JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

II Year B.Tech. CSE-II Sem

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(A40009) ENVIRONMENTAL STUDIES

UNIT I: ECOSYSTEM:

Definition, Scope and Importance of ecosystem. Classification, Structure and function of an ecosystem, Food chains, food webs and ecological pyramids Energy flow in the ecosystem, Biogeochemical cycles, Bioaccumulation, Biomagnifications, Ecosystem value, services and carrying capacity, field visits.

UNIT II: NATURAL RESOURCES:

Classification of Resources: Living and Non-living resources.

Water resources: Use and over utilization of surface and ground water, Floods, drought. Dams: benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Land resource: *forest resources.*

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.

UNIT III: BIODIVERSITY AND BIOTIC RESOURCES:

Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot-spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Conservation of biodiversity: insitu and Ex-situ conservation. National biodiversity act.

UNIT IV: ENVIRONMENTAL POLLUTION and CONTROL TECHNOLOGIES:

Environmental pollution: Classification of pollution

Air pollution: Primary and secondary pollutants, automobile and industrial pollution, ambient air quality standards.

Water pollution: Sources and types of pollution, drinking water quality standards.

Soil pollution: Sources and types, impact of modern agriculture on soil, degradation of soil.

Noise Pollution: Sources and Health hazards, standards, methods of control of noise.

Solid waste: Municipal solid wastes composition and characteristics of e-Waste and its management

Pollution control technologies: waste water treatment methods: primary, secondary and tertiary treatment effluent treatment plants (ETP).

Overview of air pollution control technologies, concepts of bioremediation.

GLOBAL ENVIRONMENTAL PROBLEMS AND GLOBAL EFFORTS: Climate change and their impacts on human environment, Ozone depletion and Ozone depleting substances (ODS. Deforestation and desertification. International Conventions/Protocols: Earth summit, Kyoto protocol and Montreal Protocol.

UNIT V: ENVIRONMENTAL POLICY, LEGISLATION & EIA

Environmental Protection Act, Legal aspects Air (Prevention and Control of pollution) Act -1981, Water (Prevention and Control of pollution) Act -1974, Forest Conservation act, wild life act, Municipal Solid Waste Management and handling rules, Biomedical Waste Management and handling rules, Hazardous Waste Management and handling rules.

EIA: EIA structure, methods of baseline data acquisition. Overview on impacts of air, water, biological and socio-economical aspects. Strategies of risk assessment, concept of Environmental Management Plan (EMP).

TOWARDS SUSTAINABLE FUTURE : Concept of Sustainable Development, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, concept of Green Building, Ecological Foot print, life cycle assessment, low carbon life style.

ENVIRONMENT

The word environment is derived from an old French word "ENVIRON" means *encircle.* In real world every thing that affects an organism during its lifetime is collectively known as its Environment.

For example, during its lifetime an animal such as rat is likely to interact with millions of other organisms (bacteria, food organisms, parasites etc.), drink abundant amount of water, breath huge quantities of air, and respond to daily changes in temperature and humidity, which will become the various components that make up the environment.

"Environment" – means 'surroundings'. The environment is a complex of so many things (Light, temperature, water, air, soil, etc.,), which surrounds an organism.

The global environment consists of three main sub-divisions:

1. The **HYDROSPHERE**, which includes all the water (liquid) component of the oceans, sea, rivers and other inland waters.
2. The **LITHOSPHERE** comprising the solid components of the earths crust, i.e., rocks, soil and minerals of the continents and other land masses.
3. The **ATMOSPHERE** formed of the gaseous cover which envelopes the hydrosphere and the lithosphere. The entire inhabited part of the earth and its atmosphere including the living and the nonliving components forms the **BIOSPHERE**. Thus, biosphere is the combination of all ecosystems or identifiable units of the earth's environment.

Species: A group of organisms that can interbreed and produce fertile offspring.

Population: A group of organisms of the same species living in the area at the same time and which are capable of interbreeding.

Habitat: Environment in which a species normally lives. Includes abiotic factors.

Niche: It is where, when and how an organisms lives. Species habit and the resources in it. It depends not only on where it lives but what is does.

Community: A group of population living and interacting with each other in a common habitat.

Biome: collection of ecosystems that share similar climatic conditions. It is the largest terrestrial community. Rainfall, temperature range, nature of soil, barriers, latitude and altitude determine the nature and extent of biome. e.g., tundra, northern conifer forest, deciduous forest, tropical rain forest, grassland, deserts etc.

Trophic level: Position that an organism occupies in a food chain. A group of organisms in a community that occupy the same position in a food chain.

Limiting factor: it is anything (biotic or abiotic) that slows or limits the growth of population. Eg. Water, food, air, space, shelter, competition, hunters, predators, light, mates, disease, climate, seasons, etc.,

UNIT-I: ECOSYSTEMS

CONCEPT OF AN ECOSYSTEM

'Eco' implies the environment;

'System' implies an interacting, inter-dependent complex.

Ecology is the study of interactions between organisms and their environment. Ecosystem is the basic functional unit of ecology.

Any unit that includes all the organisms i.e. the communities in a given area, interact with the physical environment so that a flow of energy leads to clearly defined tropic structure, biotic diversity and material cycle (i.e. exchange of materials between living and non-living components) within the system is known as ecological system or ecosystem.

TYPES OF ECOSYSTEMS:

The kind of organisms, which can live in a particular ecosystem, depends upon their physical and metabolic adoptions to the environment of that place/ ecosystem. The set of ecosystems is called a biome.
The biosphere, there are - natural and artificial biomes.

1. Natural ecosystems (biomes): Naturally ecosystems operate by themselves under natural conditions without any interference by man. On the basis of particular type of habitat, they are further sub-divided as:

- **a. Terrestrial biomes (ecosystems):** They are often defined by the vegetation types that dominate the community. This types of vegetation affect the climate and soil structure and thus characterize the particular biome. Terrestrial vegetation has a rapid exchange of oxygen, water and carbon dioxide. The CO_2 concentration is affected by terrestrial vegetation seasonally and annually. Terrestrial biomes include tropical rain forests, grasslands, deserts, cultivated lands etc.
- **b. Aquatic biomes (ecosystems):** They fall into two categories, viz., and freshwater and marine water. Fresh water biomes may be lotic (running-water) such as streams, rivers and springs; or lentic (standing-water) such as lakes, ponds, and swamps. Whereas marine biomes include deep sea and oceans.

2. Artificial ecosystems (biomes): They are maintained artificially by man. A pond constructed as part of a waste water treatment plant is an example of artificial ecosystem. And other examples are croplands, aquarium, aquaculture ponds etc.

Structure and function of an Ecosystem/ organization of an ecosystem:

The structure and function are the two major aspects of an ecosystem.

Structure means:

1. The composition of biological community including species, numbers, biomass, life history and distribution in space etc.
2. Quantity and distribution of the non-living material, such as nutrients, water, soil etc.
3. Range or gradient of conditions of existence, such as temperature, light etc.

Function means:

1. The rate of biological energy flow i.e., the production and respiration rates of the community.
2. Rate of materials or nutrient cycles, and
3. Biological or ecological regulation including both regulation of organisms by environment (photoperiodism etc) and regulation of environment by the organism (nitrogen fixing organisms etc)

Structure of an Ecosystem

Ecosystem has two major components:

i. Abiotic (non-living) component:

The non-living factors or physical environment prevailing in and ecosystem form the abiotic components. They have a strong influence on the structure, distribution, behavior and inter-relationship of organisms.

Abiotic components are mainly of two types:

a. **Climatic Factors**: which includes rain, temperature, light, wind, humidity etc.,
b. **Edaphic Factors**: which includes soil, pH, topography, minerals etc.,

Temperature: Living organisms can survive only in a narrow range of temperature which allows their metabolism. Whenever they live the organisms must develop physiological and behavioral adaptions to withstand extremes of temperature. The polar bear can live in very cold regions and hibernates during winter to avoid extreme cold. Some desert animals live inside burrows to avoid the intense heat of desert.

Water: Water is an essential requirement of life. No life can exist without water. A large number of organisms live only live in water. The requirement of varies from organism to organism. The distribution depends upon the extent of the need and special adaptations of conserving water.

Organisms which are capable of containing or avoiding strong water currents only can survive in the rivers and streams. Animals that can't actively swim live under stones or in burrows and crevices. Animals with attaching devices only can thrive in fast currents, plants found in fast flowing water have finely divided or ribbon shaped leaves.

Light: It is essential for photosynthetic organisms for the preparation of food, on which the rest of the living world depends. Plants show various adaptations for obtaining optimum light. Most animals are sensitive to light. Many animals have special PHOTORECEPTORS. The rhythm of functioning of a large number of organisms is modulated by light. E.g., cockroaches, moths and bats are active during the day. Many leguminous plants have leaves that fold up or droop at night.

Humidity: The humidity in the atmosphere directly regulates the rate at which water evaporates from the body surface of land organisms by transpiration, perspiration and other means. Different plants and animals show various adaptations to withstand dry conditions.

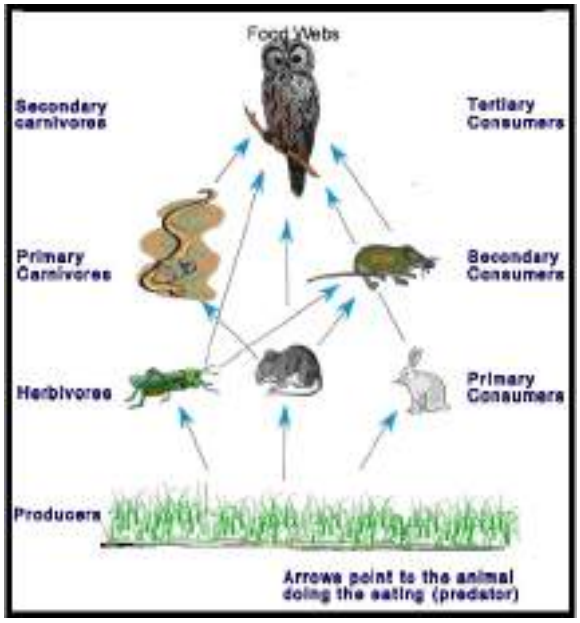
Wind: Apart from determining weather conditions air currents particularly affect plants. Wind determines the rate of transpiration. Where wind velocity is very high, only the plants with strong root system and tough stems can survive. Wind also helps in the dispersal of seeds and fruits.

pH: Most organism thrive in an optimal pH range. Some plants and aquatic animals require acidic conditions, other need neutral or alkaline conditions. pH of the soil and water has a strong influence on the distribution of organisms.

Mineral Elements: Availability and concentration of essential mineral elements control the distribution of microbes and plants and animals. Plants living in the soil deficient in nitrogen have developed special adaptations for obtaining it, such as, harboring nitrogen-fixing bacteria and the carnivorous habit. High concentration of minerals can limit the distribution of organisms. Salinity in soil or in water greatly affects the distribution of organisms.

Topography: Topography or surface configuration of an area (physical features such as hill, plain of slopes) influences distribution of organism's as much as wide geographic separation. Topographical effect may be direct. It also indirectly affects other factors like wind, water current and light or wave action. The center and edge of a pond or a stream, top-side and under-side of rock, north and south face of a ridge of a wall are generally inhabited by different species of organisms.

Background: The back ground of habitat also determines the distribution of animals by enabling them to camouflage against the color, general texture and pattern. E.g., desert animals like the lion and the camel are sand colored. Most of the jelly fishes, sea cucumbers are glassy. The chameleon can change its colour according to its background.



ii. Biotic(living) components:

Trophic (nutritional) standpoint, an ecosystem has two components:

1. Autotrophic component:

Autotrophs presence of sunlight using simple inorganic substances and built up of complex substances. The component is constituted by green plants, including photosynthetic bacteria. Members of the autotrophic components are known as 'producers'.

2. Heterotrophic components:

In which utilization, rearrangement and decomposition of complex materials. The organisms involved are known as 'consumers', as they consume the matter built up by the producers.

These consumers are further categorized as-

a. *Macro consumers:* is further categorized as-

1. **Primary consumers (Herbivores):** they feeding on grass, plant leaves etc. are mainly such grazing animals as cows, buffaloes, deer's, sheep, rabbit, mouse etc. Besides that there are also present some insects, termites, millipedes etc. that feed on the leaves of grasses.
2. **Secondary consumers (Carnivores): These** are the carnivores feeding on herbivores. These include the animals like fox, jackal, snakes, frogs, lizards, birds etc.
3. **Tertiary consumers (carnivores/omnivores):** These are the carnivores like lion, tiger etc. that eat secondary consumers.

b. *Micro consumers*: These are popularly known as 'decomposers', include bacteria, actinomycetes and fungi. They breakdown complex compounds of dead or living protoplasm, absorb some of the decomposition or breakdown products and release inorganic nutrients into environment, making them again to autotrophs.

Function of an Ecosystem

The function of ecosystem is related to energy flow and material cycles within and outside of the system.

Fixation of energy: Utilizes solar energy (2 calories/cm^2/minute) in photosynthesis.

Photosynthesis by autotrophs:

$$6CO_2 + 6\,H_2O \xrightarrow[\text{Chlorophyll}]{\text{Solar energy}} \underset{\text{glucose}}{C_6H_{12}O_6} + 6O_2 + \text{energy}$$

This sugar has several destinations.

1. Storage: Sugar can be converted into an inert, energy rich organic substance as starch.
2. Sugar combines with other molecules to form specialized carbohydrates as cellulose.
3. Sugar can combine with N, P, S, to build complex molecules like proteins, nucleic acids, pigments, hormones etc.
4. Oxidation of sugar yields usable energy which is released into the ecosystem.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{usable energy 686 K.cal}$$

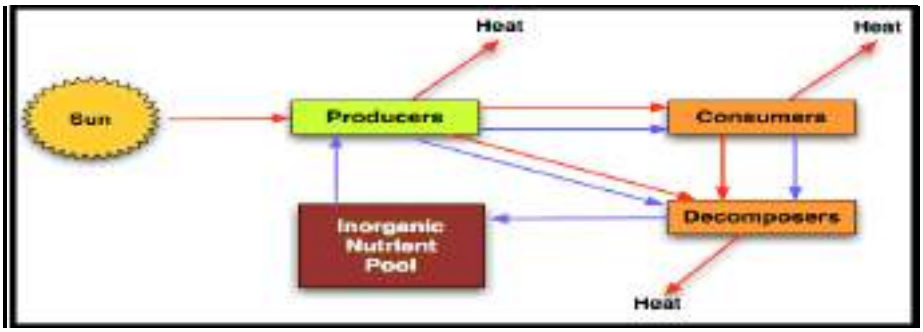
Energy flow in an Ecosystem:

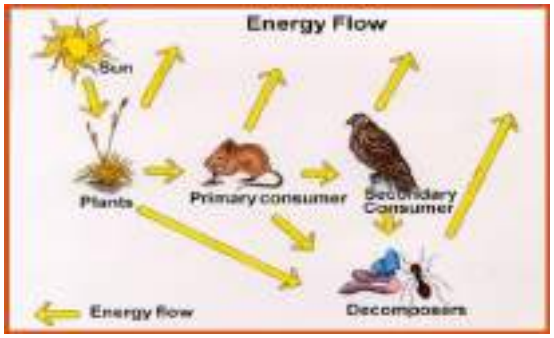
Energy flow is the movement of energy through an ecosystem from the external environment through a series of organisms and back to the external environment. It is one of the most fundamental processes that are common to all the ecosystems. Energy flow in an ecosystem, in fact, tells us about the very ecosystem, the energy flow provides a foundation for life and thus imposes a limit on the abundance and richness of life.

The behavior of energy in ecosystem can be treated energy flow due to unidirectional flow of energy.

From energetic point of view it is essential to understand for an ecosystem:

1. The efficiency of the producers in absorption and conversion of solar energy.
2. The use of this converted chemical form of energy by the consumers,
3. The total input of energy in form of food and its efficiency of assimilation,
4. The loss through respiration, hear, excretion, etc. and
5. The gross net production.





Energy flow is two types: 1.Single channel flow 2.Y-shaped energy flow

1. Single channel energy flow: The grazing food chain beginning with green plant base going to herbivores and then to carnivores.

Autotrophs	⇒	Herbivores	⇒	Carnivores
G.P: 111 g.cal		G.P: 15 g.cal		G.P: 3 g cal
Not utilization		Not utilization		Not utilisation
70 g.cal		7.0 g.cal		1.2 g.cal
Respiration		Respiration		Respiration
23 g.cal		4.5 g.cal		1.8 g.cal

(G.P :Gross production)

2. Y- shaped energy flow:

The detritus food chain beginning with dead organic matter acted by microbes, and then passing to detrivores and their consumers (predators).

ECOLOGICAL SUCCESSION:

It is defined as the process in which communities of plant and animal's species in a particular area are replaced over time by a series of different and often more complex communities.

Classification of succession

Two types of ecological succession are:

1. Primary Succession
2. Secondary Succession

Primary Succession

The succession taking place in areas that have not already been occupied by any community is known as primary succession. E.g. Volcanic lava creates new land and Glaciers' retreating exposes new land.

The first group of organisms established in such area is called as pioneer community. E.g. Moss, lichen grows on bare rock.

Rock → lichen → moss → grass → trees → forest

Secondary Succession

Development of a new community in an area where the previously existing community was removed and ecological conditions are favorable is termed as secondary succession.

e.g., abandoned crop lands, ploughed fields, flash fire forest etc.,

Process of succession

Process of succession includes the following stages;

Pioneer → Seral Stage I → Seral Stage II → Seral Stage III → Seral Stage IV → Climax

Pioneers

Pioneer is the first stage to migrate and become established in a bare area from the surrounding area in either primary or secondary succession.

The individual organisms of such community are called pioneer species and such community is known as pioneer community.

Seral stage

Seral stage is defined as the development of secondary community from the pioneers. Each seral stage appears, grows and finally dispears as the environmental changes occur. Each seral stage has its particular community called seral community.

Climax

A community finally appears that is not supported by another one, as long as major climatic changes do not occur. This relatively stable community is called climax community.

FOOD CHAIN:

Used to show how matter and energy move through an eco system. The linkage of who feeds on whom. It is simple. In any food chain, energy flows from primary producers to primary consumers (herbivores), from primary consumers to secondary consumers (carnivores), and from secondary consumers to tertiary consumers (carnivores/omnivores) and so on.This simple chain of 'eating and being eaten away' is known as food chain.

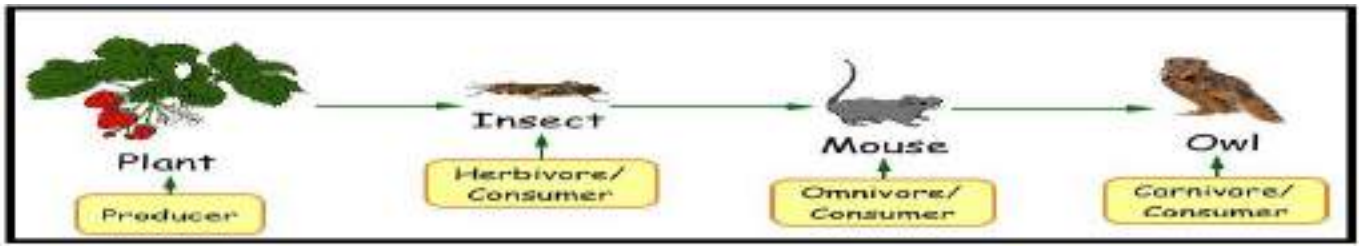
The length of the chain denotes the complexity of ecosystem.

Ex: Grass → Insects → Frog → Snake (in grassland)

Two types of food chains:

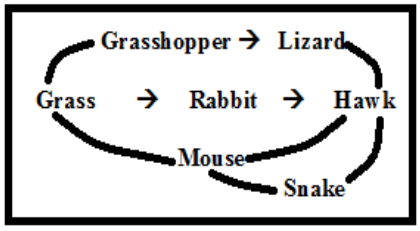
1. Grazing food chain: starts from living green plants. Ex.

Grass → Insects → Frog → Snake (in grassland)



2. Detritus food chain: This food chain goes from dead matter into micro organisms. Ex.

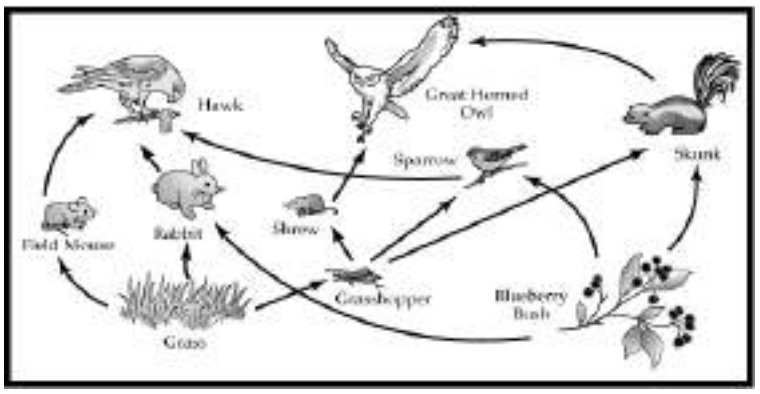
Mangrove leaves → Micro organisms (bacteria, fungi) → insect larvae → Amphipods → Small game fish → fish eating birds.



FOOD WEB:

Shows all the possible food chains in and ecosystem. It is complex. Food chains in natural conditions never operate as isolated sequences, but are interconnected with each other forming some sort of inter locking pattern, which is referred to as a food web.

Ex. Grassland ecosystem: in this five linear food chains are interlinking form food web.



Grass → Grasshopper → Hawk

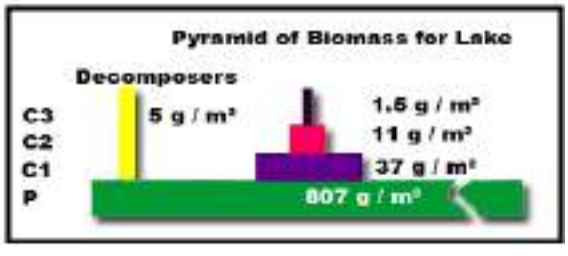
1. Grass → Grasshopper → Lizard → Hawk
2. Grass → Rabbit → Hawk
3. Grass → Mouse → Hawk
4. Grass → Mouse → Snake → Hawk

ECOLOGICAL PYRAMIDS:

The interaction of the food chain phenomenon (i.e. energy loss at each transfer) and the size metabolism relationship results in communities, having definite structure. The graphical representation of the tropic structure and also tropic function is called 'ecological pyramids'. In ecological pyramid, the first or producer level forms the base and successive levels form the tires which make up the apex. In simple words, if we arrange the organisms in a food chain according to tropic levels, they often form pyramid. The ecological pyramids are of three types, viz., the pyramid of numbers, the pyramid of biomass and the pyramid of energy.

1. The pyramid of numbers: In this the numbers of individual organisms at different tropic levels in an ecosystem are depicted. The total numbers of individual organisms at producer levels (first tropic level) form the base of the numbers pyramid, and the population of primary consumers, secondary consumers, tertiary consumers, and so on forms the successive tiers of the pyramid of numbers. The length of the bar, at different levels (tiers), represents the number (population) of organisms at that particular tropic level, by using convenient scale.

2. Pyramid of biomass: It is based on the total dry weight, calorific value, or any other measure of the total amount of living material. measured in gram per square meter. Biomass is mass of an individual x number of individual in that tropical level which get depicted at different levels.



3. The pyramid of energy: In this, the rate of energy flow and/or productivity at successive tropic levels is shown Energy flow express in Kcal/m^2/year. The energy pyramid always takes a true upright pyramid shape, provided all sources of food energy in the system are considered, because less food energy is available to the top tropic level than is available to preceding level.

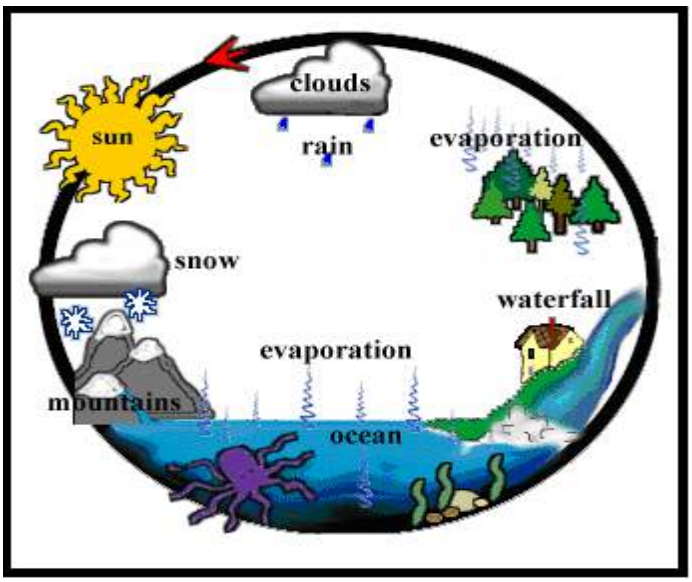
BIOGEOCHEMICAL CYCLES:

The producers of an ecosystem take up several basic inorganic nutrients from their non-living environment. These materials get transformed into the bio mass of the producers. Then they are utilized by the consumer population and are ultimately returned to the environment with the help of the reducers organisms and their non-living environment is called *biogeochemical cycle*. As indicated by the name the nutrients circulate through life (Bio) and through earth (Geo) repeatedly (cycle).

The biogeochemical (material or nutrient) cycles conserve the limited source of raw materials in the environment. Common biogeochemical cycles are:

A: WATER CYCLE/HYDROLOGICAL CYCLE:

All living things are composed mainly of water, but most of the water on Earth lies in the environment (e.g. in lakes, oceans, streams, and the air). The movement of water from the physical environment, and through the biological environment is driven by the sun. In the physical environment, the sun radiates the Earth's surface with heat, evaporating the water, slowly turning liquid water to water vapor, gaseous water. As a gas, water rises from the ground, the surface of streams, lakes, but water mainly rises from our oceans. Once in the air, air currents move the gaseous water around the Earth. But when molecules of water hits a particle, or when temperatures and pressures reach the point where water liquefied or even solidifies, water begins to condense. As water condenses, it forms into rain or snow, thus the water begins to fall to the ground as it is now too heavy to remain in the air.

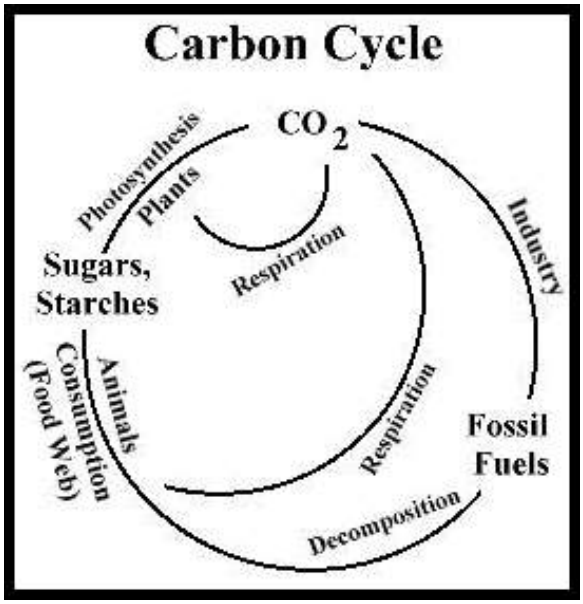


As the water strikes the ground, some of it seeps into the soil, gathering within water tables under the earth. But the majority of the water runs across the ground, slowly collecting until streams, then rivers form. Where the ground has large divots, lakes form. But eventually, most of the water again reaches the oceans.

