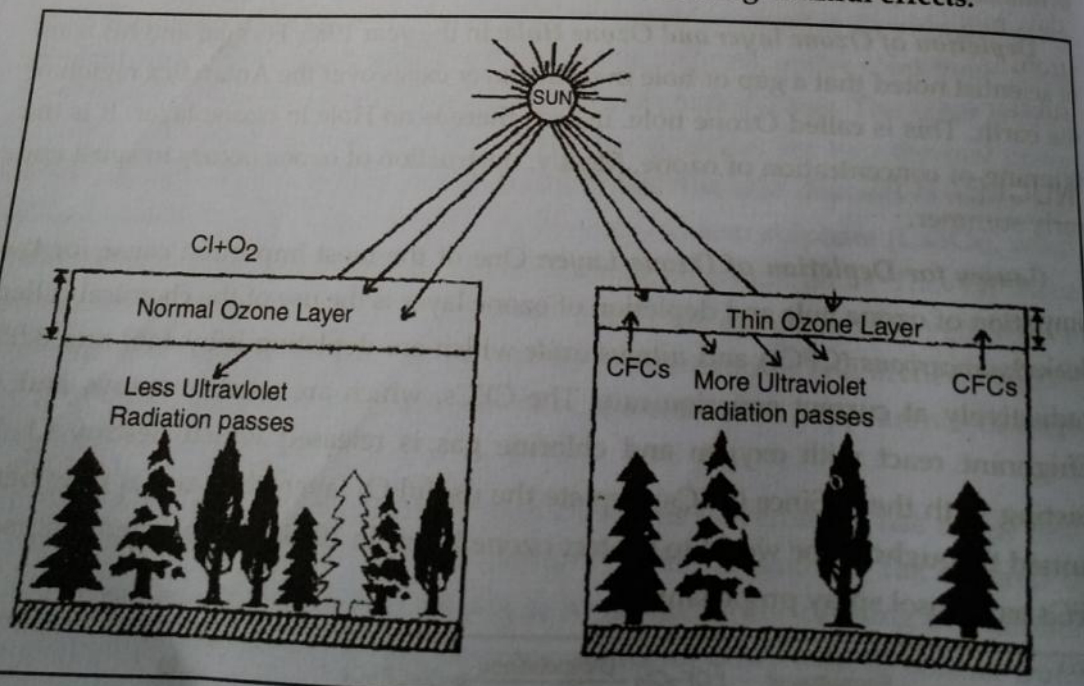


FIG. Effect of CFCs on the Ozone layer: (A) Normal ozone layer, so less UV rays reach the earth (B) Depleted ozone layer, so more UV rays reaches the earth.

(i) Increase in UV radiation will result in the increase of skin cancer among human being and animals.

(ii) The increase in UV radiation will reduce the photosynthetic pigment of the plant.

(iii) UV radiation suppresses the immune system of the body and many more diseases will develop in the body.

(iv) Increase of UV radiation will also kill many plants and animals and thus food chain will be disturbed and consequently ecosystem will also be affected.

(v) Increase in UV radiation will increase the CO_2 near the surface of the earth which will result in global warming.

(vi) Degradation of paints, plastic and other polymers will result in economic loss due to effect of UV radiation.

Ozone depletion and action plan

Due to increase in concentration of CFC's, ozone layer is being depleted day by day. Montreal Protocol held (also called Ozone treaty) in 1987, has come into force from 1st January 1989. The main aim of this treaty was to eliminate ozone depleting substances i.e. CFCs at uniform rate. 48 Nations are signatory to this treaty.

NUCLEAR ACCIDENTS AND HOLOCAUST

Leakages of radioactive materials from nuclear plants always have disastrous impacts on human beings. Nuclear plants are designed in such a way that there is no leakage. However, no nuclear plants are cent percent leakage proof. The leakage of radioactive materials from Three Mile Island nuclear plant of USA in 1979 and Chernobyl nuclear plant of USSR in 1986 are the examples of nuclear accidents. Disposal of nuclear wastes such as spent nuclear fuel is very difficult. There is no suitable method. It is very costly affairs. Large amount of radioactive wastes are produced every year. There radioactive wastes escape into the atmosphere and prove disastrous. The most significant effect of radioactivity i.e. γ – rays released by radio-active substances, is that is causes long-term effects, affecting the future of man and ultimately future of our civilization.