But the biological environment lives along side of the physical environment. Along this route, organisms live in, bath in, and drink the water, taking water into their bodies. This is important for many organisms, but it is especially important to those who live on land. Terrestrial organisms generally lose tremendous amounts of water, as it evaporates from their bodies. All organisms lose some water as they remove waste from their bodies.

a. Water from the transpiring plants, oceans, rivers and lakes evaporates into the atmosphere.
b. These water vapours subsequently cool and condense to form clouds and water.
c. Water returns to the earth as rain and snow.

B: CARBON CYCLE:



Organic chemicals are made from carbon more than any other atom, so the Carbon Cycle is a very important one. Carbon between the biological to the physical environment as it moves through the carbon cycle.

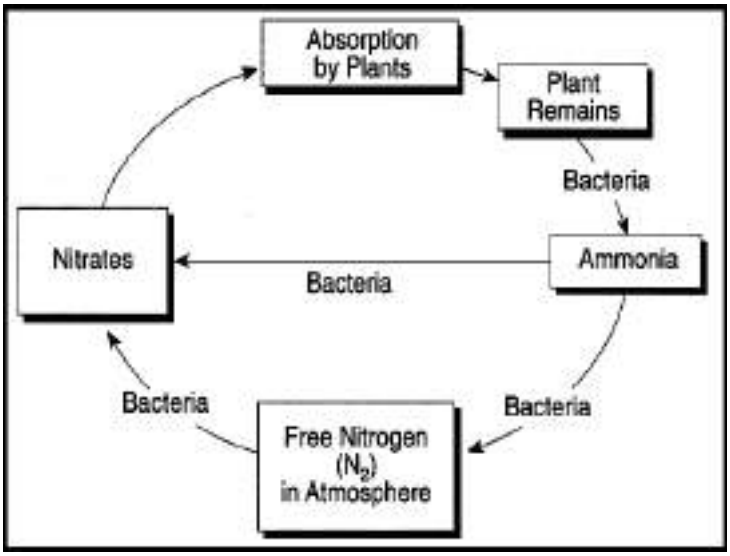
Earth's atmosphere contains 0.035% carbon dioxide, CO_2, and the biological environment depends upon plants to pull carbon into sugars, proteins, and fats. Using photosynthesis, plants use sunlight to bind carbon to glucose, releasing oxygen (O_2) in the process. Through other metabolic processes, plants may convert glucose to other sugars, proteins, or fats. Animals obtain their carbon by eating and digesting plants, so carbon moves through the biotic environment through the trophic system. Herbivore eats plants, but are themselves eaten by carnivores.

Carbon returns to the physical environment in a number of ways. Both plants and animals respire, so they release CO_2 during respiration. Luckily for animals, plants just happen to consume more CO_2 through photosynthesis than they can produce. Another route of CO_2 back to the physical environment occurs through the death of plants and animals. When organisms die, decomposers consume their bodies. In the process, some of the carbon returns to the physical environment by way of fossilization. Some of it remains in the biological environment as other organisms eat the decomposers. But by far, most of the carbon returns to the physical environment through the respiration of CO_2.

a. Most of the carbon dioxide enters the living world through photosynthesis.
b. The organic compounds synthesized are passed from the producers (green plants) to consumers (herbivores and carnivores).
c. During respiration, plants and animals release carbon back to the surrounding medium as carbon dioxide.
d. The dead bodies of plants and animals as well as the body wastes, which accumulate carbon compounds, are decomposed by micro-organisms to release carbon dioxide.

Carbon is also recycled during burning of fossil fuels.

C. NITROGEN CYCLE:



Proteins, nucleic acids, and other organic chemicals contain nitrogen, so nitrogen is a very important atom in biological organisms. Nitrogen makes up 79% of Earth's atmosphere, but most organisms can not use nitrogen gas (N_2). N_2 enters the trophic system through a process called **nitrogen fixation**. Bacteria found on the roots of some plants can fix N_2 to organic molecules, making proteins. Again, animals get their nitrogen by eating plants. But after this point, the nitrogen cycle gets far more complicated than the carbon cycle.

Animals releases nitrogen in their urine. Fish releases NH_3, but NH_3 when concentrated, is poisonous to living

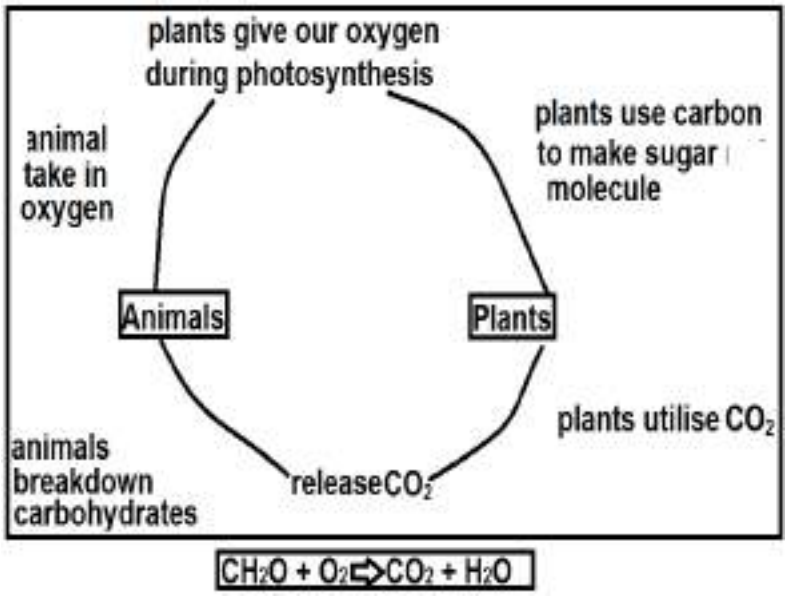
organisms. So organisms must dilute NH_3 with a lot of water. Living in water, fish have no problem with this requirement, but terrestrial animals have problems. They convert NH_3 into urine, or another chemical that is not as poisonous as NH_3. The process of releases NH_3 is called **ammonification**.

Because NH_3 is poisonous, most of the NH_3 which is released is untouchable. But soil bacteria have the ability to assimilate NH_3 into proteins. These bacteria effectively eat the NH_3, and make proteins from it. This process is called **assimilation**.

Some soil bacteria does not convert NH_3 into proteins, but they make nitrate NO_3^- instead. This process is called **nitrification**. Some plants can use NO_3^-, consuming nitrate and making proteins. Some soil bacteria, however, takes NO_3^-, and converts it into N_2, returning nitrogen gas back into the atmosphere. This last process is called **denitrification**, because it breaks nitrate apart.

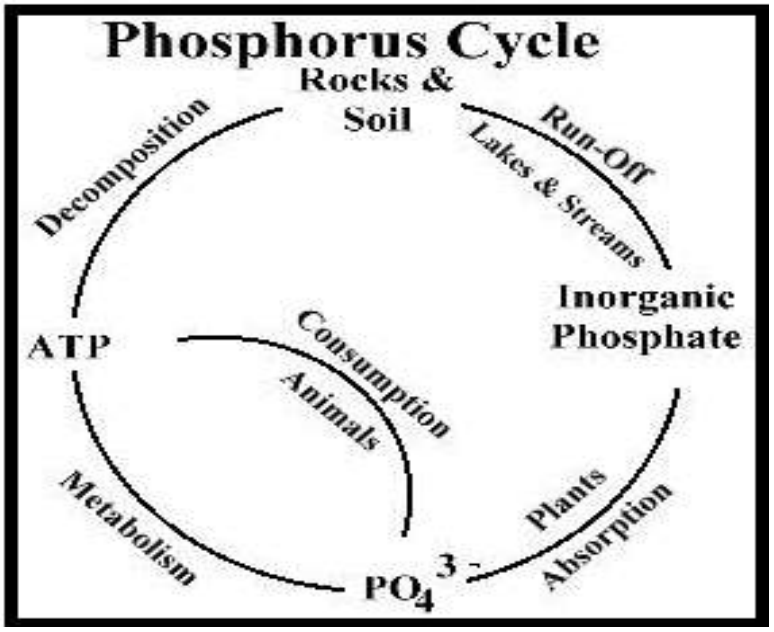
- Nitrogen of atmosphere is in the elemental form and cannot be used as such by living organisms.
- It is fixed i.e., combined with other elementals such as hydrogen, carbon or oxygen to become usable for the green plants.

Nitrogen is continuously entering into the air by the action of denitrifying bacteria and returning to the cycle through the action of lightening and electrification.



D: OXYGEN CYCLE:

Oxygen is another essential element for the construction of living body and its life process such as respiration. Oxygen exists in molecular form (O_2) and also as a part of compounds such as water and carbon dioxide. Oxygen required for respiration in plants and animals enters the body directly from the surrounding medium, that is, from air in the atmosphere or from water. Oxygen returns thereafter to the surrounding in the form of carbon dioxide and water. We know oxygen as an element also enters the body of plants as carbon dioxide and water during photosynthesis. It is released in the form of molecular oxygen as a product of the same process. Thus the oxygen and carbon dioxide content of the air and water maintained at the same level. Oxygen as a part of carbon dioxide is also released during the decay of dead organisms.



E: PHOSPHORUS CYCLE: Phosphorus is the key to energy in living organisms, for it is phosphorus that moves energy from ATP to another molecule, driving an enzymatic reaction, or cellular transport. Phosphorus is also the glue that holds DNA together, binding deoxyribose sugars together, forming the backbone of the DNA molecule. Phosphorus does the same job in RNA.

Again, the keystone of getting phosphorus into trophic systems is plants. Plants absorb phosphorous from water and soil into their tissues, tying them to organic molecules. Once taken up by plants, phosphorus is available for animals when they consume the plants.

When plants and animals die, bacteria decompose their bodies, releasing some of the phosphorus back into the soil. Once in the soil, phosphorous can be moved 100s to 1,000s of miles from were they were released by riding through streams and rivers. So the water cycle plays a key role of moving phosphorus from ecosystem to ecosystem.

In some cases, phosphorous will travel to a lake, and settle on the bottom. There, it may turn into sedimentary rocks, limestone, to be released millions of years later. So sedimentary rocks acts like a back, conserving much of the phosphorus for future eons.

TYPES OF ECOSYSTEMS

1. Aquatic ecosystems (pond, streams, lake, oceans, estuaries etc.)
2. Terrestrial ecosystems (forest, grassland, desert etc.)

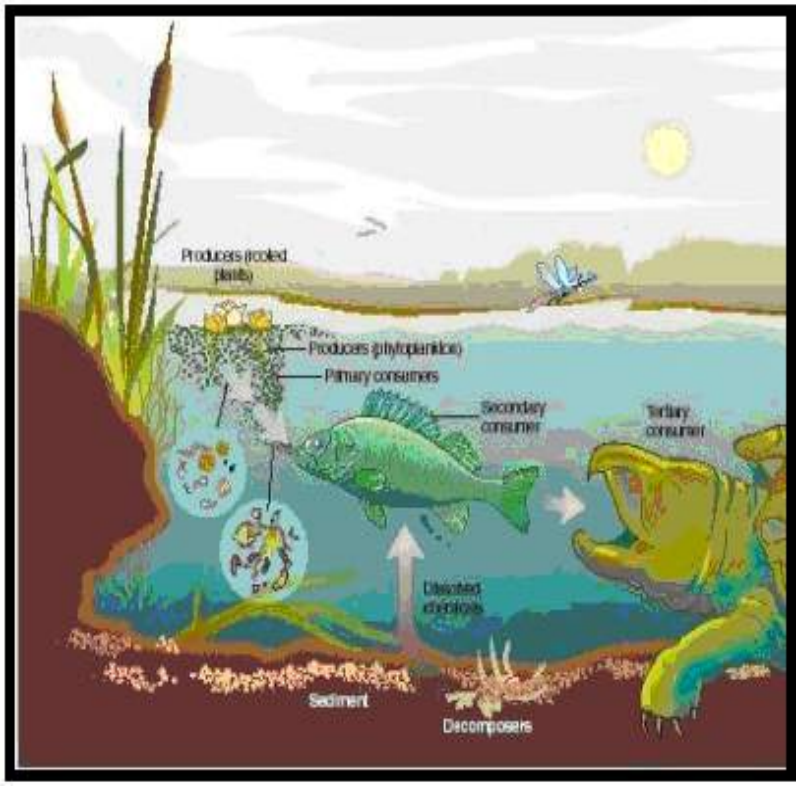
AQUATIC ECOSYSTEM

Pond Ecosystem: Basic components in the pond ecosystem are:

1. Abiotic components: Are heat, light, pH value of water, and basic inorganic and organic compounds, such as water itself, carbon dioxide, oxygen, calcium, nitrogen, phosphates, amino acids, humic acid etc. The amount of the mineral matter present at any time in the physical environment of the pond is 'standing state'.

2. Biotic components: The various organisms that constitute the biotic component are as follows:

a. Producers: These are autotrophic, green plants and some photosynthetic bacteria. The producers fix radiant energy and with the help of minerals derived from the water and mud, they manufacture complex organic substances as carbohydrates, proteins, lipids etc.



Producers are the following types:

i. Macrophytes: These are mainly rooted larger plants which include partly or completely submerged, floating and emergent hydrophytes.

Ex. Trapa, typha, hydrilla, vallisneria, lemna etc.

ii. Phytoplanktons: these are minute, floating or suspended lower plants, majority of them are such filamentous algae as Zygnema, Volvax, Spirulina, Diatoms etc.

b. Consumers: They are heterotrophs which depend for their nutrition on the organic food manufactured by producers, the green plants.

Most of the consumers are herbivores.

Consumers are further divided into-

i. Primary consumers (herbivores): These are feeding directly on living plants (producers) or plant remains. These may be large as well as minute in size.

1. **Benthos:** those are the animals associated with living plants and those are bottom forms which feed upon the plant remains living at the bottom of ponds.
2. **Zooplanktons:** they feed chiefly on phytoplanktons Ex. Euglena, Coleps, Dileptus etc.

ii. Secondary consumers (carnivores): These are feeding on the primary consumers. These are chiefly insects and fish.

iii. Tertiary consumers (carnivores/omnivores): These are large fish as game fish that feeding on the smaller fish.

c. Decomposers: They are also known as 'micro consumers'. They bring about the decomposition of complex dead organic matter of both producers (plants) as well as macro consumers (animals) to simple forms. Thus they play an important role in the return of mineral elements again to the medium of the pond. Ex. Cephalosporium, Aspergillus, Rhizopus, etc. are most common decomposers in water mud of the pond.

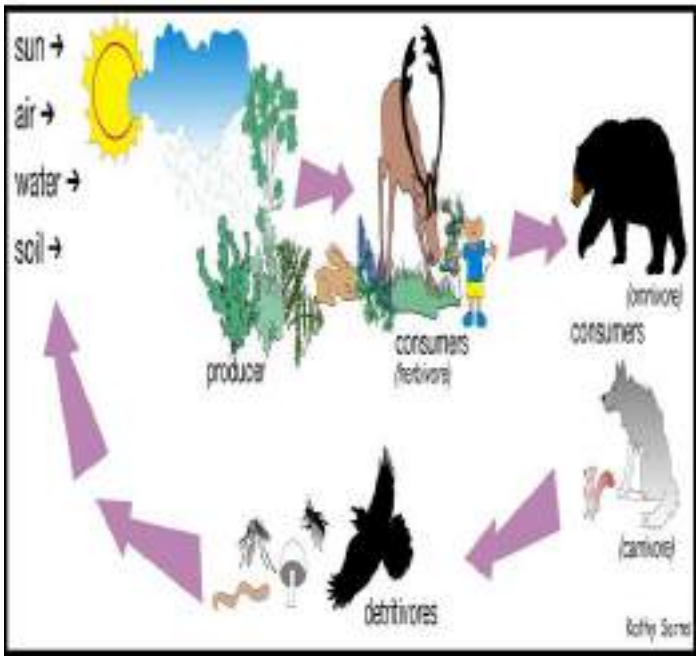
TERRESTRIAL ECOSYSTEM

1. Forest Ecosystem.

The different components of a forest ecosystem, like others, are as follows-

1. Abiotic components:

These are the inorganic as well as organic substances present in the soil and atmosphere. In addition to the minerals present in forests as dead organic debris.



2. Biotic components:

The living organisms present in the food chain occur in the following order.

i. Producers: These are mainly trees. The trees are of different kinds depending upon the kind of the forest formation developing in that climate. Besides trees, there are also present shrubs and ground vegetation. In these forests, dominant members of the flora, the producers, are such trees as Tectona grandis, Butea frondosa etc.

ii. Consumers: These are as follows-

a. Primary consumers: These are herbivores that include the animals feeding on tree leaves as ants, flies, beetles, leafhoppers, bugs and spiders etc. and larger animals grazing on shoots or fruits of the producers, the elephants, deer's, moles, squirrels, shrews, flying foxes etc.

b. Secondary consumers: These are carnivores like snakes, birds, lizards, fox etc. feeding on the herbivores.

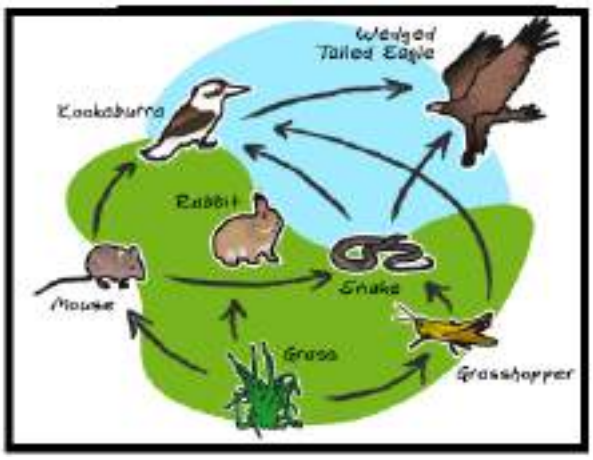
c. Tertiary consumers: These are top carnivores like lion, tiger etc. that eat carnivores of secondary consumers level.

iii. Decomposers: These are wide variety of microorganisms including fungi (species of Aspergillus, Coprinus, and Alternaria etc.), Bacteria (Species of Bacillus, Clostridium, Pseudomonas etc) and actinomycetes, like species of streptomyces etc. Rate of decomposition in tropical and sub-tropical forests is more rapid than that in the temperate ones.

2. Grassland ecosystem:

The various components of a grassland ecosystem are as follows:

1. Abiotic components: These are nutrients present in soil and the aerial environment. Thus the elements like C,H,O,N,P,S etc. are supplied by CO_2, H_2O, nitrates, phosphates and sulfates etc. present in air and soil of the area.



2. Biotic components: These may be categorized as-

a. Producers: They are mainly grasses as species of Dichanthium, Cynodon, Desmodium etc. Besides them a few herbs and shrubs also contribute to primary production.

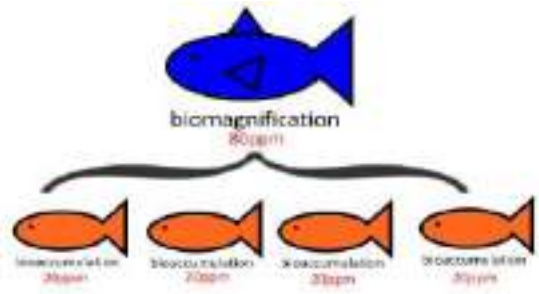
b. Consumers: These occur in the following sequence-

i. Primary consumers: The herbivores feeding on grasses are mainly such grazing animals as cows, buffaloes, deers, sheep, rabbit etc. Besides them, these are also present some insects as Cicincella, Coccinella, some millipeds etc. that feeding on the leaves of grass.

ii. Secondary consumers: These are carnivores feeding on herbivores. These include the animals like fox, jackal, snakes, frogs, lizards, birds etc.

c. Decomposers: The microbes active in the decay of dead organic matter of deferent forms of higher life are fungi, as species of Mucor, Aspergillus, Penicillium etc.

BIOMAGNIFICATION'S:



Biomagnifications is also known as biological magnification or bio amplification, refers to the ability of the living organisms to build up certain chemicals by successive trophic levels. The process occurs by the transfer of chemicals in smaller animals that are food for larger animals in the chain.

The route for transfer of chemicals Or pollutants in oceans are depicted below,

Micro-organisms → small fish → large fish → seals → polar bear

Microorganisms in the oceans are exposed to pollutants, small fish ingest these pollutants while eating these microorganisms. Larger fish eat the smaller fish; larger fish are eaten by seals which in turn are eaten by polar bears. Mercury biomagnification's has been reported in fresh water ecosystem.

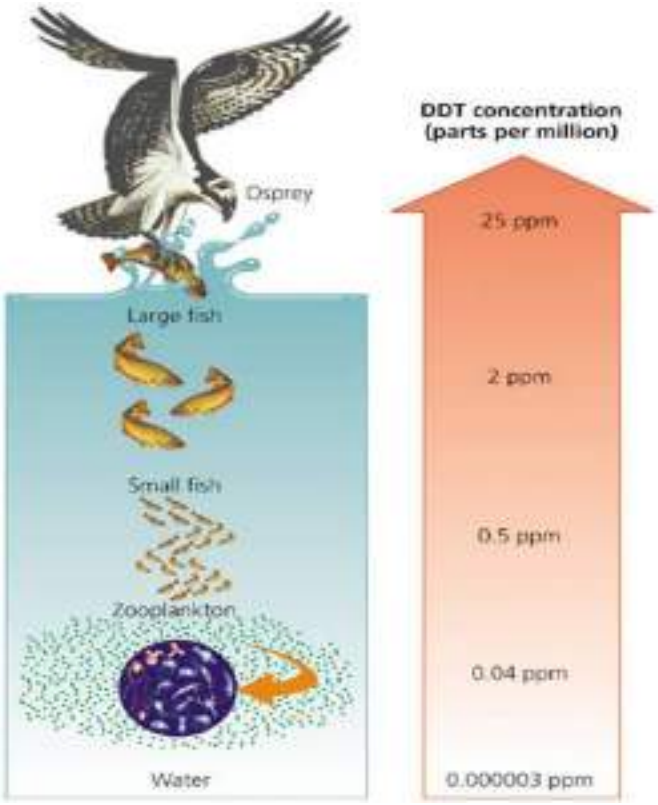
Some of the reasons for the build up of pollutants in organisms are,

a. The pollutants are less water-soluble and cannot be excreted out of the body.
b. The pollutants may bind to fat cells, thus resulting in its build up in the tissues of the organisms.

Examples of biomagnified chemicals are,

a. Inorganic chemicals: selenium, mercury, nickel.
b. Organic compounds: Methyl mercury.
c. Chlorinated hydrocarbons: such as insecticides, DDT & di-eldrin.
d. Industrial chemicals: Polychlorinated biphenyls.

A classical example of biomagnification's is that of insecticide called **Dochloro di-phenyl tri-chloro ethane** (DDT). DDT was used as an insecticide a few decades ago in the U.S. to help control mosquitoes and other insects. When the insecticide reached the water bodies, it was taken up by each organism which then biomagnified through the food web in predatory birds such as bald eagles, falcons, pelicans, golden eagle, osprey, double crested cormorant etc, that ate the fish a containing the insecticide. As a result, there was a large decline in the abundance of birds. The reason being high levels of DDT in these birds interfere with deposit of calcium in the shells of the bird's eggs. The abnormally thin bird shells were easily broken and their un-hatched offspring's died. The use of DDT was then banned in the U.S and since that time there has been a considerable increase in the population of predatory birds.



ECOSYSTEM VALUE: The simplest form of ecosystem valuation for economists it to hold that an ecosystem has a value equivalent to its ecological yield valued as it would be on commodity markets, for the value of water, wood, fish, that is purified or generated in that ecosystem. Thus, a price can be put on the natural capital of an ecosystem based on the price of natural resources it yield each year.

In natural capitalism, Paul hawken, amory lovins and hunter lovins advanced an argument to assign the value of earth in current currency. See value of earth article for that and other examples of this extreme case of ecosystem valuation, biosphere valuation.

Economists assign several types of values to ecosystems,

- Direct use value attributed to direct utilization of ecosystem services.
- Indirect use value attributed to indirect utilization of ecosystem services, through the positive externalities that ecosystems provide.
- Option value attributed to preserving the option to utilize ecosystem sevices in the future.
- Existence value attributed to the pure existence of an ecosystem.
- Altruistic value based on the welfare the ecosystem may give other people.
- Bequest value based on the welfare the ecosystem may give future generations.

ECOSYSTEM SERVICES: ecosystem services processes by which the environment produces resources.

Ecosystem services are the processes by which the environment produces resources that we often take for granted such as clean water, timber and habitat for fisheries and pollination of native and agricultural plants. Whether we find ourselves in the city or a rural area, the ecosystems in which humans live provide goods and services that are very familiar to us.

Ecosystems provide "service" that, these services are extensive and diverse affecting the quality of our land, water, food and health.

- Moderate weather extremes and their impacts.
- Disperse seeds
- Mitigate drought and floods.
- Protect people from the sun's harmful ultraviolet rays.

- Cycle and move nutrients.
- Protect stream and river channels and costal shores from erosion.
- Detoxify and decompose wastes.
- Control agricultural pests.
- Maintain biodiversity.
- Generate and preserve soils and renew their fertility.
- Contribute to climate stability.
- Purify the air and water.
- Regulate disease carrying organisms.
- Pollinate crops and natural vegetation.
- Ecosystems are nature's support systems for life.

CARRYING CAPACITY: The environment limits to the growth of any one species population determine the carrying capacity for that species. *Carrying capacity is a measure of the number of individuals of any species that a particular environment can support.*

Carrying capacity can be considered as having several levels,

1. An absolute carrying capacity which is the maximum number of individuals that can be supported by the resources of the environment at a subsistence level.
2. The level at which a species population is normally held by the influence of other species living in the same environment, those that hunt or prey upon the species and those that cause disease or parasitic infestation.

A level, which is generally considered more desirable by those concerned with the health or productivity of the species involved, termed the optimum density. At this level individuals in the population will have available an adequate supply of all essentials for existence and in consequence, will show abundant individual growth and health not limited by shortages of any essential requirements. Such optimum density can only be maintained by strong limitations on growth imposed by the behaviour of the species concerned or by removal of individuals in excess of this density by the action of other species through predation. In the latter case optimum density and security density will be the same. These are not necessarily fixed levels, but will fluctuate upwards or down

Essay Questions

1. What is ecology?
2. Define ecosystem & explain value, service & carrying capacity of ecosystem.
3. Define and elaborate the structure & functions of ecosystem.
4. Describe the components of ecosystem.
5. Explain the phenomenon of ecological succession.
6. Briefly explain the types of ecosystem with suitable examples.
7. Explain water, carbon, nitrogen and phosphorus cycles.
8. Explain in brief- energy flow, eco-pyramid, food web, food chain with examples.
9. Explain the characteristics and function of grassland & water ecosystem.
10. Describe the aquatic ecosystems.
11. Write notes on the desert ecosystem.
12. Explain the terms producers, consumers and decomposers in an ecosystem.

UNIT II: NATURAL RESOURCES

Resource: Any material which can be transformed in a way that it becomes more valuable and useful. 'Any component of the natural environment that can be utilized by man to promote his welfare is considered as a natural resource'. E.g. Land, Water, Minerals, Forests, Wildlife, Energy as well as Human beings are resources.

Classification of natural resources:

The quantity and quality of natural resources vary greatly in their location. Depending upon the availability and abundance, natural resources are of two types: inexhaustible and exhaustible.

A: Renewable Resources (inexhaustible resources)

The resources are capable of being regenerated by ecological process within a reasonable time period. They have potential to renew themselves. E.g. soil, water, air, wildlife, natural vegetation etc, The renewable resources are further sib classified into two types.

1. ***Continuous resources:*** these resources are continuously renewed. e.g., solar energy, wind, tidal energy.
2. ***Extrinsic resource***: These resources are prone to breakdown or degradation, yet are available if managed. e.g. Human skills, institutions, management abilities

B: Non-renewable resources (Exhaustible Resources)

These resources are not capable of being regenerated by ecological processes. E.g. minerals, coal, natural gas, ground water etc. The non-renewable resources are sub classified into

1. ***Biotic or organic resources:*** they obtained from biosphere. E.g. forest and forest products, crops, birds, animals, fishes, coal, minerals oils etc.
2. ***Abiotic or Inorganic resources:*** resources which are composed of non-living inorganic matter are called abiotic resources. E.g., land, water etc.

Types of Resources:

1. ***Forest resource:*** Covers 12% of India's land but estimated value should be 33%. It is renewable resource but overexploitation takes many years to develop hence it become nonrenewable.
2. ***Water Resource:*** Abundant and inexhaustible renewable resource. It covers $3/4^{th}$ of land surface of which 1% is fresh water. Most of the fresh water is used for agricultural purposes.
3. ***Mineral Resources:*** These are nonrenewable and get depleted if over exploited. These are present on land, sea.
4. ***Food Resources:*** The demand of food supply and the production of food are inadequate and unable to meet the demands of the public due to the overgrowing population. The agricultural production is also declining due to loss of genetic diversity of crop plants, livestock, fishery.
5. ***Energy Resources:*** Any material in environment that can be used to generate energy for useful purpose. These are renewable and non-energy resources. e.g, solar, wind, water, fossil fuels etc.
6. ***Land Resources:*** 328 million hectares is Indian land. It is renewable on proper utilization becomes non –renewable if wastes of industries are dumped on land.

WATER RESOURCES

Rain is the main source of water on the earth. Clouds released water is called as precipitation. This is basically 3 forms – vaporized (drizzle), liquid (rain), solid form (snow). Water resources can be classified into surface water resources and ground water resources. Main water resources in Andhra Pradesh are Godavari, Krishna and Pennar.

Forms of fresh water:

Fresh water mainly occurs in two forms: Ground water and Surface water.

1. ***Ground water:*** Ground water constitutes about 9.86 % of the total fresh water resource. It is about 35-50 times that of surface water supplies. The ground water is contained in aquifers. An aquifer is a highly permeable layer of sediment or rock containing water. Layers of sand and gravel are good aquifers, while the clay and crystalline rocks (eg. Granite) having poor permeability are not good aquifers. Aquifers are of two types:
   - ***i) Un-confined aquifers****:* These are covered by permeable earth materials and are recharged by seeping down of water from rainfall and snowmelt.
   - ***ii) Confined aquifers:*** These are present between two impermeable layers of rock and are recharged only in those areas where the aquifer meets the land surface. The recharging area of many confined aquifers may be several kilometer away from the location of the well.
2. ***Surface water:*** Surface water occurs in the forms of streams, rivers, lakes, ponds, wetlands and artificial reservoirs. It comes through precipitation (rain fall, snow) and accumulated in the water bodies, if not percolated into the ground or not returned to the atmosphere as evaporation or transpiration loss. Surface water mainly used for irrigation of crops, public water supply and industrial supply.

Uses of Surface and Ground water

The water is used mainly for two types of uses:

1. ***Consumptive use:*** Here water is completely utilized and it is not reused. e.g. in domestic application, industry and irrigation.
2. ***Non-consumptive use:*** Here water is not completely utilized and it is reused. e.g. hydropower plant.

Over Utilization of surface and Ground water

The rapid increase in population and industrial growth has increased the demand for water resources. Due to increase of ground water usage, the annual extraction of ground water is in far excess than the natural recharge.

Effects on Overutilization of water

1. *Decrease of ground water level: due to increased usage of ground water.* Other reasons a: erratic and inadequate rainfall. b: reducing the area for percolation of rainfall by building construction.
2. *Ground subsidence:* When the ground water withdrawal is more than its recharge rate, the sediments in the aquifer get compacted, which results in sinking of overlaying land surface. This process is known as ground subsidence. Leading to structural damage in building, fracture in pipes and reverses the flow of canals.
3. *Intrusion of salt water*: in coastal area, over exploitation of ground water lead to rapid intrusion of salt water from sea by which water can't be used for drinking.
4. *Earthquake and landslides*.
5. *Drying up of wells.*
6. *Pollution of water.*

FLOODS

Excess water that overflows stream banks and covers adjacent land is considered a **flood.**

Cause of Floods: It is caused by both natural as well as anthropogenic factors.

- *Natural factors:* prolonged downpour, blocking of free flow of the rivers due to siltation and landslides, heavy rainfall, melting ice or snow or combination of these, exceeds the capacity of the receiving river.
- *Anthropogenic activities:* Such as deforestation, over grazing, mining, construction activities, channel manipulation through diversion of river course etc.

Effect of floods

- Water spreads in surrounding areas and submerges villages and agricultural fields.
- The river carries fertile sediment and deposits it on the level land along its lower course.
- Extinction of civilization in some coastal areas also occurs.

Flood management

- By constructing dams or reservoirs.
- Channel management and embankments.
- Encroachment of flood ways should be banned.
- By forecasting or flood warning.
- By reduction of runoff by increasing infiltration through appropriate afforestation in the catchment area.

The biggest economic loss from floods is usually not the buildings and property they carry away, but rather the contamination they cause.

DROUGHT

Drought is lack or insufficiency of rain for an extended period, that causes considerable hydrologic imbalance and consequently water shortages, crop damage, stream flow reduction and depletion of groundwater levels and soil moisture. National commission on agriculture (1976) classified the droughts into three types:

1. ***Meteorological drought:*** It occurs when the total amount of rainfall is less than 75% of the normal rainfall. This drought will severe if the rain fall is less than 50% of rain falls.
2. ***Hydrological drought:*** It occurs when the total amount of rainfall is less than the average rainfall. It is generally associated with reduction of statistical average of water reverses available in source such as aquifers, lakes and reservoirs.
3. ***Agricultural drought:*** This occurs due to the shortage as well as the timing of overall rainfall, which in turn reduce the ground water and reservoir levels, soil moisture. It affects cropped plants.

Causes of drought:

- When annual rainfall is below normal and less than evaporation.
- High population (poor land use and makes the situation worse).
- Intensive cropping pattern and over exploitation of water.
- Deforestation.

Effects of drought:

- Hunger, malnutrition and scarcity of drinking water and change the quality of water.
- Crop failures leading shortage of food effecting human and livestock population.
- Initiates desertification.
- Retards the industrial and commercial growth (agro based industry).
- Accelerates degradation of natural resources.
- Large scale migration of people and urbanization.

Drought Management:

- Rain water harvesting programme.
- Constructing reservoirs to improve ground water level.
- Using modern irrigation technology (drip irrigation).
- Afforestation.

DAMS

For surface water utilization we construct projects like Nagarjuna Sagar. These projects are useful for production of power, irrigation and water transport and also show effects on people and environment.

Based on the *size* dams are three types – Large, Medium, Small dams.

Based on *strength* dams are Rigid dams and non-rigid dams. Rigid dams are concrete and masonry dam while non-rigid dams are earth and rock dams.

Excess water is released to the dam without effect to dam. This is known as flood disposal, this water is called as surplus water.

Purposes of water resources projects:

1. Irrigation during dry periods.
2. Ensuring a year-round water supply.
3. Hydroelectricity generation
4. Transfer of water from areas of excess to areas of deficit using canals.
5. Flood control and soil protection.
6. Drinking water.
7. Industrial needs,
8. Fish culture,
9. Recreation, Navigation, Tourism, etc.

Problems/disadvantages of water resources projects:

1. Submergence of forests with rare varieties of trees/plants.
2. Adverse effect on wild life and fish life habitat of rare species.
3. Effect on human health and sanitation.
4. Degradation in the fertility of the land – transport of sediment and fertilizer residual.
5. Rehabilitation of displaced persons.
6. Floods.
7. Some dams lose so much water through evaporation and seepage into porous rock beds that they waste more water than they make available.
8. Salts left behind by evaporation increase the salinity of the river and make its unusable when it reaches the downstream cities.
9. Growth of snail populations in the shallow permanent canals that distribute water to fields may lead to an epidemic of Schistosomiasis.

Dams and their effects on forests and people:

Big dams and river valley projects have multi-purpose uses and have been referred to as "Temples of modern India". However, these dams are also responsible for the destruction of vast areas of forests. India has more than 1550 large dams, the maximum being in the state of Maharashtra (> 600), followed by Gujarat (>250), and M.P (130).

- Hydroelectric development is another important factor, which may cause forest destruction.
- Submergence of large tracts of forestlands especially in case of large dams is inevitable. This would cause reduction in forest cover, destruction of habitats and extermination of valuable wild species.
- Forest submergence would greatly affect the tribal people by the way of submerging their dwellings and agricultural lands. The lifestyle of the tribal is intricately webbed/ connected with the forests. But when the forests are destroyed their livelihood is greatly affected.
- It would induce micro-climatic changes in the area in and around the reservoir which may effect the composition of the forests in the area.
- It would include changes in the water flow characteristics which may affect the forests and the tribal especially in the downstream areas.
- Acute scarcity of fuel wood and other forest products for tribal people.

- Increased incidence of water-borne diseases like malaria, filarial, etc.
- Disturbance of the dam site forest ecosystem.

Case Studies:

1. Silent Valley project:

Project was proposed during 1965 to generate 120 MW of HEPP at a cost of 60 crores on the river Kuntipuza on the south west slopes of Nilgiri hills. The area is covered with a rich virgin forest, of which 1000 hectares will have to be cleared for the project. A 430 m long, 130 m high concrete dam was proposed. The irrigation potential of the project is 10,000 hectares. The project can benefit the most backward regions in Kerala. Silent Valley ecosystem having 1200 plant species per hectare, elephant, barking deer, sambar, lion, rock python etc. animals, 100 rare bird species are affected by these project.

National Committee on Environmental Planning and Coordination (NRPC) refused permission for going ahead with the project. Finally this project proposal was a banded.

2. Chipco Movement:

During the 1970's commercial loggers started large scale tree felling in the 'Garwal' region of U.P. in India. Landslides and floods resulted due to deforestation. The local people were suffered a lot. With courage and determination, the village women, under the leadership of Sundarlal Bahuguna, wrapped their arms around the trees to protect them. This was known as "Chipco Movement" or "Chipco Andolan" (in Hindi- Chipco means hugging or embracing and andolan means movement.)

It is believed that the Chipco movement consists of nearly 4000 groups to save Indian's forest wealth have prevented logging on 1200 sq.km of watershed areas in the Alakananda basin.

It was a slogan of planting 5 F's – Fodder, Fuel, Food, Fiber, and Fertilizer.

Several parts of the country like "the Appico movement in Karnataka".

3. Narmada Project:

This Rs. 25,000 crore world's largest river valley project consists of 30 major, 135 medium and 3000 minor dams. On the Narmada river and tributaries, flowing through M.P. Maharashtra, Gujarat. Of the 30 major dams, 10 will be on Narmada and 20 on tributaries. The project will submerge 60,000 hectares of fertile land and rich forests. 11,300 hectares of agricultural land will also be submerged.66, 675 people (a majority tribal) have to be displaced.

The environmental damages of this project are – the displaced people will have to be rehabilitated in the forest area leading to loss of more forests. The out sees by and large have to migrate to the nearest cities in search of livelihood. This creates pressure on the urban life.

The compensatory measures are subjected to long delays and corrupt practices, denying justice to the victims of displacement.

On these grounds, the NGO's like Narmada Bachavo Andolan led by Medha Patkar have been fighting for the rights of the tribal displaced by the project. The controversy is still going on.

5. Sardar Sarovar project:

The Dam is situated on river Narmada and is spread over three states of Gujarat, Maharastra and M.P. It is one of the costliest project affecting villages in three states of M.P., Maharastra and Gujarat. About 245 villages will be submerged, of which about 193 are in M.P. alone. Over 75,000 (nearly 50,000 in M.P. alone) people will be evicted. Nearly 43,000 ha.of land will be needed for rehabilitation in the Sardar Sarovar Project. A total of 1,44,731 ha of land will be subm erged by the dam, out of which 56,547 ha is forest land.

Water Conflicts:

Conflicts over sharing of river water between neighboring countries or different states of a country have now become quite common because of shortage of water.

Some major water conflicts are-

a. ***Water conflicts in the Middle East:*** In the Middle east countries, three river basins namely the Jordan, the Tigris- Euphrates and the Nile have the shared water resources. There is a fierce battle for water among Jordan, Syria and Israel for the share of Jordan river water. Turkey has abundant water and plans to build a chain of dams on Tigris-Euphrates for hydroelectric power generation and plans to transport and sell water to other Middle East countries, which may create war like situation in these countries.

b. ***The Cauvery water dispute:*** The Cauvery river water is a matter of conflict between Tamil Nadu and Karnataka and the fighting is almost hundred years old. Tamil Nadu, occupying the downstream region of the river wants water-use regulated in the upstream, whereas, the upstream state Karnataka refuses to do so and claims it's over the river as upstream user. The river water is almost fully utilized and both the states have increasing demands due to complex cropping pattern and some cash crops demanding intensive water, thus aggravating the water crisis.

c. ***The Sutlej Yamuna Link (SYL) canal dispute:*** The issue of sharing the Ravi-Beas waters and SYL issue between Punjab and Haryana is a case of dispute between two states. The Supreme Court on January 15, 2002 directed Punjab to complete the work of SYL within a year. But till date neither the SYL has been completed nor is the conflict over sharing of Ravi-Beas water is resolved.

d. ***Tehri dam dispute:***

MINERAL RESOURCES

Minerals:

A mineral is a naturally occurring inorganic solid with a definite chemical composition and specific internal crystal structure. Minerals can be *metallic* e.g. iron, copper, gold etc. or *non-metallic* e.g. sand, stone, salt, phosphates etc. There are thousands of natural minerals like quartz, feldspar, calcite, topaz, bauxite composed of elements like oxygen, silicon, iron, Mg, aluminum, calcium etc. The eight most common minerals in the world are:

Iron: 33.3%, Oxygen: 29.8%, Silicon: 15.6%, Magnesium: 13.9%, Nickel: 2%, Calcium: 1.8%, Aluminum: 1.5%, Sodium: 0.2%.

Indian mineral resources:

India produces 64 minerals, including 4 fuel minerals, 11 metallic minerals and 49 non- metallic minerals. Ex. Coal, petroleum, bauxite, iron, manganese etc.

Uses and exploitation:

Minerals find use in a large number of ways in everyday use in domestic, agricultural, industrial and commercial sectors and thus form a very important part of any nation's economy.

Major reserves and important uses of some of the major metals:

Metal	Major world reserves	Major uses
Aluminum	Australia, Guinea, Jamaica	Packing food items, transportation, utensils and electronics.
Chromium	CIS, South Africa	For making high strength steel alloys,textile/tanning industries.
Copper	U.S.A, Canada, CIS, Chili, Zambia	Electronic and electronic goods, building, construction, vessels
Iron	CIS, South America, Canada, U.S.A	Heavy machinery, steel production, transportation
Lead	North America, U.S.A., CIS.	Leaded gasoline, Car batteries, paints, ammunition.
Manganese	South Africa, CIS, Brazil,	For making high strength, high resistant steel alloys
Platinum	South Africa, CIS	Automobiles, catalytic converters, electronics, medical uses.
Gold	South Africa, CIS, Canada	Ornaments, medical, electronic , aerospace
Silver	Canada, South Africa, Mexico	Photography, electronics, jewelers
Nickel	CIS, Canada, New Caledonia	Chemical industry, steel alloys

Major uses of some non-metallic minerals:

Non-metal mineral	Major uses
Silicate minerals	Sand and gravel for construction, bricks, paving etc.
Lime stone	Used for concrete, building stone, agriculture for neutralizing acid soils, cement industry.
Gypsum	Used in plaster wall-board, in agriculture
Potash, Phosphate	Used as fertilizers
Sulphur pyrites	Used in medicine, car battery, industry.

Benefits of Minerals:

- Igneous rocks (igni means fire or Agni) and non-metallic economic minerals like graphite, feldspar, quartz, diamond, that are valued for their beauty and rarity also are exploited badly.
- Maximum resources are produced in South America, South Africa. But maximum minerals are consumed by USA, Japan, Europe and then others.
- Sand and gravel are extracted for brick and concrete construction, pavements, transportation, filling and sand blasting.
- Pure silica is used for glass manufacturing.
- Limestone is mixed for concrete, road making, and building stones.
- Gypsum (calcium sulphate) is used for plastering.
- Potassium for fertilizers.
- Sulphur in the form of Pyrite (FeS_2) for making H_2SO_4.

Some of the major minerals in India:

a. Energy generating minerals:

Coal and lignite : West Bengal, Jharkhand, Orissa, M.P., A.P.

Uranium (Pitchblende or Uranite ore): Jharkhand, A.P. (Nellore, Nalgonda), Meghalaya, Rajasthan

b. Other commercially used minerals:

Aluminum (Bauxite ore) : Jharkhand, West Bengal, Maharashtra, M.P., Tamilnadu.

Iron (Hematite and Magnetite ore): Jharkhand, Orissa, M.P., A.P., Tamilnadu, Karnataka, Goa and Maharashtra.

Copper (Copper Pyrites): Rajasthan (Khetri), Bihar, Jharkhand, Karnataka, M.P., West Bengal, A.P., and Uttaranchal.

Environmental Effects of Extracting and using Mineral Resources:

The Environmental effects of extracting and using mineral resources depend on such factors as ore quality, mining procedures, local hydrological conditions, climate, rock types, size of operation, topography and several other related factors.

Some of the major environmental impacts of mining and processing operations are:

- Degradation of land.
- Pollution of surface and ground water resources due to the release of harmful trace elements (cadmium, cobalt, copper, lead, and others) by leaching, even if drainage is controlled.
- Serious adverse impact on the growth of vegetation due to leaching out of trace elements and minerals.
- Air pollution due to emission of dust and gases.
- Deforestation including loss of fauna and flora.
- Adverse impact on historical monuments and religious places.
- Physical changes in the land, soil, water and air associated with mining directly and indirectly affect the biological environment.
- Rehabilitation of affected population including tribal.
- Dereliction (closing or abandoning mines, i.e. deserting and left to fall into ruin): The harmful effects of dereliction include: *a. Waste of agricultural and industrial land* *b. Ugliness.*
- Health and accident hazards: land over underground mines may subside, causing houses to collapse and ground water pollution.
- Shafts that are not filled may lead to accidents.
- Old quarries and open-cast pits may also be dangerous.
- Permanent damage to landscape.

Effects of Minerals:

- Non-metal minerals are mainly silicates i.e. sand, limestone and soils. Extracting and using of this minerals release the particulates into atmosphere. Particulates effect on human health and photosynthesis in plants.
- Metal minerals like Gypsum (Calcium sulphate), Potassium etc. are harmful to environment. Metals like Fe, Al, etc. are dangerous to crops.
- Natural deposits of fluoride such as topaz, fluorspar (CaF_2) and Criolite (Na_3AlF_6) these contaminate the water.
- Fluoride (F) of up to 1mg/l is essential to prevent dental cavities in children.

  1.5 mg/l of fluoride causes yellowing of teeth called '**molting**'.

  > 5 mg/l of fluoride causes fluorosis and skeletal abnormalities.

Mineral Resource Management

- The efficient use and protection.
- Modernization of mining industries.
- Search of new deposit.
- Reuse and recycling of the metals.
- By adopting eco-friendly mining technology.

MINING:

Mining operation is for extracting minerals and fossil fuels like coal often involves vast forest areas. Mining from shallow deposits is done by surface mining while that from deep deposits is done by sub-surface mining. More than 80,000 ha of land of the country are presently under the stress of mining activities.

Effects of Mining:

The major effects of mining operations on forests and tribal people include:

- Degradation of lands.
- Loss of top soil due to deforestation.
- Pollution of surface and ground water resources due to the discharge of highly mineralized mine waters.
- Lowering of ground water table.
- Air pollution due to release of greenhouse gases and other toxic gases during mining, e.g. release of CH_4 during coal mining.
- Deforestation including flora and fauna.
- Sediment production and discharge.
- Ore transport hazards.
- Fire hazards.
- Subsidence above and near mine areas can change local hydraulic gradients and drainage basin limits and create numerous ponds.
- Drying up of the perennial sources of water like springs and streams in hilly areas.
- Tribal people may be forced into a new way of life for which they are unprepared.
- Migration of tribal people from mining areas to other areas in search of land and food.

Case Studies:

1. Mining and quarrying in Udaipur:

About 200 open cast mining and quarrying centers in Udaipur, about half of which are illegal are involved in stone mining including soapstone, building stone, rock phosphate and dolomite. The mines spread over 15,000 hectares in Udaipur have caused many adverse impacts on environment. About 150 tons of explosives are used per month in blasting. The over burden, wash off, discharge of mine water etc. pollute the water. The Maton mines have badly polluted the Aharriver. The hills

around the mines are devoid of any vegetation except a few scattered patches and the hills are suffering from acute soil erosion. The waste water flows towards a big tank of 'Bag Dara'. Due to scarcity of water people are compelled to use this effluent for irrigation purpose. The blasting activity has adversely affected the fauna and the animals like tiger, lion, deer and even fox, wild cats and birds have disappeared from the mining area.

2. Mining in Sariska Tiger reserve in Aravallis:

The Aravalli range is spread over about 692 km in the NW India covering Gujarat, Rajasthan, Haryana and Delhi. The hill region is very rich in biodiversity as well as mineral resources. The Sariska tiger reserve has gentle sloppy hills, vertical rocky valley, flat plains as well as deep gorges. The reserve is very rich in wild life and has enormous mineral reserves like quartzite, Schists, marble and granite in abundance.

Mining operations within and around the Sariska Tiger reserve has left many areas permanently infertile and barren. The precious wild life is under serious threat. We must preserve the Aravalli series as a National Herirage and the Supreme Court on December 31st 1991 has given a judgment in response to a Public Interest Litigation of Tarun Bharat Sangh, an NGO wherein both Centre and State Government of Rajasthan have been directed to ensure that all mining activity within the park be stopped. More than 400 mines were shut immediately. But, still some illegal mining is in progress.

3.Uranium Mining in Jaduguda- The public hearing:

The present reserves of Uranium in Jaduguda mines, Jharkhand can supply the yellow cake. There is a pressing need for mining more uranium to meet the demands of India's nuclear program. The Uranium Corporation of India (UCIL) proposes to mine uranium from the deposits in Lambapur and Peddagutta villages and a processing unit at about 18 kms at Mallapur. The plan is to extract the ore of 11.02 million tons in 20 years. The proposed mines would cover about 445 ha of Yellapurum Reserve Forest and Rajiv Gandhi Tiger Sanctuary. The public hearing held just recently in February, 2004 witnessed strong protests from NGOs and many villagers. The fate of the proposed mining is yet to be decided.

LAND RESOURCES

Soil as a Natural Resource:

Soil is defined as upper layer of the earth differentiated into various horizons and capable of supporting plant life. Land and its soils are considered as important resources of earth. Land as a resource it is essential for development of agriculture and forestry. Soil is one of the most important ecological factors. Plants depend for their nutrients, water supply, and anchorage upon the soil. Soil is actually formed as a result of long- term process of complex interactions leading to the production of mineral matrix in close association with interstitial organic matter-living as well as dead.

Soil has biological system of living organisms as well as some other components. It is preferred to call it a 'soil complex', which has the following five categories of components.

1. Mineral matter
2. Soil organic matter or humus
3. Soil solution or soil water
4. Soil atmosphere: O_2 and CO_2 content not filled with water.
5. Biological system: bacteria, fungi, algae, protozoa, etc.

Some important functions of soil are as under:

- ❖ It provides mechanical support to the flora.
- ❖ Due to its porosity and water-holding capacity, the soil serves as a reservoir of water and supplies water to the plants (even when the land surface is dry).
- ❖ The ion-exchange capacity of soil ensures the availability and supply of micro-and macro-nutrients for the growth of plants, microbes and animals.
- ❖ Soil also helps in preventing excessive leaching of nutrient ions, while maintaining proper pH.
- ❖ Soil contains a wide variety of bacteria (like nitrifying, nitrogen-fixing, organo trophic, etc.), fungi, protozoan's, and many other microbes which help in the decomposition and mineralization of organic matter and regeneration of nutrients.

Soil Classification:

a. Mode of their *formation*, particularly the nature of the *origin of mineral matter*, classified into-

1) *Residual soil:* These soil formations occur at a place where their parent matter (rock) is present.
2) *Transported soils*: Are those where the weathered material is taken away at other places.

b. On the basis of their *nature and composition*, soils of India have been classified into 6 major types-

1) *Alluvial soils:* These occur chiefly in the Indo-Gangetic plain covering the states of Punjab and Haryana in the NW, U.P and Bihar and Bengal and parts of Meghalaya and Orissa in the NE. The soil is generally alkaline or neutral in reaction and rich in loams and clay.
2) *Black soils:* These soils common in the Deccan traps including Maharashtra, Mysore and M.P., though also present in Krishna, Thungabhadra basin of Tamilnadu. Black soils are predominately clay, with patches of clay loams, loams and sand loams.
3) *Red soils:* They cover large areas in South, and in the NE of the Peninsula. Such soils occur in Andhra Pradesh, Tamilnadu and parts of Bihar, Orissa, U.P and West Bengal. Their red color is due to high portion of Iron components.
4) *Skeletal (mountain) soils:* They occur in North Western hills or the Aravallis, they are stony sandy hill foot fans, and in the humid south and east of the Himalayas and in Meghalaya.
5) *Desert soils:* These cover large parts of Rajasthan and the Semi-desert areas of the Rann of Kutch.
6) *Laterite soils (latosols):* These are present in the Western Ghats, the northern half of the eastern margins of Chota Nagpur platean, Meghalaya, few patches around Kathiawar, and in two areas in the centre of the Peninsula north of Bangalore and west of Hyderabad. These soils have porous clay rich in hydroxides of iron and aluminum.