In nuclear plant, radio-active substances such as Uranium, Thorium and Plutonium etc. are employed. In nuclear reactions, additional radio-active substances are generated. These reactions follow first order kinetics. It means their radio-activity is never lost, irrespective of the low or high values of their half life periods. Nuclear wastes have long term ill effects on animals and plant.

Montreal Protocol

It was held in 1987 on substances that deplete O_3 layer i.e. Ozone Depleting Substances (ODS).

Landmarks: International agreement designed to protect stratosphere O_3 layer. The earlier negotiations held at Vienna in 1985 and details of Vienna convention were defined Montreal Protocol (M.P.) is 1987.

This treaty became effective from 1st Jan 1989.

It provides for cutting down level of substances like chloro-flow hydrocarbon (CFC's) Halons, CCl_4. $CHCl_3$ and methyl chloroform as:

(a) CFC's, Halons, CCl_4. They were supposed to be reduced by 2000, $CHCl_3$ etc. was supposed to be reduced by 2005.

Developing countries like India, Malaysia, and Israel – refused to rectify the Montreal Protocol because:

(i) Developing countries use them medicines, vaccines, development etc. but developed countries use them for luxuries like aerosols.

(ii) Great amount of cost to shift over to new technology.

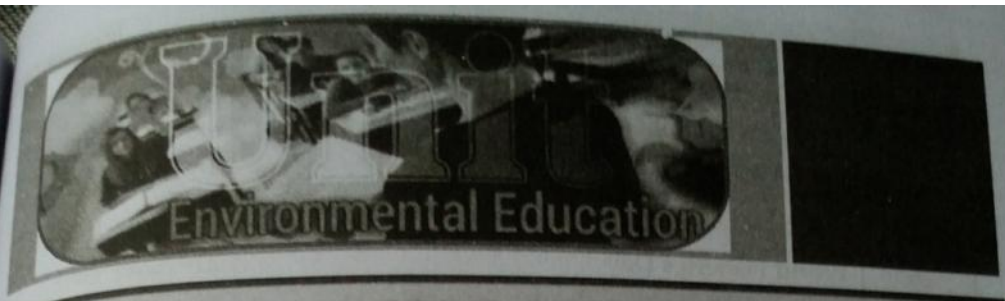
This Montreal Protocol was amended twice.

(i) In 1990 at London (ii) In 1992 at Copenhagen

In 1992, at Copenhagen, countries have agreed to stop production of ozone depicting substances CCl_4. Halons, CFC's, HCFC's etc.

Though CFC's are not completely eliminated, developed countries are manufacturing CFC's for developing countries.

Use of CFC's is allowed for use in developing countries – where no other substitute is available and the substitute if available is expensive.



IMPORTANT DAYS

1.	Wet Land Day	2nd February
2.	National Science Day	28th February
3.	International Women Day	8th March
4.	World Handicapped Day	15th March
5.	World Forest Day	21st March
6.	World Water Day	22nd March
7.	National Maritime Day	5th April
8.	World Health Day	7th April
9.	World Heritage Day	18th April
10.	World Earth Day	22nd April
11.	Asthma Day	1st May
12.	International Biodiversity Day	22nd May
13.	Anti Tobacco Day	31st May
14.	World Environment Day	5th June
15.	World Day to Combat Desertification and Draught	17thJune
16.	Vanmahautsav Week	1-7 July
17.	World Population Day	11th July
18.	World Literacy Day	8th September
19.	World Ozone Day	16th September
20.	World Wild Life Day	1st October
21.	World Nature Day	3rd October

7. You should not run after gains at the cost of nature.
8. Do not prohibit the right of future generation to live in a clean and safe environment.
9. Consume the natural resources in moderate amounts so that all may share this treasure.
10. Even our ancient Vedas and Upanishads advocate the ecological and environmental values e.g.