Land Degradation:

Land degradation refers to deterioration or loss of fertility or productive capacity of the soil. Land resources are very much related to natural disasters like volcanic eruptions, earthquakes etc. but it is due to human activities that soil gets polluted. Land degraded by soil erosion, salination, water-logging, desertification, shifting cultivation, urbanization, landslides and soil pollution.

A. Soil erosion: The top layer of the soil contains nutrient required by the plants. This fertile top soil is most valuable natural resource, at a depth of 15 – 20 cm. The loss of top soil or disturbance of the soil structure is known as 'soil erosion'.

Types of soil erosion:

a. Based on the rate of soil loss takes place, there are two main types:

1. ***Normal or geologic erosion:*** It occurs under normal, natural conditions by it-self without any interference of man. As natural, it is very slow process, unless there is some major disturbance by a foreign agent.
2. ***Accelerated soil erosion:*** This type of removal of soil is very rapid and never keeps place with the soil formation. This is the serious type of loss, generally caused by an interference of an agency like man and other animals.

b. Agents of soil erosion: Based on the various 'agents' that bring about soil erosion and the 'form' in which the soil is lost during erosion, there are following types-

1. *Water erosion:* Caused by the action of water, which removes the soil by falling on as 'rain drops', as well as by its 'surface flow' action.
2. *Soil erosion:* Soil loss by wind is common in dry (arid) regions, where soil is chiefly sandy and the vegetation is very poor or even absent. High velocity winds blow away the soil particles.
3. *Landslides or Slip erosion:* The hydraulic pressure caused by heavy rains increases the weight of the rocks at cliffs which come under gravitational force and finally slip or fall off. Sometimes entire hillock may slide down.
4. *Stream bank erosion:* The River during floods splashes their water against the banks and thus cuts through them.
5. *Deforestation & Over grazing:* Effects of deforestation and over grazing are well known on soil loss. In India annual loss of soil nutrients in this way is of the order of 5.37 million tons of N, P, K valued at about Rs.700 crores.

B. Salination: Salination refers to increase in the concentration of soluble salts in the soil. Poor drainage of irrigation and flood waters results in accumulation of dissolved salts on the soil surface. In arid and semi-arid areas with poor drainage and high temperatures, water evaporates quickly leaving behind a white crust of salts on the soil surface. The high concentration of salts in soil severely affects the water absorption process of the plants, resulting into poor productivity.

C. Water logging: Water logging may be due to surface flooding or due to high water table. Excessive use of canal irrigation may disturb the water balance and create water logging as a result of seepage or rise in the water table of the area. The productivity of water logged soil is severely affected reduce due to lesser availability of oxygen for the respiration of plants.

D. Desertification: Desertification is a slow process of land degradation that leads to desert formation. I is like a 'skin disease' over planet wherein patches of degraded land, eruption separately, gradually join together. For example, Thar Desert (India) was formed by the degradation of thousands of hectares of productive land. It may result either due to a natural phenomenon linked to climatic change or due to abusive use of land. Mismanagement of natural resources including land, certain irreversible changes has triggered the breakdown of nutrient cycles and micro climatic equilibrium in the soil indicating the ones of desert conditions.

Causes of desertification:

a. Deforestation: The process of denuding and degrading a forested land initiates a desert producing cycle that feeds on itself. Since there is no vegetation to hold back the surface run-off, water drains off quickly before it can soak into the soil to nourish the plants or to replenish the groundwater. This increases soil erosion, loss of fertility and loss of water.

b. Over grazing: This is because the increasing cattle population heavily grazes in grasslands or forests and as a result denudes the land area. 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.

c. Mining and Quarrying: These activities are also responsible for loss of vegetative cover and denudation of extensive land areas leading to desertification.

E. Shifting Cultivation: Shifting (Jhum) cultivation, a very peculiar practice of slash and burn agriculture, prevalent among many tribal communities inhabiting the tropical and sub- tropical regions of Africa, Asia and Islands of Pacific Ocean has also laid large forest tracts bare. This practice has led to complete destruction of forests in many hilly areas of India, North-East and Orissa, and caused soil erosion and other associated problems of land degradation.

F. Urbanization: Human activities are responsible for the land degradation of forests, croplands and grass lands. The productive areas are fast reducing because of urbanization i.e., the developmental activities such as human settlements and industries.

G. Landslides: Human activities such as construction of road and railway, canal, dams and reservoir and mining in hilly areas have affected the stability of hill slopes and damaged the protective vegetation cover above and below roads and other such developmental works. This has upset the balance of nature, making such areas vulnerable to landslides.

H. Soil Pollution: Industrial effluents contain high concentration of chemicals. For example Paper and Pulp industrial waste water contain organic matter, Soap industrial waste water contain fatty acids, fertilizer industrial waste water contain chemicals etc. these chemicals degrade the soil fertility and loss of microorganisms.

Control of Land Degradation

The process of soil formation is slow that soil can be considered as non-renewable resource. Therefore, control of land degradation is very important and can be achieved by taking the following measures:

a) Afforestation and reforestation

1. Afforestation means growing forests where there were no forests before, may be due to lack of seed trees or adverse factors.
2. Reforestation means replanting forests at places where they were destroyed by overgrazing, excessive felling, forest fires etc. restoring forests helps to check soil erosion, floods and water logging.

b) Better Agricultural Practices

1. **Terracing:** a large sloping drainage area is divided into a number of small distinctly separate flat fields called terraces. These slow down the speed of run-off water; hold the water longer on the land so that more of it is soaked into the land and this result in higher crop yields.
2. **Regular Cultivation:** field should not be left bare and there should be regular cultivation of the fields with a vegetation cover so that erosion is checked and maximum water in filters into the soil due to minimum run-off of water.
3. **Crop Rotation:** this involves sowing of different crops in the same field in a regular sequence for a number of years.
4. **Fallowing:** aeration, texture and fertility of soil can be improved by ploughing the fields extensively and then leaving them without sowing for a year or two.

c) Planting Wind Breaks and Shelter Belts

To check the velocity of wind, two or more rows of tall trees are planted at right angles to the direction of the prevailing winds. These wind breaks check the movements of wind and therefore check soil erosion.

Man Induced Landslides

Landslides are the process of large differential movement of two land portions. Both natural and cultural sources are responsible for land sliding.

During construction of roads and mining activities huge portions of fragile mountainous areas are cut and thrown into adjacent areas and streams. These land masses weaken the already fragile mountain slopes and lead to landslides called man induced landslides.

Causes of landslides:

1. Over exploitation of ground water.
2. Improper mining operation and its abandonment,
3. Construction of dam on faulty planes.
4. Improper abutting of hilly and border road slopes.
5. Improper construction of small hydropower plants in hilly regions.
6. Tunneling for transportation and water ways.
7. Large scale disposal of hazardous waste, through number of deep well injections and
8. Improper protection of large scale gullies formed due to soil erosion in hilly slopes and others.

Effects of landslides:

1. Loss of habitat and biodiversity.
2. Large scale destruction of vegetation.
3. Disruption of communication links.
4. Loss of infrastructure, economic loss.
5. Increases the turbidity of nearby streams, thereby reducing their productivity.

FOREST RESOURCES

A forest is a biotic community which is predominantly composed of trees, shrubs or any woody vegetation and often with a closed canopy (over-hanging covering). Approximately one third of the earth's total land area is covered by forests. Forests and wildlife are essential for ecological balance of an area. Forests are important components of our environment and economy. Forest ecosystem is dominated by trees, their species content varying in different parts of the world.

Forests have following three types of functions:

1) ***Productive functions:*** The productive functions of forests include the production of Timber- for furniture items, Wood- which is used as fuel, raw material for various industries as paper and pulp Industries, news-print, board and packing articles (for fruit, tea etc.), matches, sports goods etc. Indian forests also supply minor forest products- like canes, gums, resins, dyes, tannins, lac, fibers, flocks, medicines, Kath etc. Tribal people forests also provide food (tuber, roots, leaves, fruits, meat from birds and other animals) and Medicare.
2) ***Protective functions:*** These functions include conservation of soil and water, prevention of drought and protection against wind, cold, radiation, noise, sights and smells, etc.
3) ***Regulative functions:*** Forests are a major factor of environmental concern, providing protection to wildlife, help in balancing the gaseous (CO_2, O_2) cycles of atmosphere, tend to increase local rainfall and water holding capacity of soil, maintain the soil fertility, regulate the earth's temperature, water cycles, check soil erosion, landslides, shifting of sand and silting and reduce flood havoc.

Over Exploitation:

Human beings have depended heavily on forests for food, medicine, shelter, wood and fuel. With growing, civilization the demands for raw material like timber, pulp, minerals, fuel wood etc. shooted up resulting in large scale logging, mining, road-building and clearing of forests. Excessive use of fuel wood and charcoal, expansion of urban, agricultural and industrial areas and overgrazing have together led to over-exploitation of our forests leading to their rapid degradation.

Deforestation (forest destruction):

Total forest area of the world in 1900 was nearly 7000 M.ha. By 1975 it was reduced to 2890 M.ha. By 2005 it was reduced to 2370 M.ha. and if continues like this by 2015 it would be merely 2000 M.ha.

Destruction of biotic potential of land leads to desertification. Such problem arises due to over grazing, indiscriminate felling of trees and over exploitation of land resources.

The disadvantaging effects of deforestation in India include soil, water and wind erosions, estimated to cost over 16,400 crores every year.

Deforestation has a major impact on the productivity of our croplands. This happens in two ways- 1. Soil erosion increases manifold and the soil actually gets washed, leading to an accentuated cycle of floods and drought. 2. But equally important is the impact of the shortage of firewood on the productivity of our croplands.

Causes of deforestation:

- Forests destroyed for growing demand of the cities.
- Local cattle, goats, sheep etc. destroy the vegetation.
- Shivaliksal forests were over exploited for industrial use (railway sleepers etc.)
- Demand of fuel wood and timber due to increase population.
- Construction of roads, railways, houses, dams and power stations.
- The faulty planning of Govt. and its negligence towards forests.
- The green house effect.

Effects of deforestation:

Deforestation affects human life in several ways. The main effects of deforestation are as follows:

1. Forests, particularly on mountains, provide considerable protection from floods by trapping and absorbing precipitation (i.e rain, snow etc) and slowly releasing it later. When the forest is removes, the amount of runoff water flowing into rivers and streams increases several fold causing frequent floods.
2. Deforestation results in increased soil erosion and decreased soil fertility. In drier areas, deforestation can lead to the formation of deserts. On an average India is losing about 6,000 million tons of top soil annually due to water erosion in the absence of trees.
3. Deforestation causes the extinction of forests dwelling plant, animal and microbial species resulting into a loss if irreplaceable genetic resources.
4. Deforestation also threats indigenous (tribal) people whose culture and physical survival depend upon the forests.
5. Deforestation induces regional and global climate change. The climate has become warmer due to lack of humidity in the deforested regions.
6. The pattern of rainfall has changed in deforested areas. The rainfall has declined and droughts have become common.
7. Deforestation also contributes to global warming stored carbon into the atmosphere as CO_2, which is a greenhouse gas.
8. Human beings are deprived of benefits of forest trees and wild animals.

Timber and Wood:

Total world wood consumption is about 360 million tons i.e. about 360 million m3/ year, more than steel and plastics together, weight- wise commercial timber and round wood (unprocessed logs) are used to make lumbers, plywood, veneer, particle board and chip board. Approximately 15 crore people depend only on fuel wood for their energy. Average quantity of wood requirement in the world is 1 m^3/year/person for cooking and heating.

**China suffered a lot from erosion and floods as it has cut millions of trees 1000 years ago. However, 4.5 million hectares/ year were planted between 1983 – 1993.*

Effects of timber extraction:

There has been unlimited exploitation of timber for commercial use. Commercial/industrial demand could out-strip supply leading to decimation of forests, particularly the wood.

The major effects of timber extraction on forests and tribal people include:

- Poor logging results in degraded forests.
- Soil erosion, especially on slopes.
- Sedimentation of irrigation systems.
- Floods may be intensified by cutting of trees on upstream watersheds.
- Loss of biodiversity.
- Climatic changes, such as lower precipitation.
- New logging roads permit shifting cultivators and fuel wood gatherers to gain access to logged areas and fell the remaining trees.
- Loss of non-timber products and loss of long-term forest productivity on the site affect the subsistence economy of the forest dwellers.
- Forest fragmentation, the reduction of a large block of forest to many smaller tracts, promotes loss of biodiversity because some species of plants and animals require large continuous areas of similar habitat to survive.
- Species of plants and animals, which may occupy marrow ecological niches and whose potential value to humans is unknown, may be eliminated.
- Indigenous people may be forced into a new way of life for which they are unprepared.
- Exploitation of tribal people by the contractors.
- Cutting of more trees than permitted in a particular area by the greedy contractors.

ENERGY RESOURCES

Growing Energy Needs:

Energy is an important input for development. It aims at human welfare covering household, agriculture, transport and industrial complexes. The rapidly expanding human population, human energy needs are increasing rapidly. It will demand the exploitation of most energy sources. Like other natural resources, energy resources are also non-renewable as well as renewable.

India's per capita energy consumption today, at 350 KWH per annum, is one tenth of world's average and one fourteenth of U.S. average. The energy consumption is concentrated in the urban sector covering 30% of the country's population. For example- an electric bulb uses 100 watts of energy, A color T.V. uses 200 watts, A car uses about 30,000 watts.

Thousands of years ago people had only sun's energy and their own energy. They burnt wood for heat, used animals for pulling. Surely we'll be going to those days again, steadily and surely.

The domestic power consumption has the following pattern of percentages:

S.No.	Purpose	Urban	Rural
1	Lighting by Kerosene	45.2	84.0
2	Lighting by electricity	53.0	-
3	Cooking by non-commercial fuel	58.1	4.5
4	Cooking by Kerosene	26.5	-

The present electric power generating capacity of 10^5 W if facing a 20% deficit to meet the demand.
The world consumes energy in the following fashion.
Petroleum products = 39%, Natural gas = 24%, Coal = 32%, Tidal Power = 2.5%, Nuclear power = 2.5%.

Types of Energy Resources:

1. Non- renewable Energy Resources:

These are exhaustible resources and available in limited amount and develop over a longer period. These include-

a. FOSSIL FUELS: like coal, petroleum, natural gas and mineral oil. Coal, petroleum and natural gas, the common sources of energy, being organic (biotic) in their origin are also called 'fossil fuels'. Fossil fuels contribute 60% of the present power generation.

i) Coal: Coal is the first fossil fuel to be exploited on a large scale; so industrial revolution enabled coal to be mined at even greater depths.

Types of coal:

a) *Peat* contains 5% of carbon, 5% of volatile matter and 90% moisture. It is having low calorific value. It is generally in dry condition.

b) *Lignite* is the lowest form of coal. It is brown in color. Hence it is called as brown coal. Pure lignite is mined at Neyveli, Tamilnadu. It has 38% of carbon, 19% of volatile matter and 43% of moisture.

c) *Bituminous coal* is also called soft coal. It contains 3% of water. It is highly flammable. It has 65% of carbon, and 32% of volatile matter.

d) *Anthracite* is a hard and dense coal. This type of coal contains 96% of carbon, 1% of volatile matter and 3% of moisture. It has the highest energy content of all coals and is used for space heating and generating electricity.

ii) Oil or Petroleum: Petroleum is an inflammable liquid composed of hydrocarbons, which constitute the majority and the remainder is organic compounds like O_2, N_2, S and traces of

organic-metallic compounds. It is pumped to the surface as crude oil and refined to get desired products.

Heated crude oil —Distillation→ Fuel gas, Propane, Butane, liquefied gas
→ Gasoline
→ Kerosene
→ Furnace oil
→ Diesel
→ Lubricants
→ Asphalt

Petroleum fractionation process

As a source of energy petroleum has many advantages

- ❖ it is relatively cheap to extract and transport
- ❖ it requires little processing to produce desired products and
- ❖ It has relatively high net and useful energy yield.

However it has certain disadvantages also,

- ❖ Produces environmental pollution.
- ❖ Oil spills, in ocean cause water pollution and is expensive to clean up.

iii) Petroleum gas: It is the mixture of three hydrocarbons such as butane, propane and ethane. The main constituent of petroleum gas is butane. These are in gaseous state, which is liquefied under pressure. So it is called as LPG. A domestic cylinder contains 14kg of LPG. A strong smelling substance called ethyl mercaptane is added to LPG cylinder to help in the detection of gas leakage.

iv) Natural gas: It consists of methane with small quantities of ethane and propane. It is available in deep under crust. Natural gas is a by-product to petroleum mining. It meets about 24% of the world's energy requirement. In our country few natural gas fields have been discovered recently in Tripura, shore area of Bombay and in the Krishna, Godavari delta.

b. <u>NUCLEAR FUELS:</u> Around 2.8 % of the power generation at present is atomic power with 10,000 MW. Radioactive materials like Uranium, Thorium, Radium etc. metals are used for production of energy by fission and fusion process.

Energy is generated from uranium for the peaceful work. 1kg of Uranium liberates an energy equivalent to 35000kg of coal. Nuclear energy is used for generation of electricity and used to running submarines, warships, space-crafts etc.

The first nuclear reactor was started in USA on Dec 2, 1942. Today almost all countries have atomic reactors for power generation. In France, 73% of the commercial energy is provided by atomic reactors.

There are several types of nuclear reactors, these are:

i) Light Water Reactor (LWR) ii) Heavy Water Reactor (HWR)
iii) Gas Cooled Reactor (GCR) iv) Boiling Water Reactor (BWR)
v) Pressurized Water Reactor (PWR) vi) Liquid Metal Fast Breeder Reactor (LMFBR)

2. <u>Renewable Energy Resources:</u>

These are mostly biomass based and available in unlimited amount in nature. These are inexhaustible materials. These include:-

<u>a. Hydro energy:</u> Large amount of kinetic energy of the flowing water is tapped using water turbines. A hydro power project involves construction of Dams. Currently 20% of the world's energy demand is produced in the form of hydro-energy. India is tapping about 84000MW through hydel potential. Totally, 271 projects have been installed in India. Advantages of Hydro power- clean source of energy, provides irrigation facilities, provides drinking water to the people living around.

b. Wind energy : Wind forms in two major ways in the atmosphere.

- ❖ Unequal distribution of temperature, pressure on earth surface.
- ❖ Continuous rotation of earth.

Wind mills have a good potential as an energy source, particularly in rural areas. The mobilization of this resource at present is negligible. Most important advantages of wind energy is – a perennial sources, available all the day and night, eco-friendly, non-polluting and freely available.

c. Solar energy: The sunshine in India supplies 1600 to 200 Kw per sq. m per year. Photovoltaic cell technology can hold a good promise for realizing the solar energy available in India. Presently it used to power satellites, watches, calculating devices etc. Following are some of applications of solar energy directly useful to the human beings- solar water heaters, solar cookers, solar drier, solar refrigerator.

d. Biomass: The matter originating directly or indirectly from photosynthesis is called biomass. Plant matter, bio degradable organic wastes, combustible waste residues etc constitute the biomass that can release heat energy on chemical/ biochemical oxidation.

Wood as fuel (amounting to 68.5%), oil products (15.6%), animal dung (8.3%) etc. are the biomass energy sources in the Indian rural area.

e. Bio gas: With 240 million cattle, India is the largest cattle dung producer. This material has a good potential to yield (methane) fuel gas under an anaerobic decomposition.

The composition of bio gas - CH_4: 50 to 55%, CO_2: 25 to 35%, O_2: 6 to 8%, Other gases: 7 to 15%. Over 1,50,000 bio gas plants are in operation today in our country.

f. Animal energy: Animal energy consumed in the agricultural sector of our country, employing 70 million bullocks, 8 million buffaloes, 1 million horses and 1 million camels in addition to donkeys, elephants. This animal power amounts to 30,000 MW as against 40,000 MW of total electrical energy capacity today.

g. Geothermal energy: The earth is having large amount geothermal energy with a higher temperature that is 4500^0C. The energy comes from the molten rock material beneath the earth surface. The available thermal energy is used to produce power by running a smaller capacity thermal power plant.

h. Tidal energy: Tides, the alternate rise and fall of sea water possess lot of energy. The identified tidal power potential in India is around 9000 MW. Currently Russia, China and Canada are effectively utilizing the tidal energy to produce 2 to 3% of their energy demand.

Alternative Energy Sources:

1. **Petro plants:** The hydrocarbons present in such plants can be converted into petroleum hydrocarbons. The plants belong to Euphorbiacea, Asclepiadacea, Apocynaceae and Sapotaceae and over 385 species have been screened for hydrocarbon content. 15 species around promising.

   The Indian Institute of Petroleum, Dehra Dun has done excellent work in this area. Particularly in hydro cracking of the crude products. The products obtained from their latex processed bio crude were gases, naphtha, kerosene, gas oil, heavier, coke.
2. **Dendro thermal energy (Energy plantations):** Waste lands are being used for plantation of fast growing shrubs and trees with high Calorific value. They in turn provide fuel wood, charcoal, fodder, power.
3. **Energy from urban waste:** Sewage in cities is used for generating gas and electricity.
4. **Bagasse-based plants:** Bagesse, a waste of sugar mills can be used to generate energy. It is estimated that sugar mills in India can generate 2,000MW surplus electricity during crushing season.

Citizen's role in conservation of Natural resources:

You and I share equal responsibility in keeping our environment clean and satisfy our quest for green earth, clean air and pure water.

1. Activities should be organized to promote the awareness of the levels of pollution and their effects and impacts.
2. The right to information, that concerns their own welfare, should be asserted.
3. The provisions of public interest litigation to seek legal redress case of victimization by pollution or violation of norms should be encouraged.
4. Citizens should be –Co-ordination among the involved Governmental departments to protect the environment.

How can individuals help in conservation of different resources?

Conserve water:

- ❖ Don't keep water taps running while brushing, shaving, washing or bathing.
- ❖ In washing machines fill the machine only to the level required for your clothes.
- ❖ Install water-saving toilets that use not more than 6 lit. per flush.
- ❖ Check for water leaks in pipes and toilets and repair them promptly. A small pin-hole sized leak will lead to the wastage of 640 lit. of water in a month.
- ❖ Reuse the soapy water of washings from clothes for washing off the courtyards, driveways. etc.
- ❖ Water the plants in your kitchen-garden and the lawns in the evening when evaporation losses are minimum. Never water the plants in mid-day.
- ❖ Use drip irrigation and sprinkling irrigation to improve irrigation efficiency and reduce evaporation.
- ❖ Install a small system to capture rain water and collect normally wasted used water from sinks, cloth-washers, bath-tubs etc. which can be used for watering the plants.
- ❖ Build rain water harvesting system in your house. Even the president of India is doing this.

Conserve Energy:

- ❖ Turn off lights, fans and other appliances when not in use.
- ❖ Obtain as much heat as possible from natural sources. Dry the clothes in sun instead of drier if it is a sunny day.
- ❖ Use solar cooker for cooking food on sunny days which will be more nutritious and will cut down LPG expenses.
- ❖ Building house with provision for sunspace which will keep house warmer and will provide more light.
- ❖ Grow deciduous trees and climbers at proper places outside breeze and shade. This will cut off electricity charges on coolers and air-conditioners. The deciduous trees shed their leaves in winter. Therefore they do not put any hindrance to the sunlight and heat.
- ❖ Drive less, make fewer trips and use public transportations whenever possible. You can share by joining a car-pool if you regularly have to go to the same place.
- ❖ Add more insulation to your house. During winter close the windows at night. During summer close the windows during days if using an A.C. Otherwise loss of heat would be more, consuming more electricity.
- ❖ Instead of using the heat convector more often wear adequate woolens.
- ❖ Recycle and reuse glass, metals and paper.
- ❖ Try riding bicycle or just walk down small distances instead of using your car or scooter.
- ❖ Lower the cooling load on an air conditioner by increasing the thermostat setting as 3-5% electricity is saved for every one degree rise in temperature setting.

Protect the soil:

- While constructing your house, don't uproot the trees as far as possible. Plant the disturbed areas with a fast growing native ground cover.
- Grow different types of ornamental plants, herbs and trees in your garden. Grow grass in the open areas which will bind the soil and prevent its erosion.
- Make compost from your kitchen waste and use it for your kitchen-garden or flower-pots.
- Do not irrigate the plants using a strong flow of water, as it would wash off the soil.
- Better use sprinkling irrigation.
- Use green manure and mulch in the garden and kitchen-garden which will protect the soil.
- If you own agricultural fields, do not over-irrigate your fields without proper drainage to prevent water logging and Stalinization.
- Use mixed cropping so that some specific soil nutrients do not get depleted.

Promote sustainable agriculture:

- Do not waste food. Take as much as you can eat.
- Reduce the use of pesticides.
- Fertilize your crop primarily with organic fertilizers.
- Use drip irrigation to water the crops.
- Eat local and seasonal vegetables. This saves lot of energy on transport, storage and preservation.
- Control pests by a combination of cultivation and biological control methods.

Essay Questions:

1. Write short notes on solar power.
2. Describe the role of individual in conservation of natural resources.
3. Explain show agricultural practices implemented to increase the field from the land lead to formation of unproductive land.
4. Explain the difference in consumption of resources by the countries of the developing and developed world.
5. What are Mineral resources? Discuss the use and exploitation of mineral resources.
6. Write an essay on land resources. What are soil erosion and desertification?
7. Write an essay on renewable and non renewable resource of energy.
8. Suggest measures for solving World Food Problems.
9. Explain the natural cycles of atmosphere. How do these cycles maintain balance of nature?
10. Explain different benefits of forests.
11. Write a brief note on Floods as a series environmental hazard.
12. What is the necessity for a rational land use policy as part of the environmental policy?
13. Describe the main factors of land degradation.
14. Discuss with the help of a case study, how big dams have affected forests and the tribal.
15. What are the major causes for conflicts over water? Discuss one international and one- inter-state water conflict.

UNIT III : BIODIVERSITY AND BIOTIC RESOURCES

Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot-spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Conservation of biodiversity: insitu and Ex-situ conservation. National biodiversity act.

Biodiversity *is defined as 'richness of species (microorganisms, plants and animals) occurring in a given habitat'.* **Or**

Varity and variability among living organisms and ecological complexes in which they occurs. It is the sum of genes, species and ecosystems.

Biodiversity includes the different:

1. Types of animals, birds, fish, insects, bacteria, and other species.
2. Ways in which species interact with their environment.
3. Ways species live together.
4. Types of places species live together.
5. Characteristic within a species.

SIGNIFICANCE OF BIODIVERSITY

1. Biodiversity is very important for human life, as we depend on plants, microorganisms, earth's animals for our food, medicine and industrial products.
2. Biodiversity protects the fresh air, clean water and productive land.
3. It is also important for forestry, fisheries and agriculture, which depend on rich variety of various biological resources available in nature.
4. Loss of biodiversity has serious economic and social costs for any country.

TYPES OF BIODIVERSITY

Biodiversity is generally classified classified into three types:

1. Genetic diversity
2. Species Diversity
3. Ecosystem or Community Diversity.

1. Genetic Diversity

Genetic diversity refers to the variation of genes within species. Genes are the basic units of all life on Earth. They are responsible for both the similarities and differences between organisms. Each species is made up of individuals that have their own particular genetic composition. This means a species may have different populations of species compositions to conserve genetic diversity, different populations of species must be conserved. This type of diversity occurs at finer levels of organisms. Genetic diversity can be measured using a variety of DNA based and other techniques.

2. Species Diversity

Species diversity is the number of different species of living things available in an area. Species is a group of plants or animals that are similar and able to breed and produce viable offspring under natural conditions. This type of diversity is the most common level of diversity. It is measured in relation to a given area.

3. Ecosystem Diversity:

Ecosystem diversity is the variety of ecosystems in given place. An ecosystem is a community of organisms and their physical environment interacting together. An ecosystem can cover a large area, such as a whole forest, or a small area, such as a pond. This type of diversity is considered as a complex level of diversity.

VALUES OF BIODIVERSITY:

The value of bio diversity is classified into the following two types

1. **Direct values** and
2. **Indirect values**

1. Direct values: These are assigned to the products harvested by people,

Direct values can be further divided as follows:

a. ***Consumptive use value:*** This can be assigned to goods such as fuel wood and gum that are consumed locally and do not figure in national and international market.
eg. Firewood, food, meat.

b. ***Productive use value:*** This is assigned to products that are harvested from the wild and sold in commercial markets, both at national and international levels.
e.g timber, fish, honey, construction material, mushrooms, fruits, meat, medicinal plants etc.

2. Indirect Values: these are assigned to benefits provided by biodiversity that do not involve harvesting or destroying the resource without consumption of resource. Such benefits include water quality, soil protection, recreation, education, scientific research, regulation of climatic and producing further options for human society. Indirect values further divided into-

a. Social Values:

It refers to the manner in which the bio-resources are used to the society. These values are associated with the social life, religion and spiritual aspects of the people.

e.g. Holy plants: tulsi, peepal, lotus, betal these are used in worship.

Holy animals: cow, snake, bull, peacock, rats, etc., are used in worship.

b. Ethical Values or Existence Values:

It involves ethical issues like "all life must be preserved". In India and in other countries biodiversity is considered to have great value on religious and cultural basis. It teaches us to worship plants, animals, rivers and mountains. The ethical values mean that a species may or may not be used, but its existence in nature gives us pleasure.

E.g. Holy River Ganga, holy plants vembu, tulsi, kangaroo, zebra or giraffe feel that these should exist in nature.

c. Aesthetic Values:

The beautiful nature of plants and animals insist us to protect the biodiversity. The most important aesthetic value of biodiversity is eco-tourism.

e.g., eco-tourism: people spend lot of time and money to visit the beautiful areas and enjoy the aesthetic value of biodiversity. Wild birds, animals, butterflies, flowers, valleys etc.

d. Intrinsic Values:

It implies conservation of biodiversity and the need to facilitate continued evaluation. Humans should protect biodiversity because protection of the environment is morally good.

e. Environmental Services:

Protection of water resources, soil formation and protection, nutrient storage and cycling, pollution breakdown and absorption, contribution to climate stability, maintenance of ecosystem.

Bio Geographical Classification of India:

One of the major approaches to the classification of India's ecosystems has been based on biogeography. The major objective of this bio geographical classification based on scientific facts is to enable conservation planning, both at the national and state levels. The biogeographical classification uses four levels of planning units which are listed below:

The Biogeographic Zone: It is a large distinctive unit of similar ecology, biome representation, community and species. E.g. the Himalaya, the Western Ghats.

The Biotic Province: It is Secondary in units within a biogeographic zone, giving weight to particular community separated by dispersal barriers or gradual change in environmental factors e.g. North West and Western Himalayas either side of Sutlej River.

The Land Region: It is tertiary set of units within a province, indicating different land forms. E.g., Aravalli Mountains and Malwa Plateanu in Gujarat-Rajwara Province.

The Biome: It is an ecological unit, not a biogeographic unit. A biome such as swamp/wetland of temperate broad leaved forest could be found in several biogeographic zones or provinces.

India is classified into 10 Biogeographic Zones and is further divided into 26 Biotic Provinces. The Indian Biogeographpical Zones are following.

Zone no.	Zone name	Provinces	Zone area km^2	% of India
1	Trans-Himalaya	2	184823	5.62
2	Himalaya	4	210662	6.41
3	Desert	2	215757	6.56
4	Semi-arid	2	545850	16.6
5	Western ghats	2	132606	4.03
6	Deccan Peninsula	5	1380380	41.99
7	Gangetic Plain	2	354782	10.79
8	Coasts	3	82813	2.52
9	North East	2	171341	5.21
10	Island	2	8249	0.25
Grand Total		26	3287263	100.00

India as a Mega-diversity Nation:

India has a rich and varied heritage of biodiversity, encompassing a wide spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forests to coastal wetlands. India contains about 8% of the world's biodiversity on 2% of the Earth's surface, making it one of the 12 mega diversity countries in the world. This is based on the species richness and levels of endemism recorded in a wide range of taxa of both plant and animals. This diversity can be attributed to the vast variety of landforms and climates resulting in habitats ranging from tropical to temperate, and from alpine to desert. Adding to this is very high diversity of human influenced ecosystems, including agricultural and pasturelands and an impressive range of domesticated plants and animals. India is also considered one of the world's eight centers of origin of cultivated plants. India has got 12 biosphere reserves and 5 world heritage sites.

India due to its varied physical features and its geographical location, experience almost all kinds of climate, from tropical to alpine and from desert to humid. On the basis of temperature the landmass of India is classified into four zones:

1: ***Tropical zone:*** This is very hot round the year and does not have a winter.
2: ***Subtropical zone:*** This is hot for the year and with a cool winter.
3: ***Temperate zone:*** This has a short summer and a pronounced winter.
4: ***Arctic or Alpine zone:*** This has a short summer and a long and severe winter.

The following is a list of important facts about the Indian biodiversity:

- India is a home to 33% of life forms found in the world and is one among the 12 mega diverse countries of the world.
- India comprises 2% of the world's landmass but is home to 8% of biodiversity of the world.
- India can be divided into 10 biogeographic zones and 26 biotic provinces, which represents all the major ecosystem of the world.
- There are 33 Botanical Gardens, 89 national parks, 275 zoos, 504 sanctuaries and 12 biosphere reserves in India.
- There are 47000 species of plants and 81000 species of animals identified in the country.
- 60% of this wealth can be found in the Western Ghats, which is one of the hotspots of diversity in India.
- Of 81,000 species of animals recorded 372 are mammals, 1228 are birds, 428 reptiles, 204 amphibians, 2536 fishes, 57,245 insects, 5042 mollusks and several other species of invertebrates.
- India is a signatory to the international conventions like Convention of International Trade on Endangered Species and Convention of Migratory Species which aim at conserving biodiversity.
- India is home to 5 world heritage sites and 6 Ramsar wetlands, amongst the protected areas. (Kaziranga National Park, Keoladeo Ghana National Park, Manas Wildlife Sanctuary, Nanda Devi National Park, Sundarban National Park).

Hot Spots of Biodiversity:

Hotspots are regions that harbor a great diversity of endemic species and, at the same time, have been significantly impacted and altered by human activities. Plant diversity is the biological basis for hot spot designation. To qualify as a hotspot a region must satisfy the following conditions.

- Must support 1500 endemic plant species, 0.5% of global total. Existing primary vegetation is the basis for assessing human impact in a region;
- Must have lost more than 70% of its original habitat.

Plants have been used as qualifiers because they are the basis for diversity in other taxonomic groups and are well known to researchers. Typically, the diversity of endemic vertebrates in hotspot regions is also extraordinarily high. Thus hotspots are extremely rich in species, have high endemism, and are under constant threat.

The hotspot concept targets regions where the threat is greatest to the number of species and allows conservationists to focus cost effective efforts there. The 25 biodiversity hotspots of the world' contain 44% of all plant species and 35% of all terrestrial vertebrate species in only 1.4% of the planet's land area.

World Hotspots list:

1. Tropical Andes.	**2. Mesoamerica**	3. Caribbean
4. Brazil's Atlantic forest	**5. Choc.Darien/Western Ecuador**	6. Brazil's Cerrado
7. Central Chile	**8. California Floristic Province**	9. Madagascar
10. Eastern Arc and Costal forests of Tanzania/Kenya		11. Western African Forests

12. Cape Floristic Province
13. Succulent Karoo
14. Mediterranean Basin
15. Caucasus
16. Sundaland
17. Wallace a
18. Philippines
19. Indo-Burma
20. South Central China
21. Western Ghats
22. SW Australia
23. New Caledonia
24. New Zealand
25. Polynesia/Micronesia.

HOTSPOTS OF INDIA

Among the 25 hotspots of the world, two are located in India extending into neighboring countries the ***Indo-Burma region (eastern Himalayas) and the Western Ghats.*** These areas are particularly rich in floral wealth and endemism, not only in flowering plants but also in reptiles, amphibians, butterflies, and some mammals.

Eastern Himalayas:

Geographically the eastern Himalayas area comprises Nepal, Bhutan and neighboring states of Northern India, along with a continuous sector of the Yunnan Province in southwest China. The following are salient features of Eastern Himalayan regions.

- The Eastern Himalayas display an ultra-varied topography, a factor that fosters species diversity and endemism.
- Many deep and semi isolated valleys are exceptionally rich in endemic plant species. In Sikkim, in an area of 7298 km^2, of the 4250 plant species, 2550(60%) are endemic.
- In India's sector of the area, there are about 5800 plant species, of which roughly 2000(36%) are endemic.
- In Nepal, there are around 7000 plant species, many of which overlap with those of India, Bhutan, and even Yunnan. Of these species, at least 500(8%) are believed to be endemic to Nepal.
- Bhutan possesses an estimated 5000 species, of which as many as 750(15%) are considered to be endemic to the Eastern Himalayas.

Western Ghats:

Out of India's 49219 plant species, 1600 endemics (40% of total number of endemics) are found in 17000km^2 strip of forest along the sea side of Western Ghats in Maharashtra, Karnataka, Tamil Nadu and Kerala. There are two main centers of diversity, the Agastyamalai Hills and the Silent Valley/New Amambalam Reserve basin.

One third of all the flowering plant species in India are found in this region.450 odd plants found in this region, 40% are endemic. A few of the indigenous and exotic tree and plant species in the Western Ghats are the teak, jamun, cashew, hog plum, coral tree, jasmine and crossandra.

MAJOR THREATS TO BIODIVERSITY:

Any disturbance in a natural ecosystem tends to reduce its biodiversity. The waste generated due to increase in human population and industrialization, spoils the environment and leads to more diversity in biological species. Any change in the system leads to a major imbalance and threatens the normal ecological cycle. Causes for biodiversity or various threats to Indian biodiversity are

1. Habitat Loss
2. Poaching of wild life.
3. Man-wildlife Conflicts.

1. HABITAT LOSS

The loss of populations of interbreeding organisms is caused by habitat loss. Habitat loss threatened a side rang of animals and plants. Factors influencing habitat loss are:

1. ***Deforestation:*** Forest and grasslands have been cleared for conversion into agricultural lands or settlement areas or developmental project. The forest and grasslands are the natural homes of thousands of species, which disintegrate due to loss of their natural habitat.
2. ***Destruction of wetlands:*** The wetlands, estuaries and mangroves are destroyed due to draining, filling and pollution, which cause huge biodiversity loss.
3. ***Habitat Fragmentation:*** It is process of division of population into number of small and smaller groups. These small populations are increasingly susceptible to inbreeding depression, high infant mortality and susceptible to environmental stochasticity and consequently in the end possible extinction.
4. ***Raw material:*** For the production of hybrid seed, the wild plants are used as raw materials. As a result many plant species become extinct.
5. ***Production of Drugs:*** Many pharmaceutical companies collect wild plant for the production of drugs. Therefore several medicinal plant species are on the verge of extinction.
6. ***Illegal Trade*** on wild life also reduces the biodiversity and leads to habitat loss.
7. ***Development Activities*****:** Construction of massive dams in forest area, discharge of industrial effluents kills the birds and other aquatic organisms.
8. ***Diseases:*** Pathogens, or disease organisms, may also be considered predators. The incidence of disease in wild species may increase due to human activities.
9. ***Pollution:*** Environmental pollution is the most harmful to habitat degradation. Most common causes of which are pesticides, industrial effluents and emissions, and emission from automobiles.
10. ***Introduction of exotic species:*** Organisms introduced into habitats where they are not native are termed as exotic. They can be thought of as biological pollutants and are considered to be among the most damaging agents of habitat alteration and degradation.

2. POACHING OF WILDLIFE:

Poaching means killing of animals or commercial hunting. It leads to loss of animal diversity.

a. ***Subsistence Poaching:*** It is killing animals to provide enough food for their survival.
b. ***Commercial Poaching:*** It is hunting and killing animals to sell their products.
E.g. Furs, horns, tasks, live specimens, herbal products, ivory, and meat.

3. MAN-WILDLIFE CONFLICTS:

It arises when wildlife starts causing immense damage and danger to man. Under such conditions it is very difficult for the forest department to compromise the affected villagers and to gain the villagers support for wildlife conservation. Factors influences conflicts are

1. Shrinking of forest cover compels wildlife to move outside the forest and attack the field and humans for food.
2. Human encroachment into the forest area.
3. Injured animals, female wildlife attack humans.
4. Electrification of crop field from wildlife.
5. Cash compensation paid by govt. is less than the damage which makes farmers anger and takes revenge by killing them.
6. Garbage or food crop near forest areas attacks wild animals.

BIODIVERSITY CONSERVATION

In order to retain the capabilities of life supporting systems it is essential to save and maintain species and ecosystems ultimately for survival of human race. Efforts have been made to save biodiversity both by ex-situ and in-situ conservation.

1. ***Ex-situ conservation:*** It refers to conservation of species in suitable locations outside their natural habitat. The need to conserve species in ex-situ arise when its population is so fragile/fragmented that its survival in wild may no longer be possible or in other words a threatened or endangered species.

   e.g Botanical/Zoological gardens, aquarium and research centers, Field Gene Banks(pollen, semen, ova, cells), Seed Banks, In Vitro(in Grass: meristem tips, buds and stem tips kept under low temp. for slow growth for longer storage).
2. ***In-situ conservation:*** The preservation of species in its natural ecosystem is called in-situ conservation. It is being done by declaring the area as 'protected area' with either to save the entire area or an endangered species. As a consequence, protected area are being identified and maintained for natural conservation of species by individual countries in the world. Protecting the areas helps not only in conserving individual species but preserves ecosystem also. In these protected areas – tourism, explosive activities, poaching, shooting, grazing of domestic animals, cutting of trees are strictly prohibited. We have protected area network of Biosphere, National park and Sanctuaries etc.

Steps for Conservation of Biodiversity:

1. Biodiversity inventories and assessments – population surveys and assessments – population surveys and assessment.
2. Identifying and expanding protected areas.
3. Conserving biodiversity in seed banks and gene banks.
4. Controlling wild life trade.
5. Providing environmental education to the people.
6. Reviewing agricultural practices.
7. Controlling urbanization.
8. Geographical information system for planning and monitoring.
9. Restoration of biodiversity.
10. Population control.
11. Implementing environmental protection Act (EPA).
12. Involving more non-government organizations (NGOs).

THE NATIONAL BIOLOGICAL DIVERSITY ACT, 2002

It is an act of the Parliament of India for preservation of biological diversity in India, and provides mechanism for equitable sharing of benefits arising out use of traditional biological resources and knowledge. The act was enacted to meet the obligations under Convention on Biological Diversity (CBD), to which India is a part.

Biodiversity and Biological Resource

Biodiversity has been defined under Section 2(b) of the Act as 'the variability among living organisms from all sources and the ecological complexes of which they are part, and includes diversity within species or between species and of ecosystem". The Act also defines Biological resources as plants, animals and micro-organisms or parts thereof, their genetic material and by by-products (excluding value added products) with actual or potential use or value, but does not include human genetic material".

National Biodiversity Authority and State Biodiversity Boards.

The National Biodiversity Authority(NBA) is a statutory autonomous body, headauter in Chennai, under the ministry of Environment and Forests, Government of India established in 2003 to implement the provisions under the Act, State Biodiversity Boards (SBB) has been created in 29 States along with 31,574 Biological management committees (for each local body)across India.

Functions

1. Regulation of acts prohibited under the Act.
2. Advises the Government on conservation of biodiversity.
3. Advises the Government on selection of biological heritages sties.
4. Take appropriate steps to oppose grant of intellectual property rights in foreign countries, arising from the use of biological resources or associated traditional knowledge.

Regulations

A foreigner, non-resident Indian as defined in clause (30) of selection 2 of The Income tax Act, 1961 or a foreign company or body corporate need to take permission from the NBA before obtaining any biological resources or associated knowledge from India for research, survey, commercial utilization, India citizens or body corporate need to take permission from the concerned State Biodiversity Board.

Result of research using biological resources from India cannot be transferred to a non-citizen or foreign company without the permission of NBA. However, no such permission is needed for publication of the research in journal or seminar, or in case of a collaborative research made by institutions approved by Central Government.

No person should apply for patent or other form of intellectual property protection based on the research arising out of biological resources without the permission of the NBA. The NBA while granting such permission may make an order for benefit sharing or royalty based on utilization of such protection.

Benefit Sharing

Benefit sharing out of usage of Biological Resources can be done in the following manner:

1. Joint ownership of intellectual property rights.
2. Transfer of technology.
3. Location of production, research development units in the area of source.
4. Payment of monetary and non-monetary compensation.
5. Setting up of venture capital fund for aiding the cause of benefit claimers.

Penalties

If a person, violates the regulatory provisions he will be ‘punishable with imprisonment for a term which may extend to five years, or with a fine which may extend to ten lakh rupees and where the damage caused exceeds ten lakh rupees such fine may commensurate with the damage caused, or with both”.

Any offence under this Act is non-bailable and cognizable.

Essay Questions

1. Define biodiversity.
2. Explain different types of biodiversity.
3. Write a note on biogeographical classification of India.
4. Discuss briefly on value of biodiversity.
5. Justify India as a mega diversity nation.
6. Explain the various threats to and measures recommended for conservation of biodiversity.
7. What is mean by endangered species? Give types of endangered species with eg.
8. Explain factors affecting endangered species.
9. Give advantages of conservation of biodiversity.
10. List of the factors affecting biodiversity.
11. Explain In-situ and Ex-situ conservations.
12. Suggest suitable steps for conservation of biodiversity.

UNIT IV
ENVIRONMENTAL POLLUTION AND CONTROL

Definition and Classification of Pollutants

Question 1: Define pollution and pollutant. Classify pollutants?

Pollution: Any atmospheric condition, in which certain substances are present in such concentration that they can produce undesirable effects on man and his environment. **OR**

Pollution is defined as the excess discharge of any substance into the environment which affects adversely quality of environment and causing damage to human, plants and animals.

Pollutant: Any substance which causes pollution called as pollutant.

Classification of Pollutants: It is done from different point of view.

(I) Depending upon their existence in nature pollutants are of two types, namely quantitative and qualitative pollutant.

a) Quantitative pollutants: these are those substances normally occurring in the environment, who acquire the status of a pollutant when their concentration gets increased due to the unmindful activities of man. For example, carbon dioxide, if present in the atmosphere in concentration greater than normal due to automobiles and industries, causes measurable effects on humans, animals, plants or property, and then it is classified as quantitative pollutant.

b) Qualitative pollutant: these are those substances which do not normally occur in nature but are added by man. e.g. Insecticides.

(II) Depending upon the form in which they persist after being released into the environment, the pollutants are categorized into two types, namely primary and secondary pollutants.

a) Primary Pollutants: these are those which are emitted directly from the source and persist in the form in which are added to the environment. E.g. Ash, smoke, dust, fumes, SO_2, HC etc.

b) Secondary Pollutants: These are those which are formed from the primary pollutants by chemical interaction with some constituent present in the atmosphere. E.g.SO_3, NO_2, O_3, aldehyde.

(III) From the ecosystem point of view, i.e., according to their natural disposal, pollutants are two types:

a) Bio-degradable Pollutants: these are the pollutants that are quickly degraded by natural means. E.g., heat or thermal pollution, and domestic sewage etc.

b) Non-degradable Pollutants: these are the substances that either do not degrade or degrade very slowly in the natural environment. E.g. Hg salt, DDT, Aluminum cans etc.

Classification of Pollution:

On the basis of type of environment being polluted, pollution classified into- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear pollution.

AIR POLLUTION

TYPES, SOURCES AND EFFECTS OF AIR POLLUTANTS

Question 2: Define air pollution. What is primary and secondary air pollutant? Write sources and effects air pollutants.

Solution: Air pollutants are two types:

a. Primary pollutants: These are those that are emitted directly from source. Sources are steel mills, power mills, oil refiners, paper and pulp industries, automobiles etc.

Ex. Particulate matter such as ash, smoke, dust, fumes, mist and spray; inorganic gases as SO_2, H_2S, NO, NH_3, CO, CO_2, HF, Olefin and aromatic hydrocarbons and radio active compounds.

b. Secondary pollutants: These are formed in the atmosphere by chemical interactions among primary pollutants and normal atmospheric constituents. Pollutants such as SO_3, NO_2, PAN((peroxyethenoyl nitrate), O_3, aldehydes, ketones, and various sulphate and nitrate salts include in this category.

Sources and effects of air pollutants

1. Particulate Pollutants:

Particulate refers to all atmospheric substances that are not gases but they may be suspended droplets or solid particles or mixtures of the two. Their size ranges from 100 µm to 0.1 µm and less. Larger particles like sand and water droplets quickly settle down in still air and smaller particle s like dust remain in air for longer time whereas very fine particles like tobacco smoke do not settle down at all.

Particulates classifies as-

Dust: Size 1 to 200 micrometers. These are formed by natural disintegration of rock and soil or by the mechanical process of grinding and spraying. They have large setting velocities and are removed from the air by gravity and other inertial process.

Smoke: Size 0.001 to 1 micrometer. This can be liquid or solid and are form by combustion or other chemical process.

Fumes: Size 0.1 to 1 micrometer. There are solid particles which are normally released from chemical or metallurgical processes in industries.

Mist: Size < 10 micrometer. It is made up of liquid droplets. These are formed by condensation in the atmospheric or released from industrial operations.

Effects: Respiratory problems, lungs damage, Bronchitis, asthma, irritation, visibility decreases, Reduces solar radiation, effects weather condition, effects atmosphere constituents, etc.

2. Gaseous Pollutants

1. Oxides of sulfur:

Sources: Chemical industries, metal smelting, pulp and paper mills, oil refineries.

SO_2 is a colorless gas with a characteristic, sharp, pungent odor. It is moderately soluble in water forming weak acid H_2SO_3. It is oxidized slowly in clean air to SO_3 In polluted atmosphere SO_2 reacts photo chemically or catalytically with other pollutants or normal atmospheric constituents to form SO_3, H_2SO_4 and salts of H_2SO_4.

Effects:

- SO_2 and moisture can accelerate the corrosion of steel, copper, zinc and other metals.
- H_2SO_4 mist in the atmosphere causes deterioration of structural monuments or materials such as marble and lime stone.
- Clothes, leather and Paper discolored by SO_2.
- 8 – 12 ppm of SO_2 - immediate throat infection, 10 ppm SO_2 – eye irritation, 20 ppm – immediate coughing.
- High concentration of SO_2 suffers plats from chlorosis (disappearance of chlorophyll), metabolic inhibition, plasmolysis and even death.

2. Nitrogen Dioxide:

Sources are natural and manmade.

Naturally nitrogen dioxide coming from high energy radiation, biological and non-biological activities (lightening, radiations, bacterial decomposition etc).

Man-made nitrogen dioxide coming from incineration process, pesticide industries, automobiles.,

Effects:

- NO_2 combine with hydrocarbons to form photochemical smog its cause most damage to human health.
- In lungs NO_2 converted to nitrous and nitric acids which are highly irritating and cause damage to the lung tissues.
- It causes acid rain and cancer.
- In plants premature fall of leaves and retards growth which reduces yield.

3. Carbon monoxide:

Sources: Incomplete combustion of carbon fuels in automobiles, industries etc.

The main sources of CO in the urban air are smoke and exhaust fumes of many devices burning of coal, gas or oil.

Effects: CO reacts with blood hemoglobin to form carboxyhemoglobin.

1-5% COHb in blood –reduction in oxygen carrying capacity of blood.

30-40% COHb in blood- Severe headache, vomiting.

50-60% COHb in blood- Coma.

70-80% COHb in blood – Fatal coma (death).

4. Hydrocarbons:

Sources: Are automobiles, natural fire, industrial source (refineries), spray paintings, inks, etc.

Effects: Skin, nose, throat, eye irritation. Cause cancer in human beings.

CONTROL OF AIR POLLUTION

Question 3: Explain various techniques for reducing air pollution.

Solution: The following methods are most effective for dealing with the control of air pollution.

(a) Source Correction Methods.

(b) Pollution Control Equipment.

(c) Diffusion of Pollutant in air.

(d) Vegetation.

(e) Zoning.

A. Source Correction Methods:

Industries make a major contribution towards causing air pollution. Formation of pollutants can be prevented and their emission can be minimized at the source itself. By carefully investigating the early stages of design and development in industrial processes e.g., those methods which have minimum air pollution potential can be selected to accomplish air pollution control at source itself.

These source correction methods are:-

1.Substitution of raw materials:

Raw material causing air pollution should be substituted by another purer grade raw material which reduces the formation of pollutants. e.g. coal with LPG or LNG.

2.Process Modification:

The existing process may be changed by using modified techniques to control emission at the source. e.g. fly ash emissions are reduced by washing coal before pulverization and by adjusting air intake of boiler furnace.

3.Modification of Existing Equipment:

By suitable modifications in the existing equipment air pollution can be minimized.

Open hearth furnaces are replaced with controlled basic oxygen furnaces or an electric furnace reduces smoke, CO and fumes.

In petroleum refineries if storage tanks are designed with floating roof covers reduces loss of hydrocarbon vapors.

4.Maintenance of Equipment:

Poor maintenance of equipment (leakage around ducts, pipes and pumps etc.) pollution is caused which can be minimized by routine checkup of seals and gaskets.

B. Pollution Control Equipment:

Sometimes pollution control at the source is not possible by preventing the emission of pollutants. Then it becomes necessary to install pollution control equipment to remove the gaseous pollutants from the main gas stream.