"The whole universe together with its creatures belongs to the Lord (Nature) ..... Let no one species encroach over the rights and privileges of other species. —***Isha Upanishad***

So environmental ethics demand that man should learn to live as a part of nature and not as a master of nature. He must make sincere efforts to renew the natural resources so that all species may survive in nature.

Environment Laws: Salient features

Q. Write the salient features of the Environment Protection Act, 1986.

Ans. Environment (protection) act, 1986: In response to the 1972 United Nations Conference on the Human Environment at Stockholm, India enacted 'The Environment (Protection) Act, 1986' and the corresponding 'Environment (Protection) Rules, 1986'. This is a general enactment that empowers the Central Government to prevent, control and abate environmental pollution. For the effective implementation of the Act, the various provisions of this Act have been amended from time to time. The salient features of the Environment (Protection) Act, 1986 are briefly discussed as under:

Objectives of the Act

The objectives of the Act are:

(a) protection and improvement of the environment;

(b) prevention of hazards to all living creatures (plants, animals and humans) and property; and

(c) maintenance of harmonious relationship between humans and their environment.

Important Terms Used In The Act

(a) Environment— according to the Act 'includes water, air and land and the interrelationship which exists among and between

water, air and land, and human beings, other living creatures, plants, micro-organisms and property'.

(b) *Environmental Pollutant*— according to the Act' includes any solid, liquid or gaseous substance present in such concentrations as may be injurious to environment'.

(c) *Environmental Pollution*— means 'the presence of any environmental pollutant in the environment'.

(d) *Hazardous Substance*— means any substance which is liable to cause harm to human beings, other living creatures and property or environment by reason of its chemical or physio-chemical properties or handling'.

Details of the Act

I. General Powers of the Central Government. For the protection and improvement of environment, and for the prevention, control and abatement of environmental pollution, the Act (under Section 3) empowers the Central Government to take following measures

(a) To co-ordinate actions of State Government Officers and other authorities under this Act and under any other related law.

(b) To plan and execute a nationwide programme for the prevention, control and abatement of environmental pollution.

(c) To lay down standards for the quality of environment in its various aspects and for emission or discharge of environmental pollutants from different sources. These standards are provided in the schedule to the Environment Protection Rules, 1986.

(d) To demark and segregate industrial areas from non-industrial ones.

(e) To lay down procedures and safeguards for the handling of hazardous substances for prevention of accidents causing environmental pollution and remedial measures.

(f) To examine the manufacturing processes materials and substances likely to cause environmental pollution.

(g) To inspect any premises, plant, manufacturing process, equipment or machinery and give directions to prevent, control and abate environmental pollution.

(h) To establish and recognize environmental laboratories and institutes to evolve standardized methods for sampling and analysis of various types of environmental pollutants, to analyse samples, to carry out investigations, to lay down standards for the

quality of environment and discharge of environmental pollutants, to monitor and enforce the standards set, and to report periodically to the Central Government.

(i) To carry out and sponsor investigations and research in environmental pollution problems.

(j) To prepare manuals, codes or guides to disseminate collected information in matters relating to environmental pollution and its prevention, control and abatement.

(k) To take up any matter, necessary or expedient for the implementation of the provisions of this Act.

(l) To constitute an authority, if necessary, for the purpose of performing such functions and powers of Central Government under Section 4.2 of this Act.

Further, to regulate environmental pollution, the Central Government may, by notification in the official gazette, make rules in respect of all or any of the matters referred to in Section 3 above (from a to I) under Section 6.3.

II. Provisions for the Prevention, Control and Abatement of Environmental Pollution:

For the prevention, control and abatement of environmental pollution, the Act has following important provisions:

(a) Under Section 7.1— 'no person carrying on any industry, operation or process shall be permitted to discharge any environmental pollutant in excess of the prescribed standards'.

(b) Under Section 8.2— 'no person shall handle hazardous substances without complying with the prescribed procedural safeguards'.

(c) Under Section 9.3—'a person is responsible to mitigate environmental pollution and to intimate any occurrence relating to environmental pollution to the concerned authorities and also assist those authorities in preventing or mitigating environmental pollution'.

(d) Under Section 10— 'the Central Government and its officers have the power to enter and inspect any place for the purpose of performing any function entrusted under the legislation'.

(e) Under Section 11— 'the Central Government and its officers have the power to take samples of air, water, soil or substances

from the factory or place, for analysis according to the laid down procedures in the Act'.

(f) Under Section 12 'the Central Government has the power to establish environmental laboratories or recognise any laboratory or institute as an environmental laboratory'.

(g) Under Section 13— 'the Central Government may appoint or recognise government analysts for the purpose of analysis of samples of air, water, soil or any other substance'.

(h) Under Section 14— 'the report signed by a government analyst may be used as an evidence of the facts stated therein in any proceedings under the legislation'.

The Act also made it clear that the expenses incurred with respect to remedial measures shall be recoverable from the persons responsible'.

III. Penalties for Violating the Provisions in the Act

(a) Under Section 15.5, any person violating any of the provisions of the Act shall be punishable with imprisonment for a term which may extend upto five years or with a fine which may extend to one lakh rupees or both.

In case the violation continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term of seven years.

(b) Under Section 16, the criminal liability is also fixed on the company's directors and principal officers in case of an offence being committed by a company.

(c) Under Section 17, the criminal liability is also fixed on the heads of department of government where an offence is committed by the concerned department and the head of the department is unable to prove that the offence was committed without his knowledge or that he exercised all diligence to prevent such an offence.

Air (prevention and control of pollution) Act. 1981

Q. Discuss, in brief, the salient features of the Air (Prevention and Control of Pollution) Act, 1981.

Ans. Air (prevention and control of pollution) act, 1981 Air pollution, it seems, has come to the notice of the legislature a little later than water pollution. The delay of about seven years could be attributed to this. It is interesting to note that the control of water pollution was India's own initiative, while the measures on air pollu-

tion came only as a response to the 1972 Stockholm Conference. The United Nations Conference on the Human Environment at Stockholm in 1972 asked all participating states to take appropriate steps for the preservation of natural resources of the Earth, including the preservation of the quality of air and control of air pollution. The salient features of this Act are briefly described as under

Objectives of The Act

The objectives of the Act are:

(a) prevention, control and abatement of air pollution;

(b) maintaining the quality of air; and

(c) establishment of Boards for the prevention and control of air pollution.

Important Terms Used in the Act

(a) Air Pollution-according to the Act means 'the presence in the atmosphere of any air pollutant'.

(b) Air Pollutant-means 'any solid, liquid or gaseous substances (including noise) present in the atmosphere in such concentrations as may be or tend to be injurious to human beings or other living creatures or property or environment'.

(c) Control Equipment according to the Act means 'any apparatus, device, equipment or system to control the quality and manner of emission of any air pollutant and includes any device used for securing the efficient operation of any industrial plant'.

Constitution and Functions of Boards

In order to have an integrated approach for tackling the problems related to pollution, the Air (Prevention and Control of Pollution) Act, 1981 provides that the Central and State Pollution Control Boards established under the Water (Prevention and Control of Pollution) Act, 1974 shall also act as Air Pollution Control Boards under this Act. But in those states in which State Pollution Control Boards for water pollution are not established, separate State Boards for Air Pollution Control will be established. Also, the provisions regarding the Board's composition, essential qualifications of members, meetings, committees, etc. are identical to those relating to the Boards under the Water (Prevention and Control of Pollution) Act;

The functions of the Central and State Pollution Control Boards for the Control of air pollution are also identical to the func-

tions of the Central and State Pollution Control Boards for the control of water pollution, except that they aim to control air pollution instead of water pollution.

Powers of the Boards

The Central and State Pollution Control Boards established under the Water (Prevention and Control of Pollution) Act, 1974 exercise powers in relation to air pollution as well.