Pollution control equipment's are generally classified into two types:

Control devices for particulate contaminants.	Control devices for gaseous contaminants.
Gravitational Settling Chamber	Wet absorption methods.
Cyclone Separators (Reverse Flow Cyclone)	Dry absorption methods.
Fabric Filters	
Electrostatic Precipitators	
Wet Collectors (Scrubbers)	

CONTROL DEVICES FOR PARTICULATE CONTAMINANTS.

a. ***Gravitational Settling Chamber:*** For removal of particles exceeding 50µm in size from polluted gas streams, gravitational setting chambers are put to use.

This device consists of huge rectangular chambers. The gas streams polluted with particulates is allowed to enter from one end. The horizontal velocity of the gas stream is kept low in order to give sufficient time for the particles to settle by gravity. The several horizontal shelves or trays improve the collection efficiency by shortening the settling path of the particles.

b. **C*yclone Separators (Reverse Flow Cyclone***): Centrifugal force is several times greater than gravitational force it is generated by spinning gas stream and this quality makes cyclone separators more effective in removing much smaller particulates than gravitational settling chambers.

It consists of cylinder with a conical base, a tangential inlet discharging near the top and outlet for discharging the particulates is present at the base of the cone.

c. ***Fabric Filters:*** In this a stream of the polluted gas is made to pass through a fabric that filters out the particulate pollutant and allows the clear gas to pass through. The particulate matter is left in the form of a thin dust mat on the insides of the bag. This dust mat acts as a filtering medium for further removal of particulates increasing the efficiency of the filter bag to sieve more sub-micron particles (0.5µm).

A typical filter is a tabular bag which is closed at the upper end and has a hopper attached at the lower end to collect the particles when they are dislodged from the fabric. Many such bags are hung in a bag house. For efficient filtration and a longer life the filter bags must be cleaned occasionally by mechanically shakers to prevent too many particulate layers from building up on the inside surface of the bag.

d. ***Electrostatic Precipitators:*** It works on the principal of electrostatic precipitation i.e., electrically charged particulates present in the polluted gas are separated from the gas stream under the influence of the electrical field.

In this equipment, two electrodes are used to separate the dust particles from stream. The gas stream is allowed to pass between the two electrode wires. The electrical charge is

imparted to the particles through a high voltage direct current corona. The high voltage field ionizes the gas molecules in the air stream and makes the particulate matters with negative charge. The negatively charged particles are attracted by the positively charged electrodes which are called as collectors. The charge of the particles is neutralized at the moment of collection, and they can be removed from the collectors by rapping, washing or plain gravity.

e. ***Wet Collectors (Scrubbers):*** In this the particulate contaminants are removed from the polluted gas stream by incorporating the particulates into liquid droplets. Common types of scrubbers are: *1. Spray Tower ii. Venturi Scrubber iii. Cyclone scrubber.*

Each type of scrubber has unique applicability, among the above types of scrubbers spray tower is the simplest type. They are low energy scrubbers and that can be used to remove particles of size 5 to 10 µm. venture scrubbers are of high energy scrubbers and they can be effective in removal of particles of size smaller than 3 µm.

In the spray tower the air stream with particles is introduced at the bottom. The polluted gas flows upwards. Water is introduced at the top by means if spray nozzles. By internal impaction and interception the particulate matters are entrained by the water molecules. The water with particles is collected at the bottom and disposed.

The efficiency depends on the velocity of water, size of spray, droplet size, velocity of a gas, quality of water and gas introduce and droplet trajectories. Efficiency increases with decreasing diameter of water droplet and with increasing droplet quantity.

C: Diffusion of Pollutants in Air:

Dilution of contaminants in the atmosphere is another approach to control air pollution it is accomplished through the use of tall stacks which penetrate the upper atmospheric layers and disperse the contaminants so that the ground level pollution is greatly reduced.

However, the method of dilution is a short term control measure and it is not suitable for long term control. Because, the pollutants dispersed by the tall chimneys are carried and spread around the area of disposal. This may cause harmful effects to the surrounding area.

D: Vegetation:

Plants contribute towards controlling air pollution by utilizing CO_2 and releasing oxygen in the process of photosynthesis. This purifies the air for the respiration of animals. Gaseous pollutants are fixed by some plants. Plenty of trees should be planted especially around those areas which are declared as high risk areas of pollution.

E: Zoning:

This method of controlling air pollution can be adopted at the planning stages of city. Zoning advocates setting aside of separate areas for industries so that they are far removed from the residential areas. The heavy industries should not be located too close to each other.

NATIONAL AMBIENT AIR QUALITY STANDARDS

S.No	Pollutants	Time Weighted Average	Concentration in Ambient Air			Measurement Method
			Sensitive Area µg/m^3	Industrial Area µg/m^3	Residential Area µg/m^3	
1	Sulphur Dioxide (SO_2)	Annual 24 hours	15 30	80 120	60 80	West &Greek method UV Fluorescence
2	Oxide of Nitrogen (N_2O)	Annual 24 hours	15 30	80 120	60 80	Jacob & Ochheiser Metho Gas Phase Chemilumloesence
3	Suspended Particulate Matter (SPM)	Annual 24 hours	70 100	360 500	140 200	High volume Sampling (avg. flow rate not less than 1.1m^3/min)
4	Respirable particulate matter	Annual 24 hours	50 75	120 150	60 100	Repirable Particulate Matter Sampler
5	Lead	Annual 24 hours	0.50 0.75	1.0 1.5	0.75 1.00	ASS Method after sampling using EPM 2000
6	Carbon Monoxide	8 Hours 1 Hours	1.0 2.0	5.0 10.0	2.0 4.0	Non Dispersive IR

WATER POLLUTION

DEFINATION AND SOURCES OF WATER POLLUTION

Question 4: Define water pollution. What are point and non-point sources of water pollution? Write its source and effects?

Solution: Water pollution is defined as any physical, chemical or biological change in quality of water that has a harmful effect on living organisms or make unsuitable for needs.

Cause of water pollution:

There are two major cause/sources of water pollution, namely point and non-point sources.

A: Point sources: those sources which can be identified at a single location are known as point sources. Identification, monitoring and control makes easy. For instance, the flow of water pollutants through regular channels like sewage systems, industrial effluents, power plant out lets etc.

B: Non-point sources: those sources whose location cannot be easily identified are called non-point or diffused sources. Identification, monitoring and control are not easy. For instance, agriculture (pesticide, fertilizers), mining, construction, acid deposition from atmosphere etc.

MAJOR POLLUTANTS:

1. **Oxygen Demanding Waste**:
   Source: Sewage effluent, agricultural runoff, industrial effluent (paper, pulp processing unit)
   Effects: decomposition by anaerobic bacteria depletes level of dissolved oxygen in water.
   Flora and fauna persistent. Further decomposition by anaerobic bacteria produces foul smell.
2. **Plants Nutrients:**
   Source: Sewage effluent, phosphate from detergents, agricultural runoff, nitrates and phosphates from fertilizers.
   Effects: Algal bloom (eutrophication), aquatic life is effected, organic matter increases.
3. **Acids:**
   Source: Acid rains, mine drainage, excessive planting of coniferous forest makes soil acidic.
   Effects: Acidification of natural waters, species diversity affected, aquatic life diminishes, toxic metal level increases, lower crop yields, accelerates corrosion, unusable for drinking or irrigation.
4. **Toxic metals Hg, Pd, Cd, Zn, Sn.**
   Source: Mining and its associated industries, vehicles, batteries discharge etc.
   Effect: Bio magnification of toxic metal with successive stage of food chain, threat to consumers.
5. **Oil:**
   Sources: Drilling operation, oil tanker spills, natural seepage, waste disposal.
   Effect: Contamination of aquatic environment leading to death of birds, fishes and mammals.
6. **Sediments**
   Source: Land erosion
   Effect: Cloud water and photosynthesis reduces disrupt aquatic food webs, carry pesticides, bacteria and other harmful substances, clog and fill lakes, reservoirs, stream channels etc.
7. **Radiation**
   Source: Natural source, nuclear weapons testing's, X-rays, nuclear energy, industries
   Effect: Degree of tissue damage risk of death depends on exposure persistent in environment.
8. **Heat**
   Source: Coolant water from industry, power plants
   Effect: Species diversity changes, aquatic life effected, killed by suffocation, disruption of reproductive cycle of fish and aquatic organisms.

Question 5: What are Indian standard specifications for drinking water?

Solution: Drinking water quality standards refers to a reference point for standard setting and drinking water safety. Drinking water is the potable water meant for human consumption for drinking and cooking purposes from any source. It should be of the highest purity to meet the needs of the community.

Based on international standards for drinking water quality issued by WHO in India Bureau of Indian Standard specification IS: 10500-1991 governed the quality of drinking water supplies.

WATER QUALITY PARAMATERS AND DRINKING WATER STANDARDS

S.NO	PARAMETERS	UNITS	DRINKING WATER IS:10500-1991	
			DESIRABLE	MAXIMUM
1.	Colour	Hazen Unit	5	25
2.	Odour	-	Unobjectionable	-
3.	Taste	-	Agreeable	-
4.	Turbidity	NTU	5	10
5.	pH value	-	6.5 to 8.5	No relaxation
6.	Total Hardness	mg/l	300	600
7.	Iron	mg/l	0.3	1.0
8.	Chlorides	mg/l	250	1000
9.	Residual Free Chlorine	mg/l	0.2	-
10.	Dissolved Solids	mg/l	500	2000
11.	Calcium	mg/l	75	200
12.	Copper	mg/l	0.05	1.5
13.	Manganese	mg/l	0.1	0.3
14.	Sulphate	mg/l	200	400
15.	Nitrate	mg/l	50	No relaxation
16.	Fluoride	mg/l	1.0	1.5
17.	Phenolic compounds	mg/l	0.001	0.002
18.	Mercury	mg/l	0.001	No relaxation
19.	Cadmium	mg/l	0.01	No relaxation
20.	Selenium	mg/l	0.01	No relaxation
21.	Arsenic	mg/l	0.05	No relaxation
22.	Cyanide	mg/l		No relaxation
23.	Lead	mg/l	0.05	No relaxation
24.	Zinc	mg/l	5	15
25.	Anionic detergent	mg/l	0.2	1.0
26.	Chromium	mg/l	0.05	No relaxation
27.	Polynuclear Aromatic HC	mg/l	-	-
28.	Mineral oil	mg/l	0.01	0.03
29.	Pesticides	mg/l	Absent	0.001
30.	Radioactive material (a) Alpha emitters (b) Beta emitters	 Bq/l Pci/l	 - -	 0.1 0.037
31.	Alkalinity	mg/l	200	600
32.	Aluminum	mg/l	0.03	0.2
33.	Boron	mg/l	1	5

Control of water pollution

Question 6: Write control measures of water pollution?

Solution: Various ways or techniques for control of water pollution are as follows:

1. **Stabilization of ecosystem:** This is the most scientific way to control water pollution. The basic principles involved are the reduction in waste input (thus control at source), harvesting and removal of biomass, trapping of nutrients, fish management and aeration.

2. Farmers can reduce the running of fertilizers from their agricultural lands to the nearby water bodies and leaching into aquifers. This can be obtained by using slow release fertilizers in sloped ground. Also this can be achieved by providing buffer zones between the surface water body and the agricultural land.
3. Over fertilization and improper application of pesticides can be avoided. By using more bio-fertilizers, biological control pests, the chemical pesticide usage may be minimized.
4. Acid/alkali/organic/toxic substances in industrial or municipal wastes should be treated properly.
5. Soil erosion can be minimized by reforesting and water sheds.
6. By improving manure control and planting buffer zones, the runoff and infiltration of manure from animal feedlots may be controlled.
7. Reutilization and recycling of waste: Urban waste (sewage) may be recycled to generate cheaper fuel gas and electricity. One distillery in Gujarat is able to treat 450000 liters of waste daily and generating energy equal to that produced by 10 tons of coal.
8. Removal of pollutants: Various pollutants (radioactive, chemical, biological) present in water body can be removed by appropriate methods such as adsorption, electrolysis, ion-exchange, reverse osmosis etc. Eg., Ammonia removed by ion-exchange process, Mercury-selective ion exchange resin, phenolics-polymeric adsorbents, discoloration of water-electrolytic decomposition, sodium salts reverse osmosis.
9. Setting up effluent treatment plants to treat waste.
10. Industrial wastes must be treated before discharge.
11. Educate public for preventing water pollution and the consequences of water pollution.
12. Strict enforcement of water pollution control act.
13. Continuous monitoring of water pollution at different places.
14. Developing economical method of water treatment.
15. River, streams, lakes and other water reservoirs must be well protected from being polluted.

WASTE WATER TREATMENT METHODS

Question 7: Explain Sewage treatment method.

Solution: The main objectives of waste water treatment are,

1. To convert harmful compounds into harmless compounds.
2. To eliminate the offensive smell.
3. To remove the solid content of the sewage.
4. To destroy the disease producing microorganisms.

A) <u>EFFLUENT TREATMENT PLANTS(ETP):</u>

Raw sewage consists of residential, commercial and industrial liquid water discharges. Such waste water are processed in waste water treatment plants to produce an effluent of higher quality and then discharged back to the environment.

The effluents may be treated by one of the following processes.

1. Physical treatment.
2. Chemical treatment.
3. Biological treatment.

A. **Physical Treatment:**

The suspended solids in effluents may be separated by centrifugation, filtration, decantation, filter press, rotary vacuum filter, belt press, micro strainers, slow sand filters, up flow sand filters, rapid gravity sand filters, surface skimmers, grit chambers, misers, aerators and diffusers.

In some cases, screens are used for removal of large suspended matter. Comminutor are used for reduce the particle size of suspended solid matter. Constant velocity channels are used in effluent treatment plants to remove grit from suspended matter to prevent damage to sewage treatment plants. Sedimentation tanks are large tanks used to remove fine suspended matter. The sewage is passed into sedimentation tanks where the sludge settles to the bottom of the tank. The floating materials like oil and grease are skimmed off while the sludge settled at the bottom of the tank is continuously removed.

B. **Chemical Treatment:**

Chemical treatment includes coagulation and flocculation processes. The chemical coagulants used in the chemical process are ferrous or ferric sulphate, aluminum sulphate, calcium hydroxide and polyelectrolytes. Addition of a suitable chemical coagulant to the effluent results in the formation of a precipitate or flock that settles to form sludge.

Further treatment of effluent is accomplished by flocculation process which is mediated by addition of polyelectrolytes of the effluents. This is followed by passing the effluents through sinuous flocculation channels, hydrodynamic flocculators of mechanically mixed flocculators.

C. **Biological Treatment:**

The biological treatment of effluents is achieved by either of the ways,

i) Aerobic process ii) Anaerobic process. .

B) <u>SEWAGE TREATMENT PLANTS(STP):</u>

Sewage is contaminated water discharged from domestic, industrial, municipal and other sources. Sewage treatment plant is designed to remove the contaminants from the water so that they can be recycled and reused. Both organic and inorganic contaminants are removed by using different physical, chemical and biological processes. The treatment plant produces waste stream which is a treated effluent and a solid waste or sludge which are reused.

Sewage is collected and transported via a network of pipes and pump stations to a municipal treatment plant. Normally three stages are involved for treating sewage- primary, secondary and tertiary. After being treated the effluent can be reused to flush toilets, greening parks, or for recharging ground water.

Objective: - The Principal objective of waste water treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment.

Conventional wastewater treatment processes

Conventional wastewater treatment consists of a combination of Physical, chemical, and biological processes and operations to remove solids, organic matter and, sometimes, nutrients from wastewater.

A. Preliminary treatment

The objective of preliminary treatment is the removal of coarse solids and other large materials often found in raw wastewater. Removal of these materials is necessary to enhance the operation and maintenance of subsequent treatment units. Preliminary treatment operations typically include coarse screening, grit removal and, in some cases, communication of large objects.

B. Primary treatment

The objective of primary treatment is the removal of settle able organic and inorganic solids by sedimentation, and the removal of materials that will float (scum) by skimming.

C. Secondary treatment

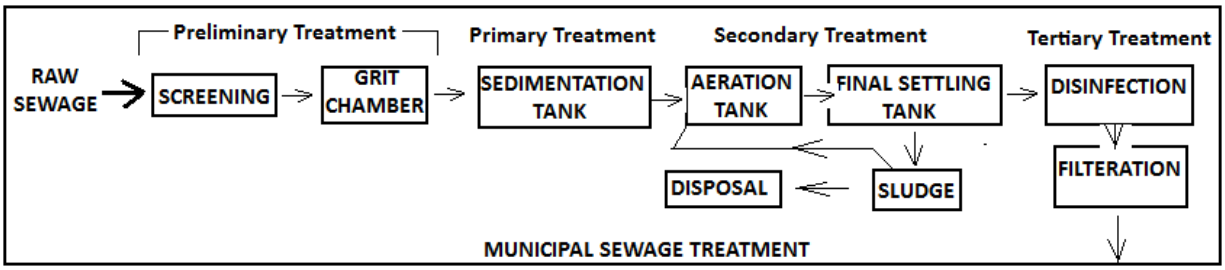
The objective of secondary treatment is the further treatment of the effluent from primary treatment to remove the residual organics and suspended solids. In most cases, secondary treatment follows primary treatment and involves the removal of biodegradable dissolved and

colloidal organic matter using aerobic biological treatment processes. Aerobic biological treatment is performed in the presence of oxygen by aerobic microorganisms (principally bacteria) that metabolize the organic matter in the waste water, thereby producing more microorganisms and inorganic end-products (principally CO_2, NH_3, and H_2O). Several aerobic biological processes are used for secondary treatment differing primarily in the manner in which oxygen is supplied to the microorganisms and in the rate at which organisms metabolize the organic matter. Common high-rate processes include the activated sludge processes, trickling filters or bio filters, oxidation ditches, and rotating biological contractors (RBC). A combination of two of these processes in series (e.g. bio filter followed by activated sludge) is sometimes used to treat municipal wastewater containing a high concentration of organic material from industrial sources.

D. Tertiary Treatment

Wastewater is given tertiary treatment to further enhance its quality before they are discharged in the environment. After the secondary treatment removes most of the organic matter present in sewage lowers BOD (25ppm). The popular methods that are used in this stage are filtration, flocculating, removal of chemicals like nitrogen and phosphorus etc.

Different sewage treatment processes are required to remove nitrogen and phosphorus. Nitrogen is removed through the biological oxidation of nitrogen from ammonia to nitrate, followed by denitrification, the reduction of nitrate to nitrogen gas which is removed to the atmosphere. Phosphorus on the other hand can be removed by using two process that is by the use of specific bacteria, called polyphosphate that accumulate large quantities of phosphorus within their cells they are removed from the water and are used as fertilizer. Chemical precipitation can also be used to remove phosphorus. Municipal Wastewater is sometimes further disinfected by using chlorine, ozone gas and ultraviolet light.



C) COMMON AND COMBINED EFFLUENT TREATMENT PLANTS(CETP):

Common Effluent Treatment Plants is the concept of treating effluents by means of collective effort mainly for a cluster of small scale industrial units. This concept is similar to the concept of Municipal Corporation treating sewage of all the individual houses. The main objective of CETP is to reduce the treatment cost for individual units while protecting the environment.

- To achieve 'Economics of scale' in waste treatment, thereby reducing the cost of pollution abatement for individual factory.
- To minimize the problem of lack of technical assistance and trained personnel as fewer plants require fewer people.
- To solve the problem of lack of space as the centralized facility can be planned in advance to ensure that adequate space is available.
- To reduce the problems of monitoring for the pollution control boards.
- To organize the disposal of treated wastes and sludge and to improve the recycling and reuse possibilities.

SOIL POLLUTION

In modern economics, various types of activity, including agriculture, industry and transportation, produce a large amount of wastes and new types of pollutants.

Question 8: Write sources and effects of soil pollution and write how it can be controlled?
Solution: Sources and effects of soil pollution:

1. **Chemical pollutants:** The chemical pollutants such as calcium carbonate, bicarbonates, calcium sulphate, and soluble salts etc. from eroded sediments pollute the soil. It is estimated that 85% of phosphorus and about 70% of nitrogen loading of surface water are brought from eroded soil from hills or other places. The tanneries, synthetic drug factories and distilleries discharge lot of suspended and dissolved solids which pollute the soil. The presence of all these substances also retards growth of plants, retards reproduction process and also fruit production.
2. **Metallic pollution:** The metallic pollutants from Cu, Steel, Cd, Zn, factories pollute the soil due to excess of Cu, Fe, Cd and Zn. Besides this, the presence of Co, Ni, Pb, Ba, Mn, Al, Si, Ca etc, added to the soil from various industries in combined form also pollute the soil such pollution by metals is called metallic pollution.
3. **Industrial effluents:** Industries are major sources of soil pollution now a day. Sugar factories, textile, steel, paper, chemical and pesticide, petroleum, engineering, cement, glass, dyeing, oil refineries and other factories are responsible for addition of more than 40 million tons of substances in the soil as industrial wastes.

   These toxic chemicals through soil and water enter into vegetables, fruits, grains, etc. and enter into food chain of human beings and are responsible for number of diseases and even cancer.
4. **Agricultural wastes:** For increasing the production in agriculture – lot of fertilizers, pesticides, herbicides etc. are added in each season with the soil is getting harder every year due to these inorganic chemicals called agricultural wastes in agricultural fields.

   Soil conditioners, fumigants contain toxic metals such as Cd, Hg, Co, Pb, etc. increase of their concentration in soil they enter into crops and finally to food chain of human being causing mental, skin, lung, blood and urine diseases.

   Today 30% diseases in human beings are suffered due to presence of fungicides, insecticides, herbicides etc, Fertilizers add phosphorus, nitrogen, sodium, potassium, sulphate, nitrate etc. in the soil. The high concentration of nitrates and phosphates also cause eutrophication, choking the whole aquatic ecosystem in nature.

   The animal waste have been found to contain high BOD (>300 ppm) and high COD (>500 ppm) and nitrogen (>450 ppm) and hence such wastes are very harmful for human beings.

   The villages in India, villagers use cow dung for burning purposes but it is dangerous for health as it generates benzo-pyrene in smoke which causes cancer to human beings.
5. **Urban wastes:** The urban wastes contain substances like glass bottles, glass plates, plastics, paper, rubber, fibres, iron pieces, garden leaves, branches, flowers, parts of vehicles, food residues, vegetable residues, fuel residues, dust, metallic pieces, cane etc. polythene bags and other household articles.
6. **Radioactive pollutants:** The radio nuclides such as Iodine -129, Cesium -137, Barium -140, Strontium – 90, Promethium- 144, Ruthenium- 106 which are produced from nuclear fission get deposited on the soil which continuously emit gamma radiation which are harmful for plants, aquatic life and human beings.
7. **Biological agents:** The biological agents cause pollution of soils and crops. Bacteria, algae, nematodes, actinomycetes, rotifers, protozoans etc. are important biological agents which change

the physical texture of the soil and are responsible for changing the fertility of the soil. The human and animals excreta are the major source of land pollution.

8. **Pesticides:** Pesticides like DDT, BHC, malathion, endrin, aldrin, parathion etc. cause impairment of human tissues, failure in the functioning of liver, kidney, intensive and gonads.
9. **Detergents:** Detergents pollute the soil and river water. They destroy the fertility of the soil and retard the growth of plants and fruits.

Control of Soil Pollution:

1. Garbage's can be converted into compost manure by cobalt and nickel techniques recently developed.
2. Half of the total dung collected in villages is used as fuel. This must be stopped at once as this fuel on burning releases benzo-pyrene which cause cancer. If this bio-manure is used in fields the crop production will be increased.
3. Solid wastes should be treated by pyrolysis method. Fluided bed furnaces and multiple hearth furnaces can also be used to yield better results.
4. Salts flow to soil from industries must be stopped.
5. Environment protection Act, 1986 be implemented with full force to factories and municipal corporations to check the flow of untreated wastes directly into the soils.
6. The land act should be implemented strictly against the industries which pollute the soil.
7. A huge plantation is necessary along the roads, fields, waste places, marshes, and nearby railway linings. Among these plants planted on the boundary of the fields to avoid soil erosion and to increase the fertility of the soil.
8. The industrial effluents should be first treated and then allowed to discharge through constructed drains.
9. The use of pesticides should be avoided as it will destroy the fertility of the soil in time to come.
10. The organic manure be used in the fields in place of chemical fertilizers as later will also destroy gradually the fertility of the soil.
11. The garbage first be treated and then it should be converted into manure as is happening in western countries. It should never be used in fields as it will destroy the fertility of the soil permanently.
12. Environmental awareness programs are arranged to create awareness among students and others to check the pollution of soil.
13. Toxic and non-degradable materials must be totally banned.
14. Recycling and reuse of industrial and domestic wastes can minimize soil pollution considerably.

NOISE POLLUTION

Question 9: What is noise pollution? Write its sources, effects and control.

Solution: *"Unwanted sound dumped into the atmosphere leading to health hazards." Or*
"Wrong sound in the wrong place at the wrong time." Or
"The unwanted, unpleasant or disagreeable sound that causes discomfort for an living beings."

The sound intensity is measured in decibel (dB). Sounds at 0-10 dB are so quit that they are almost impossible to hear, while at the top end of the scale, at around 150dB it can damage the eardrums. Some common sound with decibel rating are 0dB total silence, 13dB human heart beat, , library place 30dB, heavy street traffic 60-80dB, boiler factories 120dB, jet planes (take off)- 150dB, rocket engines 180dB.

Sources of noise

Main contributors to noise are industries, transportation (air, rail and road) and community and religious activities.

1. **Industrial sources:**
   Progress in technology (industrialization) has resulted in creating noise pollution.
   E.g. Textile mills, printing presses, engineering establishments and metal works etc.
2. **Transport Vehicles:**
   Automobile revolution in urban centers has proved to be a big source of noise pollution.
   E.g. heavy trucks, buses, trains, jet-planes, motor cycles, scooters, etc.
3. **Domestic noise:**
   It is any noise from residential areas such as house, apartment and flat. The noise coming from neighbors and the most common problems are banging of doors, noise of playing children, crying of infants, moving of furniture, loud conversation, record player, TVs, mixer-grinders, pressure cookers, A.C, vacuum cleaner, barking of dogs, car alarms etc.
4. **Incompatible land use:**
   Generally the determination of land use zoning includes the separation of activities which are incompatible due to noise levels.
   E.g. heavy industrial area will be separated from residential areas by light industrial, recreational facilities and retail activities.
5. **Construction noise:**
   Construction noise is defined as 'the noise created by the equipment's at the construction sites for the fabrication, erection, modification, demolition or removal of any structure of facility, including all related activities such as land clearing, site preparation, excavation, landscaping'. It is a major source of noise pollution which is emitted by construction equipment's. e.g. rollers, tractors, trucks, concrete mixers, cranes, pumps, generators, hammers, drillers, saws, vibrators, cutters etc.

Effects of Noise Pollution:

Noise is generally harmful and serious health hazard. It has far reaching consequences and has many physical, physiological as well as psychological effects on human beings.

1. **Physical Effects:**
   It is the effect on earing ability. Repeated exposure to noise may result in temporary or permanent shifting of hearing threshold of a person depending upon the level and duration of exposure. "Deafness" caused due to continuous noise exposure. Temporary deafness occurs at 40–60 dB noise. Permanent loss of hearing occurs at 100dB. Bombay and Calcutta are the noisiest cities in the world.