(a) Under Section 19.1, the State Government, after consultation with the State Pollution Control Board, may

(i) declare any area or areas as Air Pollution Control Areas by notification in the official gazette;

(ii) prohibit the use of any fuel or appliance causing or likely to cause air pollution in an Air Pollution Control Area; and

(iii) prohibit burning of any material causing or likely to cause air pollution in an Air Pollution Control Area.

(b) Under Section 20.2, the Boards have the power to ensure that the laid down emission standards of air pollutants from automobiles are complied with.

(c) Under Section 21.3, no person shall, without the previous consent of the State Pollution Control Board, establish or operate any industrial plant in an Air Pollution Control Area.

(d) Under Section 22.4, no person operating any industrial plant in any Air Pollution Control Area shall discharge or cause or permit to be discharged, the emission of any air pollutant in excess of the laid down standards by the State Pollution Control Boards.

(e) Under Section 24.5, any person empowered by the State Pollution Control Board shall have the right to enter any place for;

(i) performing any of the functions of the Board entrusted to him;

(ii) examining and testing any industrial plant, record, register, document, control equipment, etc.; and

(iii) seizing any such control equipment, if he has reasons to believe that it may' furnish evidence of an offence punishable under the Act.

(f) Under Section 26, any person empowered by the Board shall have the power to take samples of air or emission from any chimneys duct or flue, etc. for the analysis purpose and send the same to

(c) establishment of Central and State Boards for the prevention and control of water pollution.

Definition of 'pollution'

In this Act, 'pollution' has been elaborately defined as, "the contamination of water, or the alteration of the physical, chemical or biological properties of water, or the discharge of any sewage or trade effluent (whether directly or indirectly) which is likely to render such water harmful or injurious to:

(a) Public health or safety.

(b) Domestic, commercial, industrial, agricultural or other uses.

(c) Life and health of plants, animals or aquatic organisms.

Constitution, functions and Powers of boards

The 1974 Act provides for Central Pollution Control Board (CPCB) as also State Pollution Control Boards (SPCBs). The CPCB has a full-time Chairman (to be nominated by the Central Government; while an SPCB may have a full-time or a part-time Chairman (to be nominated by the State Government). There can also be joint Boards between any two Governments. A board may constitute as many committees as necessary for effective implementation of the various provisions of the Act. Under Section 8, the Act directs the Boards to have at least one meeting in every three months.

Constitution of central pollution Control board

According to Section 3, the CPCB shall consist of the following members

(a) A full time Chairman having knowledge or practical experience in matters related to environmental protection or having knowledge and experience in administration of institutions dealing with such matters.

(b) A full-time Member-Secretary (to be appointed by the Central Government) having knowledge and experience of scientific engineering or management aspects of pollution control.

(c) Not more than five officials nominated by the Central Government.

(d) Not more than five persons nominated by the Central Government from amongst the members of State Pollution Control Boards.

(e) Not more than three non-officials nominated by the Central Government to represent the interests of agriculture, fishery, etc.

(f) Not more than two persons nominated by the Central Government to represent the companies or corporations owned by the Central Government.

Constitution of State Pollution Control Boards: According to Section 4 of this Act, the State Pollution Control Board may be constituted having same constitution as the Central Pollution Control Board.

Constitution of joint Pollution Control Board: According to Section 14 of the Act, under agreement between two or more contiguous States, joint Pollution Control Board may be constituted for those states by the Central or State Governments.

Functions of the Central Pollution Control Board: Under Section 16-A, the functions of the Central Pollution Control Board are:

(a) Advising the Central Government on matters regarding the prevention and control of water pollution.

(b) Co-ordinating the actions of the State Pollution Control Boards and resolving disputes among them, if and when arise.

(c) Providing technical assistance and guidance to the SPCBs in carrying out research in prevention and control of water pollution.

(d) Organising training for persons engaged in pollution control.

(e) Organising comprehensive programme for water pollution control through mass media.

(f) To set standards, verify, modify or annual them as and when necessary, for streams or wells.

(g) Preparing manuals, codes or guides for treatment and disposal of sewage and trade effluents.