2. **Physiological Effects:**
   a. Headache by dilating blood vessels of the brain.
   b. Increase in the rate of heart beat.
   c. Narrowing of arteries.
   d. Fluctuations in the arterial blood pressure by increasing the level of cholesterol in the blood.
   e. Decrease in heart output.
   f. Pain in the heart.
   g. Digestive spasms through anxiety and dilation of the pupil of eye, thereby causing eye-stain.
   h. Impairment of night vision.
   i. Decrease in the rate of color perception.
   j. Lowering of concentration and affect on memory.
   k. Muscular stain and nervous breakdown.
3. **Psychological Effects:**
   a. Depression and fatigue which reduces the efficiency of a person.
   b. Insomnia as a result of lack of undisturbed and refreshing sleep.
   c. Straining of senses and annoyance (irritation).
   d. Affecting of psychomotor performance of a person by a sudden loud sound.
   e. Emotional disturbance.
4. **Communication Interference:**
   Noise masks speech as a result greater pains for the talker as well as the listener.

Control of Noise Pollution:

1. **Control at Receiver's End:**
   For people working in noisy installation, ear-protection aids like ear-plugs, ear-muffs, noise helmets, headphones etc. must be provided to reduce occupational exposure.
2. **Suppression of noise at source:**
   a. Designing, fabricating and using quieter machines to replace the noisy ones.
   b. Proper lubrication: This can be done by- designing and fabricating silencing devices in air crafts engines, automobiles, industrial machinery and home appliances. And by segregating the noisy machines.
   c. Installing noisy machines in sound proof chambers.
   d. Covering noise producing machine parts with sound absorbing materials to check noise production.
   e. Reducing the noise produced from a vibrating machine by vibration damping.
   f. Using silencers to control noise from automobiles, ducts, exhausts etc. And convey systems with ends opening into the atmosphere.
   g. Using glass wool or mineral wool covered with a sheet of perforated metal for the purpose of mechanical protection.
3. **Acoustic zoning:**
   Increased distance between source and receiver by zoning of noisy industrial area, bus terminals, and railway stations aerodromes etc. away from the residential areas would go a long way in minimizing noise pollution.
4. **Planting of trees:**
   Planting green trees and shrubs along roads, hospitals, educational institutions etc. helps in noise reduction to a considerable extent.
5. **Legislative measures:**
   Strict legislative measures need to be enforced to curb the menace of noise pollution like
   a. Minimum use of loudspeakers and amplifiers especially near silence zones.
   b. Banning pressure horns in automobiles.
   c. Framing a separate noise pollution act.

SOLID WASTE

Question10: What is solid waste and write the components of Municipal Waste and its effects?

The wastes generated and discarded from human and animal activities that are normally solid are called as solid wastes. The term 'refuse' is often interchangeably with the term solid wastes.

Types of solid wastes

Depending upon the nature, solid wastes is broadly classified into three types,

1. Municipal wastes.
2. Industrial wastes
3. Hazardous wastes.

MUNICIPAL or URBAN WASTES

Components of Municipal wastes:

Type and Characteristics of wastes	Example
1. **FOOD WASTES:** These are resulting from the handling, preparation, cooking and eating of foods. These are highly putrescible and decompose rapidly in warm weather condition.	Meat, bones, fruit residues, vegetable residues, spoiled food items etc.,
2. **RUBBISH:** These are solid wastes of house-holds, institutions, commercial activities etc. these wastes don't decompose rapidly. *a. Combustible Rubbish* *b. Non-Combustible Rubbish*	 Paper, cardboard, wood, rubber, leather, textiles, furniture, garden trimming etc., Glass, crockery, tin cans, metal, dirt, aluminum cans etc.
3. **TREATMENT PLANT WASTES:** Wastes generated from treatment plants. Their specific characteristic depends on the nature of treatment process.	Solid and semi-solid wastes from water, wastewater and industrial waste treatment plants.
4. **CONSTUCTION AND DEMOLISTION WASTES:** Wastes generated from construction, demolition, repair, and remodeling of residential, commercial and industrial buildings.	Bricks, stones, dust, concrete, plaster of Paris, electrical, plumbing, sanitary parts etc.
5. **ASHES AND RESIDUES:** These are remaining's from burning of wood, coal, coke and other combustible materials.	Fine powdery materials, clinkers, partial burned materials etc.
6. **SPECIAL WASTES:** Wastes not included in any of the above categories.	Street sweepings, roadside litter, dead animals, abundant vehicles etc.

CAUSES OF SOLID WASTE

Majorly three reasons for rapid growth in quantity of solid wastes are

1. Overpopulation *2.Affluence* *3.Technology*

1. **Over population:** as the number of people producing a pollutant increase, pollution will naturally increases. It is same with solid waste.
2. **Affluence (wealth):** (i.e. production or per capita consumption)with affluence there is a tendency to declare items as being in or out of fashion and promptly throw away the ones out of fashion. This results in solid waste pollution.
3. **Technology:** (i.e. amount of pollution produced per unit of economic goods) it made returnable packaging to non-returnable packaging.eg. Bottles with cans, pet bottles, plastic containers etc.
4. **Lack of awareness.**
5. **lack of public participation** and
6. **Poor enforcement of laws.**

CONTROL MEASURES URBAN WASTES (SOILD WASTE MANAGEMENT)

Question 11: What is solid waste management how it is achieved?

The objective of solid waste management is to minimize the adverse effects before it becomes too difficult to rectify in the future. Solid waste management is a manifold task involving many activities like: a) Collection of solid wastes.
b) Disposal of solid wastes
c) Waste utilization.

(I) Collection of solid wastes:

It includes all the activities associated with the gathering of solid wastes and the hauling of the wastes collected to the location from where the collection vehicle will ultimately transport it to the site of disposal. Three basic methods of collection:

a. Community storage point: municipal refuse is taken to fixed storage bins and stored till the waste collection agency collects it daily for disposal in a vehicle.
b. Kerbside Collection: in advance of collection time, the refuse is brought in the containers and placed on the footway from where it is collected by the waste collection agency.
c. Block collection: individuals bring the waste in containers and hand it over to the collection staff that empties it into the waiting vehicle and return the container to the individuals.

(II) Disposal of solid wastes:

For discarding solid wastes the following methods are adapted.

1. **Salvage or manual component separation:**
   Manually sorted out or salvaged either for recycling or for recycling or for resale before ultimate disposal in order to improve the efficiency of solid waste disposal system. E.g. cardboard, newsprints, high quality paper, glass, metals, wood, Al cans, plastics etc.
2. **Compaction or Mechanical Volume Reduction:** After separation of reusable or disposable articles, compacters are used to compress the waste materials directly into large containers or to form bales that can be then placed in large containers. Compaction increases the useful life of landfills.
3. **Incineration or Thermal Volume Reduction:**
   Combustible wastes are subjected to incineration i.e., burning at very high temperatures. e.g., plastics, cardboard, rubber, paper, food waste etc.
4. **Open Dumping:**
   It is done in low lying areas and outskirts of the towns and cities. Being comparatively cheaper, this method of disposal is used extensively in India.
5. **Sanitary Landfilling or Controlled Tipping:**
   It involves the disposal of municipal wastes on or in the upper layers of the earth's mantle especially in degraded areas in need of restoration.

   In landfilling, the solid wastes are compacted and spread in thin layers, each layer being uniformly covered by a layer of soil. The final layer is covered by a final cover of about one meter of the earth to prevent rodents from burrowing into the refuse and scattering. This is a biological method of waste treatment and bacterial refuse digestion results in decomposition products like CO_2, CH_4, NH_3, H_2S, and H_2O which can be harnessed as renewable sources of energy.

   This method does not cause environmental damages by creating nuisances or health hazards as the refuse is covered and prevents breeding of pests and diseases vectors.
6. **Pyrolysis or Destructive Distillation:**
   In this method, the solid wastes are heated under anaerobic conditions (burning without O_2). The organic components of the solid wastes split up into gaseous liquid and gaseous fractions (CO, CO_2, CH_4, tar, charred carbon).

Unlike the highly exothermic process of combustion, pyrolysis is a highly endothermic process and that is why it is also called destructive distillation.

7. **Landfarming:**
   This method, the biodegradable industrial wastes are treated by the biological, physical and chemical processes occurring in the surface of the soil. The organic wastes are either applied on the top of the land or injected below the soil surface with suitable equipment, where they undergo bacterial and chemical decomposition.at frequent intervals, the land farming sites can be reused without any adverse effects provided the land farming site is properly managed.
8. **Composting or Biodegradation:**
   It is Bacterial decomposition of the organic components of the municipal solid wastes results in the formation of humus or compost and the process is known as composting.

   In this process a compost pile is constructed by making alternate layers of organic matter and soil. Some fertilizer and water is periodically added to the compost pile to stimulate microbial action and to maintain he necessary moisture content (55%).

   Periodically, the refuse is turned over to allow aeration i.e. penetration of oxygen to all parts of the organic refuse to facilitate aerobic bacterial decomposition.it takes nearly a month for composting to be complete.

(III) WASTE UTILISATION

It is achieved by three techniques:

1. **Reuse:** A given material has multiple uses.
2. **Reclamation:** A component of the waste is recovered for use in a manner different from its original use.
3. **Recycling:** isolating the material from which a given product was made and reintroducing it into the production cycle for production of the same product.

Question12: What is e-waste management?

COMPOSITION AND CHARACTERSTIC OF e-WASTE AND ITS MANAGEMENT

E-waste, popularly referred to electronic waste of electronic goods (including discarded computers, TVs sets, VCRs, stereos, copiers, fax machines, electronic lamps, cell phones, audio equipment, batteries, pagers, scanners, refrigerators, washing machines, microwaves ovens, DVDs, floppies, tapes, printing cartridges, military electronic waste, chips, processors, motherboard and other electronic devices) which have become outdated due to advancement in technology, modifications in the life-style, fashion or nearing the end of their useful life.

The amount of e-waste generated in our country is rapidly increasing due to the generation of our own waste as well as dumping of e-waste from the developed countries.

COMPONENTS OF e-WASTE:

Some of the components of e-waste include lead, cadmium, mercury, hexavalent chromium, PVC, barium, toxic dioxins and furans (Polybrominated dibenzodioxins, polychlorinated dibenzo furans)

HEALTH EFFECTS:

Damage to central and peripheral nervous systems, damage to brain, heart, kidney, liver, skin, respiratory disorders, reproductive and developmental problems, damages to immune system, disruption of endocrine system functions.

MANAGEMENT OF E-WASTE:

1: Waste Minimization Techniques: it involves following aspects,

i) ***Inventory Management***: a reduction in the quantity of waste generation can achieved by proper control of the materials used in the manufacturing process by reducing the amount of hazardous material and raw material used in the process. The inventory management

procedure should ensure that all materials be approved before purchase. The material should be evaluated for hazardous constituents and opt for alternative non-hazardous materials if available. As needed basis materials should be purchased.

ii) ***Alternation in the Production Process***: Modifications in the production process can minimize the waste generation. This includes changing the materials used to make the product and efficient use of input material. A proper training program must be given to the employees, including correct operation and handling procedures, proper equipment use, precise specifications about maintenance and inspection schedules and management of waste materials.

iii) ***Reduction in Hazardous Portion of Waste***: Reduction in the volume of hazardous waste can be accomplished by source segregation and waste concentration. Both these methods are economical techniques for waste reduction. The techniques used in volume reduction are gravity, vacuum filtration, ultra filtration, reverse osmosis, freeze vaporization etc.

iv) ***Recovery and Reuse of E***-Waste: e-waste is recovered on-site or at an off-site facility by various techniques including reverse osmosis, electrolysis, condensation, filtration, centrifugation etc.

2: Designing Sustainable Products: Efforts should be made to reduce material use and propose a centralized network system. Bio-based products such as tonners, glues and inks must be used. Moreover, the product designers should ensure reusable, repairable and upgradeable materials that are safer.

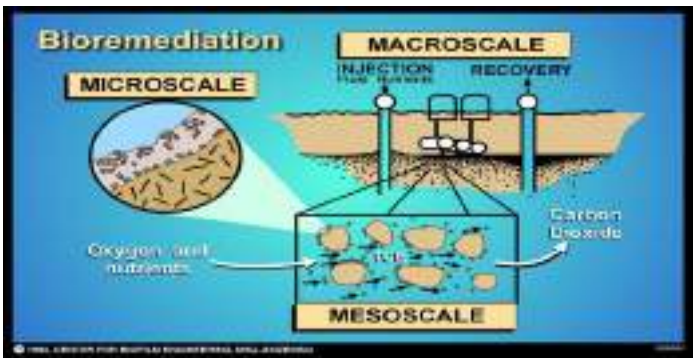
BIOREMEDIATION:

It is completely safe and natural process that uses microorganisms, fungi, green plants or their enzymes to return the natural environment altered by contaminants to its original condition. These naturally occurring microbes are placed within the contaminated site in which they immediately begin to start breaking down the organic contaminant. This "breaking down" process consists of these microbes breaking the carbon chains of which make up all organic molecules.

The microbes thus work on breaking down the carbon chains until the contaminant is eliminated and no longer an environmental threat. As a result of this process carbon dioxide and water are left behind as by-products with trace elements of fatty acids.

The optimal pH for the bacterial growth is approximately 7; this is in the acceptable range for soil pH suitable for bioremediation.

Bacteria require a carbon source for cell growth and an energy source to sustain their metabolic functions, the nitrogen and phosphorus serve as an energy source and the carbon dioxide in the air is used as the carbon source.



Methods of Bioremediation :

Bioremediation processes vary in their methods of remediation. Depending upon the location of the contamination Bioremediation techniques can either be applied to the surface and subsurface, or require above ground remediation. Surface and subsurface Bioremediation deals with contaminated soil down to twelve inches below ground level.

In this technique water and nutrients are added, in addition to tilling the soil, in order to optimize bacterial growth and begin the bioremediation process. In oppose to techniques that are directly applied to surface and subsurface contaminations, above ground bioremediation involves treatment of soils out of the given area.

Such treatments used in above ground bioremediation include that of slurry-phase and solid-phase remediation. Slurry-phase treatment involves the initial combination of water with the contaminated soil and later degradation in a bioreactor. Solid- phase treatment achieves the similar goal of the former treatment yet, in this process, the contaminated soil is placed in a bed and nourished with nutrients, moisture and oxygen in hopes that decomposition will occur.

Types of Bioremediation: There are two main types of bioremediation

1.In-Situ Remediation:

In-situ Bioremediation treats the contaminated soil or groundwater in the location in which it is found. In this technology oxygen and occasionally nutrients are pumped under pressure into the soil through wells. The nutrients are spread on the surface to infiltrate into the contaminated area of material or the saturated zone.

2.Ex-Situ Remediation:

Ex-situ Bioremediation requires pumping of the groundwater or excavation of contaminated soil prior to remediation treatments. Ex-situ Bioremediation can be further broken down into two main components or processes; Slurry-phase and solid-phase treatment.

Slurry-phase: This treatment involves the initial combination of water with the contaminated soil and later degradation in a bioreactor.

Solid-phase: This treatment achieves the similar goal of the former treatment yet, in this process, the contaminated soil is placed in a bed and nourished with nutrients, moisture and oxygen in hopes that decomposition will occur.

Bioremediation techniques are currently being used at hazardous waste sites. Specifically, they are applied to waste sites facilitating the cleanup of biodegradable contaminants. The majority of environmental hazards in which Bioremediation has proved successful include those of oil spills, gasoline contaminations, chlorinated solvents and other toxic chemical leaks.

GLOBAL ENVIRONMENTAL PROBLEMS AND GLOBAL EFFORTS CLIMATE CHANGE

Q13: Explain about the climate change and its causes?

Solution: Climate represents sum of all statistical weather information of the atmospheric elements, with specified area over a long period of time. Climate never remains static but is a dynamic process, greater of lesser degree, it is changing. Climatic change is common deviation from the average as well as extreme conditions.

The Earth's surface and lowest part of the atmosphere have warmed up on average by about 0.6^0C during the last 100 years. If the climate change is at the same rate as now, global average surface temperature could be anywhere between 1.4 and 5.8^0C higher than in 1990 by 2100. Sea-level rise is projected to be between 9 and 88 cm by 2100.

The Framework Convention on Climate Change (1992) and Kyoto Protocol (1997) represent the first steps taken by the international community to protect the climate system from various dangerous man-made inferences. Currently, nations have agreed to reduce greenhouse gas emissions by about 5% by 2008 to 2012. In practical terms, this means using resources, particularly fossil fuel derived energy, more efficiently, reusing and recycling products where possible, and developing renewable forms of energy which are inexhaustible and do not pollute the atmosphere.

Cause of climate change

Climate change on the earth is influenced by the following factors:

1. Variations in the Earth's orbital characteristics.
2. Atmospheric CO_2 variations.
3. Volcanic eruptions.
4. Variations in solar output.

Effects of Climate Change

The climate change has more effects on every parts of earth. It affects both living and non-living components of most of the ecosystems in the world. Some of the effects of climate change are:

1. Main sea level is increased on an average of around 1.8mm per year.
2. Many ecosystems of the world have to adapt to the rapid change in global temperature.
3. The rate of species extinction will be increased.
4. Human agriculture, forestry, water resources and health will be affected.
5. Climate change, through increasing surface temperatures, and changing rates of precipitation and evapo-transpiration, will influence the hydrological cycle.
6. The frequency and intensity of extreme weather events is possible and it makes unexpected flooding and drought.
7. The societies currently experiencing existing social, economic and climatic stresses will be both worst affected and least able to adapt.

OZONE LAYER DEPLETION

Q14: What is ozone layer depletion? Write the reasons behind its depletion? Explain its ill effects and measures to control.

Ozone occurs naturally throughout the atmosphere, but most highly concentrated in the stratosphere in between 10–50 km above sea level, where it is known as the *Ozone layer*. Ozone is odorless, colourless gas is formed in the atmosphere when ultraviolet radiation (short wavelength < 240nm) from the sun strikes the stratosphere, splitting oxygen molecules into atomic oxygen. The atomic oxygen quickly combines with further oxygen molecules to form ozone.

$$O_2 + hv \longrightarrow O + O \quad ; \quad O + O_2 \longrightarrow O_3$$

At ground level, ozone is health hazard and is a major constituent of photochemical smog. However in the stratosphere we need ozone to absorb some of the potentially harmfully UV radiation from sun which can cause skin cancer and damage vegetation.

Although the UV radiation splits the ozone molecules, ozone can reform through the following reactions resulting in no net loss of ozone:

$$O_3 + hv \longrightarrow O_2 + O \quad ; \quad O + O_3 \longrightarrow O_3$$

Ozone is also destroyed by the following reaction with atomic oxygen.

$$O + O_3 \longrightarrow O_2 + O_2$$

a. The CFCs themselves do not destroy ozone molecules. But they are decaying the ozone molecules at the low temperatures. Small amounts of chlorine atom and chlorine monoxide are functioned as catalyst in the process of destruction of ozone.

$$Cl + O_3 \longrightarrow ClO + O_2$$
$$ClO + O \longrightarrow Cl + O_2$$
$$\underline{O_3 + O \longrightarrow 2O_2}\ .$$

The chlorine atom in above reaction is functioning as a catalyst and it is not consumed by the reaction. The chlorine atom used in the reaction remains there as chlorine even at the end of the reaction. Once the chlorine has broken up one ozone molecules, it is freed to repeat the process again and again, until its removal by any other means or reaction in the atmosphere. The CFCs released are stable and can live about 100 years.

b. Chemical and photochemical reactions in atmosphere, nuclear explosion, supersonic jet etc., generate nitric oxide.

$$O_3 + NO \longrightarrow NO_2 + O_2$$

c. Hydroxyl radical generated by biomass

$$O_3 + OH^- \longrightarrow O_2 + HOO^-$$
$$HOO^- + O \longrightarrow OH^- + O_2$$

Measuring Ozone Layer

Stratospheric ozone measurement unit is Dobson Unit. It is a scale for measuring the total amount of ozone occupying a column overhead of the atmosphere. Dobson Units are measured by how thick the layer of ozone would be if it were compressed into one layer at 0^0C and with a pressure of one atmosphere above it. Every 0.01mm thickness of the layer at 0^0C and one atmospheric pressure is equal to one D.U.

The average amount of ozone in the stratosphere across the globe is about 300 DU (or a thickness of only 3mm at 0^0C and 1 atmospheric pressure).

Ozone Depleting Substances (ODS)

Chlorofluorocarbons (CFCs) also known as Freon is non-toxic, non-flammable, non-reactive with other chemicals and non-carcinogenic. These desirable safety characteristics, along with their stable thermodynamic properties, make them ideal for many applications as coolants for commercial and home refrigeration unit, propellants in aero jet, sprays, solvents (cleaners) in electronic industry, and blowing agents in fire extinguishers. *e.g. Trichlorofluoromethane-$CFCl_3$(CFC-11), Dichlorodifluromethane-CF_2Cl_2(CFC-12), Trichlorotrifluroethane-$C_2F_3Cl_3$(CFC113), Dichlorotetrafluroehane-$C_2F_4Cl_2$(CFC114), Chloropentafluroethane-C_2F_5Cl(CFC115)*

A single CFC molecule can destroy up to 10,000 ozone molecules. A 1% loss of ozone results in a 2% increase in UV rays reaching the earth surface.

Effect of Ozone Layer Depletion

As the ozone layer gets deteriorated the harmful UV rays will reach the ground and cause various adverse effects.

1. ***Effect on Human Health***
   - Skin cancer.
   - Reddening of skin in sun shine (sun burn).
   - Reduction in body's immunity to disease.
   - Eye disorders like Cataracts and blindness.
2. ***Effect on Aquatic Systems***
   - Decreases population of Phytoplankton which forms the base of Ocean food chain disrupts the ecosystem.
3. ***Effect on Materials***
   - Degradation of paints, plastics and other polymeric material will result in economic loss due to effects of UV radiation.
4. ***Effect on Climate***
   - The ozone depleting chemicals can contribute to the global warming i.e., increasing the average temperature of the earth's surface.
5. ***Effect on plants***.
   - Restricted growth and crop damage (reduction in chlorophyll content and increase in harmful mutations).

Steps to Protect the Ozone Layer

1. Avoid using fire extinguishers that contain halons, which have bromine in them replace them by CO_2, water, or dry chemical extinguisher, foam packaging.
2. Avoid buying and using aerosols and sprays composed of CFC.
3. Maintain air-conditioning of car, freezer and clean with concern technician. If A.C doesn't function properly, they emit CFC to atmosphere.
4. Opt to buy a refrigerator or A.C without CFC.

DEFORESTATION

Q15: Write short note on Deforestation and Desertification.

Deforestation is the permanent destruction of indigenous forests and woodlands. The clearing of forests across the Earth has been occurring on a large scale basis for many centuries. This process, generally known as deforestation, involves the cutting down, burning, and damaging of forests. The loss of forest is more profound than merely destruction of destruction of beautiful areas. If the current rate of deforestation continues, the world's forests will vanish within the next 100 years-causing unknown effects on global climate and eliminating the majority of plants and animal species on the planets.

Causes of Deforestation

1. ***Population Explosion:***
   Forest land are cleared of tress to reclaim land for human settlements (factories, agriculture, housing, roads, railway tracks etc.) growth of population increases the demand for forest products like timber, firewood, paper, and other valuable products of industrial importance, all necessitating felling of trees.
2. ***Forest Fires:***
   Fires in the forests may be due too natural calamities (ground fires, surface fires, crown fires) or human activities (burning).
3. ***Grazing Animals:***
   Overgrazing by livestock has four reaching effects such as loss of porosity of soil, soil erosion and desertification of the previously fertile forest area.
4. ***Pest Attack:***
   Forest pests like insects etc. destroy tress by eating up the leaves, boring into shoots and by spreading diseases.
5. ***Natural forces:***
   Floods, storms, snow, lightening etc. are the natural forces which damage forests.
6. ***Mining and Petroleum Exploration:***
   It leads to greater destruction of forest for exploration of ores.
7. ***The cash crop economy:***
   It is an integral part of Third World 'development' and a major cause of deforestation. The best land is taken to earn export income, which is very often used to pay the foreign debt.
8. ***Dams:***
   To generate hydroelectricity and for irrigation, dams are built which led to destruction of forest.

Effects of Deforestation

1. Habitat destruction of wild animals (tree-using animals are deprived of food and shelter).
2. Increased soil erosion due to reduction of vegetation cover.
3. Reduction in oxygen liberated by plants through photosynthesis.
4. Increase in pollution due to burning of wood and due to reduction in CO_2 fixation plants.
5. Decrease in availability of forest products.
6. Loss of cultural Biodiversity.
7. Scarcity of fuel wood.
8. Deterioration in economy (ecotourism) and quality of life of people residing near forests.
9. Lowering of water table due to more run-off and thereby increased use of the underground water increase the frequency of droughts.
10. Rise in CO_2 level has resulted in increased global warming which in turn results in melting of ice caps and glaciers and consequence flooding of coastal areas.
11. Disruption of weather patterns and global climate.

12. Induces and accelerates mass movements/landslides.
13. Breaks the nutrient cycle.
14. The stress of environmental change may make some species more susceptible to effects of insects, pollution, disease and fire.

DESERTIFICATION

It refers to continuous degradation of land ecosystem due to poor rainfall, harsh climate and human activities, thus leading to reduction or loss of the biological or economic productivity. About 33% of the global land surface is subjected to desertification.

Causes of Desertification:

1. ***Increased Human Demand for Ecosystem Services:***
   Due to increase in population demand towards food, forage, fibre, freshwater and building materials for livestock, irrigation and sanitation increases.
2. ***Unsustainable use of scarce Natural Resources by local Land Users:***
3. ***Socioeconomic and Policy Factors:***
   Absence of coherent national and regional policies for the management of watersheds, rangelands and irrigated agriculture contribute to desertification.
4. ***Extensive Cultivation of One Crop:***
   Over cultivation of crop and failure to employ crop rotation cause exhaustion of soil, land degradation, reduction in biomass productivity and soil erosion.
5. ***Use of Chemical Fertilizers and Pesticides:***
   Unsustainable farming methods, overuse of chemical fertilizers and pesticides or insufficient use of fertilizer after harvesting contribute to desertification.
6. ***Shifting Cultivation:***
   It refers to the phenomenon where in pieces of land are cultivated temporarily until the soil loses fertility and then the land is abandoned, as it becomes infertile and unsuitable for crop production. The abandoned piece of land may be reclaimed back by allowing soil properties to recover by natural vegetation.
7. ***Industrial and Mining Activities:***
   The discharge of toxic effluents from industries into nearby lands, unplanned open cast mining, dumping of mine refuse affect the productivity of land which gradually turn into waste lands.
8. ***Overgrazing:***
   Overgrazing by livestock has four reaching effects such as loss of porosity of soil, soil erosion and desertification of the previously fertile forest area.
9. ***Logging and Illegal Felling:***
   Unchecked cutting of forest trees cause erosion of top soil by wind storms and dust storms.
10. ***Forest Fires:***
    Forest fires and smoke created by wildfires make it more difficult to form raindrops, thus resulting in scanty rainfall.
11. ***Unsustainable Water Management:***
    Poor and inefficient irrigation practices over extraction of ground water contribute to desertification.