(h) Compiling and publishing technical and statistical data relating to water pollution.

(i) Establishing and recognizing laboratories for analysis of water samples from any stream, well or trade effluent.

Functions of the State Pollution Control Boards: According to Section 7-B, the functions of the SPCB are:

(a) To plan a comprehensive programme for the prevention, control and abatement of pollution of streams/rivers and wells.

(b) To advise the State Government on matters concerning water pollution control or location of industrial units.

(c) To collaborate with the CPCB for training personnel engaged in water pollution control programmes.

(d) To collaborate with the CPCB for organising educational programs spreading information for water pollution control through mass media.

(e) To promote and conduct research on the subject towards evolving economical and reliable methods of the sewage treatment and trade effluents, disposal of sewage, etc.

(f) To prescribe the, effluent standards for the sewage and trade effluent to be discharged into any stream or on land.

(g) To inspect trade effluents and wastewater treatment plants.

(h) To establish or recognise laboratories for analysis of water samples from any stream/river, well or trade effluent.

(i) To perform such functions as may be assigned or entrusted by the CPCB or State Governments.

Powers of the State Governments:

(a) Under Section 20.2, the State Pollution Control Board may carry out surveys, take measurements or seek information for the purpose of performing functions under this Act.

(b) Under Section 21(1)A, the State Government has the power to collect samples of water of any stream or well or any effluent being discharged into such a stream or well, for analysis.

(c) Under Section 22.4, the SPCB has the power to obtain a report of the results of the analysis by a recognised laboratory.

(d) Under Section 23.5, the SPCB is empowered by the State Government to enter any place for the purpose of performing any of the functions entrusted to it.

(e) *Under Section* 24.6,

(i) no person shall knowingly avow the entry of any matter into any stream, which may impede the proper flow of water resulting in substantial aggravation of water pollution.

(ii) no person shall knowingly allow the entry of any toxic, noxious or polluting matter , directly or indirectly into any stream, well or sewer or on land.

(f) *Under Section* 25.7,

(i) no person shall establish any industry, operation or, any treatment disposal system, which is likely to" discharge any sewage or effluent into stream or on land.

(ii) no person shall begin to make any new discharge of sewage

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(iii) no person shall use any new outlet for discharge of sewage.
(g) The Board can also levy and collect a cess on water consumed by industries and authorities for increasing its (Board's) resources under the Water (Prevention and Control of Pollution) Cess Act, 1977.

Penalties for Violating the Provisions of the Act:
(a) in case of failure to provide information by a person discharging effluents into streams or well or regarding construction or establishment of an effluent disposal system, the penalty is imprisonment upto three months or fine upto Rs. 10,000.00 of both. If the omission continues, tie offender is penalised with an additional fine upto Rs. 5,000.00 per day.
(b) In case of violation of order prohibiting discharge of any polluting matter into stream, well or land, or violation of Board order of closure of industry or stoppage of electricity or water supply, etc., the penalty is imprisonment for one and a half years to six years or fine or both. If the violation continues, the penalty is an additional fine of Rs. 5,000.00 per day; and if it continues beyond one yelr, then the penalty is imprisonment of two to seven years on conviction. And the name of the offender is published in newspapers at offenders expense.
(c) In case of destroying or damaging the property of the Board, obstructing the functions of the Board, failure to provide information about accidents under Section 31, giving wrong information or making false statements to get Board's consent, the penalty is imprisonment upto three months or fine upto Rs. 10,000.00 or both.

WILDLIFE PROTECTION ACT

Q. Discuss the salient features of Wild life Protection Act.

Ans. Wildlife protection act: India is a signatory to the Convention on International Trade in Endangered Species of Wild Flora and Fauna. Under this treaty, export or import of endangered species of flora and fauna are subject to strict control and commercial exploitation of such species is prohibited.

Although India had Madras Wild Elephant Preservation Act in 1873, All India Elephant Preservation Act in 1879, The Wild Birds and Animals Protection Act in 1912 and Bengal Rhinoceros Preservation Act in 1912; but after Independence, India came about