Effects of desertification:

- Destruction of topsoil.
- Loss of land's ability to sustain crops, livestock's or human activity.
- Increase in the price of agricultural goods.
- Threatens live hood of vulnerable population on planet.
- Increase in the intensity of wildfires and winds.

EARTH SUMMIT

Q16: Write about earth summit?

The Earth Summit was the largest environmental conference held at Rio De Janeiro, Brazil for 12 days in June 1992. The conference had more than 30,000 participants including more than 100 heads of states. The objective of the Summit was to support the Brundtl and report, which warned the world to take immediate action towards sustained economic development without depleting the natural resources or harming the environment.

The aims was to respond,

1. Myriad global environmental problems.
2. Conservation of biodiversity.
3. Combat climate change.
4. Promote sustainable forest management.

In this context, the advanced nations demanded environmental sustainability while the developing countries argued that they should be given the opportunity to be at par with the developed world, both socially and economically.

The five major agreements made at the Rio Earth Summit include the following,

1. The convention on Biological Diversity.
2. The Framework Convention on Climate change.
3. Principles of Forest Management.
4. The Rio Declaration on Environment and Development.
5. Agenda 21 is involved in development of societies and economies by focusing on the conservation and preservation of our environments and natural resources.

The UN General Assembly has agreed to arrange for a 'Rio + 20' Earth Summit in 2012 in Brazil with focus on four areas,

1. Review of commitments.
2. Emerging issues. (Food crisis, oil prices, climate change, biodiversity loss etc.)
3. **Green Economy** for poverty eradication and sustainable development.
4. Institutional framework for sustainable development.

KYOTO PROTOCOL

Q17: Give the salient features of Kyoto protocol?

The Kyoto Protocol is an international agreement developed under UNFCCC (UN Framework Convention on Climate Change). The Protocol was adopted in Kyoto, Japan on 11th December 1997, which came into force on 16th February 2005. Its purpose is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human-induced interference with the climate system.

The participant countries are committed to cut emissions of greenhouse gases (GHGs) such as CO_2, CH_4, N_2O, CFCs to extent possible. According to the protocol, the participants must cut down the emission of greenhouse gases by 5.2% lower than the mission levels of 1990 by 2012. Different countries were assigned different targets of emission levels and some nations were allowed an increase in emission levels. E.g. the USA was expected to lower its emission by 7%. India and china though agreed upon the protocol need not reduce greenhouse gases emissions as they are considered as the developing countries.

MONTREAL PROTOCOL

Q18: Give the salient features of Montreal protocol?

The Montreal Protocol is and international environmental agreement designed to restriction the production and consumption of ozone depleting substances to protect the stratospheric ozone layer. This agreement was signed by 24 countries and the European Economic Community on 16th September 1987 at the Headquarters of the International Civil Aviation Organization in Montreal. Therefore, each year **September 16th** is celebrated as the **International Day for Prevention of Ozone Layer**.

The ozone depleting substances includes CFCs, CCl_4, methyl chloroform; HCFC etc. are released in the lower atmosphere (troposphere) and carried to the stratosphere through mixing where they are broken down by UV radiation which depletes the ozone layer. Ozone layer protects us from the damaging UV radiation of sun.

UNIT V: ENVIRONMENTAL POLICY, LEGISLATION, RULES AND REGULATION

Environmental Protection Acts

Introduction

Constitution of India has a number of provisions demarcating the responsibility of the central and state government towards 'Environmental Protection'. The state's responsibility has been laid down under article 48-A which reads as follows, "the state shall endeavour to protect and improve the environment and safeguard the forests and wildlife of the country". Environmental protection has been made a fundamental duty of every citizen of this country under article 51-A(g) which read as "it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures". Article 21 read as, "no person shall be deprived of his life or personal liberty except according to procedure established by law".

Definition of Environment under Indian Law

According to section 2(a) of Environmental Protection Act (1986), 'Environment' includes, (i) water, air and land, (ii) the interrelationship which exists among and between, (a) water, air and land and (b) human beings, other living creatures, plants, micro-organisms and property.

Various statues / legislations are enacted in India exclusively for Environment Protection are:

(a) The Water (Prevention and Control of Pollution) Act, 1974
(b) The Air (Prevention and Control of Pollution) Act, 1981
(c) The Environmental Protection Act, 1986
(d) The Forest Conservation Act, 1980
(e) The Wild Life Protection Act, 1972
(f) The Public Liability Insurance Act, 1991, etc.

The Environmental Protection Act, 1986

Objective of this act

a. To protect and improve the air, water and land environment.
b. To prevent hazards to all living creatures and properties and
c. To maintain a pleasant relationship between human beings and their environment.

Powers of Central Government to protect and improve environment

For the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution, the Central Government has the powers to take the following measures.

1) Co-ordination of actions by the State Governments, officers and other authorities under this Act or under any other law.
2) Planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution.
3) Laying down standards for the quality of environment in its various aspects.
4) Laying down standards for the emission or discharge of the environmental pollutants from various sources.

5) Restriction of areas in which any industries, operations or processes or class of industries, operations or process shall not be carried out or shall be carried out subject to certain safeguards.
6) Laying down procedures and safeguards for the prevention of accidents.
7) Laying down procedures and safeguards for the handling of hazardous substances.
8) Examination of such manufacturing processes, materials and substances as are likely to cause environmental pollution.
9) Carrying out and sponsoring investigations and research relating to problems of environmental pollution.
10) Inspection of any premises, plant, equipment, machinery, manufacturing or other process, materials or substances likely to cause any environmental pollution.
11) Establishment or recognition of environmental laboratories and institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act.
12) Collection and dissemination of information in respect of matters relating to environmental pollution.
13) Preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution.
14) Such other matters as the Central Government deems necessary or expedient fort the purpose of securing the effective implementation of the provisions of this Act.

Rules to regulate environmental pollution

The Central Government may, by notification in the Official Gazette, make rules in respect of all or any of the following.

a. The standards of quality of air, water or soil for various areas and purposes;
b. The maximum allowable limits of concentration of various environmental pollutants (including noise) for different areas;
c. The procedures and safeguards for the handling if hazardous substance;
d. The prohibition ad restrictions on the handling of hazardous substances in different area;
e. The prohibition and restrictions in the location of industries and the carrying on the processes and operations in different areas;
f. The procedures and safeguards for the prevention of accidents which may cause environmental pollution and for such accidents.

Powers of entry and inspection

Subject to the provisions of this section, any person empowered by the Central Government in this behalf shall have a right to enter, at all reasonable times with such assistance as he considers necessary, and any place-

a. For the purpose of performing any of the functions of the Central Government entrusted to him;
b. For the purpose of determining the functions are to be performed.
c. For the purpose of examining and testing any equipment, industrial plant, record, register, document or any other material objects.

Powers to take samples

The Central Government or any officer empowered by it, shall have power to take, for the purpose of analysis, samples of air, water, soil or other substance from any factory, premises or other place. The person taking the sample under sub-section (1) shall-

a. Serve a notice to the occupier or his agent or person in charge of the place;
b. In the presence of the occupier or his agent or person, collect a sample for analysis;

c. Cause the sample to be placed in a container or containers which shall be marked and sealed and shall also be signed both by the person taking the sample and the occupier or his agent or person;
d. Send without delay, the containers to the laboratory.

Penalty for violating this Act

1. Whoever fails to comply with or contravenes any of the provisions of this Act, or the rules made of orders or directions issued there under, shall, in respect of each such failure or contravention, be punishable with imprisonment for a term which may extend to five years or with fine which may extend to one lakh rupees, or with both, and in case the failure or contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure continues.
2. If the failure continues beyond a period of one year the date of conviction the offender shall be punishable with imprisonment for a term which may extend to seven years.

Air (Prevention and Control of Pollution) Act, 1981

Objective of this Act

This Act has been passed to provide for the following:

1. Pre prevention, control and abatement of air pollution.
2. Maintaining the quality of air.
3. Establishment of Boards for the prevention and control of air pollution.

Powers and Functions of Central Board

The main function of the central board as specified in Section 16 of the act shall be to improve the quality of air and to prevent, control or abate air pollution in the country.

a. Advice to Central Government on any matter related to air quality and the prevention, control or abatement of air pollution.
b. Plan and cause to be executed a nation-wide awareness programme for the prevention, control or abatement of air pollution.
c. Co-ordinate the activities of the State Boards and resolve disputes among them;
d. To provide technical assistance and guidance to State Boards, carry out and sponsor investigations and research relating to problems of air pollution;
e. Plan and organise the training of persons engaged or to be engaged in programmes for the for prevention, control or abatement of air pollution;
f. Organise through Mass Media a comprehensive programme regarding the for prevention, control or abatement of air pollution;
g. Collect technical and statistical data to prepare manuals, code, guide related to air pollution and measures devised for its effective prevention, control or abatement of air pollution;
h. To lay down standards for the quality of air;
i. Collect and disseminate information in respect of matters relating to air pollution;
j. Perform such other functions as may be prescribed.

Functions of State Boards

The functions of State Board shall be-

a. To plan a comprehensive programme for the prevention, control or abatement of air pollution and secure the execution thereof-
b. To advise the State Government on any matter concerning for the prevention, control or abatement of air pollution.
c. To collect and disseminate information relating to air pollution.

d. To collaborate with the Central Board in organising the training of persons engaged or to be engaged in programmes relating to for the prevention, control or abatement of air pollution and to organise mass education programme relating thereto.
e. To inspect, at all reasonable times, any control equipment, industrial plant or manufacturing process and to give, by order, such directions to such persons as it may consider necessary to take steps for the prevention, control or abatement of air pollution.
f. To inspect air pollution control areas at such intervals as it may think necessary, assess the quality of air there in and take steps for the prevention, control or abatement of air pollution in such areas.
g. To lay down, in consultation with the Central Board and having regard to the standards for the quality of air laid down by the Central Board, standards for the emission of air pollutants into the atmosphere from industrial plants and automobiles or for the discharge of any air pollutant into the atmosphere from any other source whatsoever not being a ship or an aircraft.
h. To advise the State Government with respect to the suitability of any premises or location for carrying an any industry, which is likely to cause, air pollution.
i. To perform such other functions as may be prescribed or as may, from time to time, to entrusted to it by the Central Board of the State Government.
j. To do such other things and to perform such acts as it may think necessary for the proper discharge of its functions and generally for the purpose of carrying into effect the purpose of this Act.

Importance of Various Section of Air Act
Section 10 – Lays down the standards for emission of air pollutants from automobiles
Section 19 – Declaration of air pollution control area

Penalty for Contravention of Certain Provision of the Act

Whoever contravenes any of the provisions of this act or any order or direction issued there under for which no penalty has been elsewhere provided in this act shall be punishable with imprisonment for a term which may extend to 3 month or with a fine extend to Rs. 10,000/- or with both. Both companies and government departments are also prosecuted under the Air Act.

No court shall take cognizance of any offence except on a complaint made by any person who has given notice of not less than 60 days, in the manner prescribed of the alleged offence and his intention to make a complaint to the board.

The Water (Prevention and Control of Pollution) Act, 1974

Objective of this Act
a. To provide for the prevention and control of water pollution
b. To maintaining or restoring of wholesomeness of water.
c. To establishment of boards for the prevention and functions relating thereto and for matters connected therewith.
d. To confer on and assign to the Boards powers and functions relating to the above purpose.

Salient features of this Act
1. Establishment of Central and State Boards for pollution control.
2. Provision of joint boards for two or more States.
3. Prohibition of the use of streams and wells for the disposal of polluting matters.
4. Consent of Pollution Control Board to open new outlets and discharges into streams or wells.

Constitution of Central State Board (State Board)
1. A full time chairman- A person having special knowledge or particle experience in respect of matters relating to environmental protection or a person having knowledge and experience in

administering institutions dealing with the matters aforesaid, to be nominated by the Central (State) Government.

2. Not exceeding five numbers of officials to be nominated by the Central (State) Government.
3. Not exceeding five persons to be nominated by the Central (State) Government from amongst the members of the State Boards (local authorities).
4. Not exceeding three non-officials to be nominated by the Central (State) Government, to represent the interests of agriculture, fishery or industry or trade or any other interest.
5. Two persons to represent the companies or corporations owned, controlled or managed by the Central (State) Government.
6. A full time member- secretary, possessing qualifications, knowledge and experience of scientific, engineering or management aspects of pollution control, to be appointed by the Central (State) Government.

Functions of Central Board

The Central Board may perform all or any of the following functions, namely:

(a) Promote cleanliness of streams and wells in different areas of the state.

(b) Advise the central government on any matter concerning the prevention and control of water pollution

(c) Co-ordinate the activities of the state boards and resolve dispute among them.

(d) Provide technical assistance and guidance to the state board, carryout and sponsor investigations and research relating to problems of water pollution.

(e) Organize through mass media, a comprehensive programme regarding the prevention and control of water pollution.

(f) Collect, compile and publish technical and statistical data relating to water pollution and the measure devised for its effective prevention and control and prepare manuals, codes regarding the treatment and disposal of sewage and trade effluents.

(g) Establish and recognize a laboratory to enable the board to perform its functions under this section effectively, including the analysis of samples of water from any stream or well of samples of any sewage or trade effluents.

Functions of State Board

a. To plan a comprehensive programme for the prevention, control or abatement of pollution of stream and wells in the state and to secure the execution there of.
b. To advise the state government on any matter concerning the prevention, control or abatement of water pollution
c. To collect and disseminate information relating to water pollution, prevention, control or abatement of water pollution.
d. To encourage, conduct and participate the investigations and research relating to problems of water pollution.
e. To collaborate with central board in organizing the training of persons engaged in programmes relating to water pollution, prevention, abatement and treatment.
f. To inspect effluent treatment plants trade waste and domestic waste.
g. To lay down, modify standard for trade and domestic wastes.
h. To evolve economical and reliable methods of treatments, utilization of treated effluent for agriculture and disposal into land.
i. To lay down standards of treatment of sewage and trade effluents to be discharged into a stream during dry weather flow.
j. To advise state government with respect to the location of any industry the carrying on which is likely to pollute a steam or well.

Importance of Section 24 of Water Act, 1974

No person should knowingly cause or permit any poisonous, noxious or polluting matter determined in accordance with such standards as may be laid down by the state board to enter into any stream or well or

sewer or on land. However, a person shall not be part of an offence under subsection (1), by reason only of having done or could to be done by any of the following acts namely;

(a) Constructing bridge, weir, dam, sluice, dock, pier, drain or sewer or other permanent works which he has a right to construct, improve or maintain.

(b) Depositing any material on the bank or in the bed of any stream for the purpose of reclaiming land or for supporting repairing or protecting the bank or bed of such stream provided such materials are not capable of polluting such streams.

(c) Polluting into any stream by any sand or gravel or other natural deposit which has flowed from or been deposited by the current of such stream.

Whoever contravention of provisions of section (24) shall be punishable with imprisonment upto six years and with fine. Even the municipality corporation, companies, government departments also be prosecuted under water act. Varieties of powers are given to the central / state boards to make application to courts for restrains apprehended pollution of water in streams and wells.

Forest (Conservation) Act, 1980 with Amendments Made in 1988

An Act to provide for the conservation of forests and for matters connected therewith or ancillary or incidental thereto. Be it enacted by Parliament in the Thirty-first Year of the Republic of India as follows:-

1. Short title, extent and commencement.

(1) This Act may be called the Forest (Conservation) Act, 1980.

(2) It extends to the whole of India except the State of Jammu and Kashmir.

(3) It shall be deemed to have come into force on the 25th day of October, 1980.

2. Restriction on the preservation of forests or use of forest land for non-forest purpose.

Notwithstanding anything contained in any other law for the time being in force in a State, no State Government or other authority shall make, except with the prior approval of the Central Government, any order directing-

(i) that any reserved forest (within the meaning of the expression "reserved forest" in any law for the time being in force in that State) or any portion thereof, shall cease to be reserved;

(ii) that any forest land or any portion thereof may be used for any non-forest purpose;

(iii) that any forest land or any portion thereof may be assigned by way of lease or otherwise to any private person or to any authority, corporation, agency or any other organisation not owned, managed or controlled by Government;

(iv) that any forest land or any portion thereof may be cleared of trees which have grown naturally in that land or portion, for the purpose of using it for reafforestation.

Explanation - For the purpose of this section, "non-forest purpose" means the breaking up or clearing of any forest land or portion thereof for-

(a) the cultivation of tea, coffee, spices, rubber, palms, oil-bearing plants, horticultural crops or medicinal plants;

(b) any purpose other than reafforestation; but does not include any work relating or ancillary to conservation, development and management of forests and wildlife, namely, the establishment of check-posts, fire lines, wireless communications and construction of fencing, bridges and culverts, dams, waterholes, trench marks, boundary marks, pipelines or other like purposes.

3. Constitution of Advisory Committee.

The Central Government may constitute a Committee consisting of such number of persons as may deem fit to advise that Government with regard to-

(i) the grant of approval under Section 2; and

(ii) any other matter connected with the conservation of forests which may be referred by the Central Government.

3A. Penalty for contravention of the provisions of the Act.

Whoever contravenes or abets the contravention of any of the provisions of Section 2, shall be punishable with simple imprisonment for a period which may extend to fifteen days.

3B. Offences by the Authorities and Government Departments.

(1) Where any offence under this Act has been committed -

(a) by any department of Government, the head of the department; or

(b) by any authority, every person who, at the time the offence was committed, was directly in charge of, and was responsible to, the authority for the conduct of the business of the authority as well as the authority; shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

Provided that nothing contained in this sub-section shall render the head of the department or any person referred to in clause (b), liable to any punishment if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where an offence punishable under the Act has been committed by a department of Government or any authority referred to in clause (b) of sub-section (1) and it is proved that the offence has been committed with the consent or connivance of; or is attributable to any neglect on the part of any officer, other than the head of the department, or in the case of an authority, any person other than the persons referred to in clause (b) of sub-section (1), such officer or persons shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

4. Power to make rules.

(1) The Central Government may, by notification in the Official Gazette, makes rules for carrying out the provisions of this Act.

(2) Every rule made under this Act shall be laid, as soon as may be after it is made, before each House of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, the rule shall thereafter have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

5. Repeal and saving.

(1) The Forest (Conservation) Ordinance, 1980 is hereby replaced.

(2) Notwithstanding such repeal, anything done or any action taken under the provisions of the said Ordinance shall be deemed to have been done or taken under the corresponding provisions of this Act.

Wildlife protection act, 1972 (amended in 2002)

1. Definition of wildlife: The section 2(37) of the Act defines wildlife as wildlife includes any animal, bee's butterflies, crustaceans, fish and moths and aquatic or land vegetation which forms part of habitat.

2. **Authorities Constituted Under wildlife (protection) Act:**

As per the Sec. 3of this Act, the Central Government may appoint a Director of Wildlife Preservation, Assistant Directors of Wildlife Preserves ration and such other officers and employees as may be necessary.

As per the Sec. 4 of this Act, the State Government may appoint a Director of Wildlife Preservation, Assistant Directors of Wildlife Preserves ration and such other officers and employees as may be necessary.

As per the sec 6, the State Government and the Administrators in Unon Territories shall constitute a Wildlife Advisory Boaed.

3. **The Wildlife Advisory Board (Sec 6):**
   The Sec.6 of this Act enforces and enables the state government and the administrators of the Union territories.
4. **The members of Wildlife Advisory Board:**
   It shall consist of the Minster in charge of Forests in the State of Union Territories as Chairman. If there is no such minister, then the Chief Secretary will be the chairman of the board. The other members are, two members of State Legislature or Legislature of Union territory; Secretary to the State Government or the government of the union territory, in charge of forests; the Forest Officer in charge of the State Forest Department; an officer nominated by the Director of Wildlife Preservation; Chief wildlife warden; officers of the state government not exceeding 5; and such other persons, not exceeding 10, who in the opinion of the state government, are interested in the protection of wildlife, including the representatives of tribal not exceeding 3.
5. **Duties of Wildlife Advisory Board (sec.8):**
   The wildlife Advisory board mainly constituted to advise the state government in the following matters:
   a. In the selection of areas to be declared as Sanctuaries, National Parks and Closed areas and the administration thereof;
   b. In the formulation of the policy for protection and conservation of wildlife and specified plants;
   c. In any matter relating to the amnmdement of any schedule;
   d. In relation to the measure to be taken for harmonizing the needs of the tribal and other dwellers of the forest of the forests with the protection and conservation of wildlife;
   e. In any other matter connected with protection of wildlife which may be referred to it by the state government.
6. **Hunting of Wild Animals (Sec9):**
   Sec 9 of the Act prohibits hunting of any wild animal specified in Schedules 1, 2, 3 and 4.

   Any person who hunts any wild animals shall be punishable with imprisonment for a term which may extend to 3 years of with fine which may extend to 25000- of both. However if any person commits the offence in the sanctuary of national park, with respect any animal specified in Schedule 1, he shall be punishable with imprisonment which shall not be less than 1 year but extended to 6 years and also with fine which shall not be less than 5000/-.
7. **Hunting of Wild animals to be permitted in certain cases:**
   The Chef Wildlife Warden may permit hunting of wild animals in certain situations. They are:
   a. The Chief Wildlife Warden may , if he is satisfied that any wild animal specified in Schedule I has become dangerous to human life or is so disabled or diseased as to be beyond recovery, by order in writing and stating the reasons therefore permit any person to hunt such animal or cause animal to be hunted.
   b. The Chief Wildlife Warden or the authorized officer may, if he is satisfied that any wild animal specified In Schedule II or II or IV has become dangerous to human life or the property including standing crops on any land or is so disabled or diseased as to be beyond recovery, by order in writing and stating the reasons therefore, permit any person to hunt such animal or cause such animal to be hunted.
   c. The killing or winding in good faith of any wild animal in defense of oneself or of any other person shall bit be an offence; provided that anything in this subsection shall exonerate any person show, when such defense becomes necessary, was committing any act in contravention of any provision of this Act or any rule or order made there under.
   d. Any wild animal killed or wounded in defense of any person shall be Government property.
8. **Grant of permission for hunting for special purposes:**
   the Chief Wildlife Warden, permit , by order in writing stating the reasons therefore, to any person, on payment of such fee as may be prescribed, which shall entitle the holder of such

permit to hunt, subject to such conditions as may be specified there in, any wild animal specified in such permit, for the purpose of,

a. Education;
b. Scientific Research;
c. Scientific management; means and includes
    i. Translocation of any wild animal to an alternative suitable habits; or
    ii. Population management of wildlife, without killing or poisoning or destroying any wild animals.
d. Collection of specimens
    i. For recognized zoos subject to the permission under section 38-I or
    ii. For museums and similar institutions;
    iii. Derivation, collection or preparation of snake venom for the manufacture of life saving drugs.

9. Protection of Specified plants:

Sec. 17 A of the Act prohibits picking, uprooting, etc., of specified plants.

No person shall:

a. Will fully pick, uproot, damage destroy, acquire or collect any specified plant from any forest land and area specified, by notification, by the Central Government,
b. Possess, sell, other for sale , or transfer by way of gift or otherwise, or transport any specified plant, whether alive or dead, of part or derivative thereof:

10. Sanctuaries, National Parks, Zoo parks:

Section 18 provides that the State Government may, by notification, declare its intention to constitute any area other than park comprised with any reserve forest or the territorial waters as sanctuary, national park if it considers that such area is of adequate ecological, faunal, floral, geomorphological, natural or zoological significance, for the purpose of protecting, propagating or developing wildlife or its environment.

11. Punishment:

Provided that where the offence committed is in relation to any animal specified in Scheduled I or Part II of Schedule, II or meat of any such animal, animal article, trophy, or uncurled trophy derived from such animal or where offence relates to hunting in, or altering the boundaries of a sanctuary or a National Park, such offence shall be punishable with imprisonment for a term which shall not be less than 1 year but ma extend to 6 years and also with fine which not less than 5000/-. Provided further that in the case of a second or subsequent offence of the nature mentioned in this sub-section, the term of imprisonment may extended to 6 years and shall not be less than 2 years and the amount of fine shall not be less than 10000 /- rupees.

Any person who contravenes any provisions of Chapter V A, (Prohibition of Trade or Commerce in Trophies, Animal Articles etc, derived from Certain animal) shall be punishable with imprisonment for a term which shall not be less than one year but which may be extended to seven years and also with a fine which shall not be less than five thousand rupees.

Any person who contravenes the provisions of Section 38 J (tease, molest, injure or feed any animal or cause disturbance to the animals by noise or otherwise, or litter the grounds in zoo) shall be punishable with imprisonment for a term which may extended to six months of with fine which may extended to 2000 /- rupees or with both. Provided that in case of second or subsequent offence the term of imprisonment may extended to one year or the fine may extend to five thousand rupees as per section 52.

Municipal Solid Waste (Management & Handling) Rules, 2000

The Central Government draft rules in exercise of the powers conferred by section 3, 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules to regulate the management and handling of the municipal solid wastes, namely :-

1. Short title and commencement

These rules may be called the Municipal Solid Wastes (Management and Handling) Rules, 2000.

2. Application

Municipal Solid Waste (Management & Handling) Rules, 2000 (MSW Rules) are applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solids. The Rules contains four Schedules namely;

1	Schedule-I	Relates to implementation Schedule
2	Schedule-II	Specifications relating to collection, segregation, storage, transportation, processing and disposal of municipal solid waste (MSW).
3	Schedule-III	Specifications for landfilling indicating; site selection, facilities at the site, specifications for landfilling, Pollution prevention, water quality monitoring, ambient air quality monitoring, Plantation at landfill site, closure of landfill site and post care.
4	Schedule-IV	Indicate waste processing options including; standards for composting, treated leachates and incinerations.

3. Local bodies

	Population	**Class**	**No. of cities**
1	>10,00,000 and above (metro only)		35
2	>1,00,000 and above	Class I	393
3	50,000 – 99,999	Class II	401
4	20,000 – 49,999	Class III	1,115
5	10,000 – 19,999	Class IV	1,344
6	5,000 - 9,999	Class V	888
7	> 5,000	Class VI	191
8	Unclassified		10
			4377

4. Authorities and Responsibilities

S.No	**Agencies/ Authorities**	**Responsibility**
1	**Municipal Authorities**	i. Ensuring that municipal solid wastes to be handled as per rules. ii. Seeking authorization from State Pollution Control Board (SPCB) for setting up waste processing and disposal facility including landfills. iii. Furnishing annual report. iv. Complying with Schedule I, II, III and IV of the rules
2	**State Government** 1.Secretary In-Charge of Department of Urban Development 2. District Magistrates/ Deputy Commissioner	Overall responsibility for the enforcement of the provisions of the rules in the metropolitan cities. Overall responsibility for the enforcement of the provisions of the rules within the territorial limits of their jurisdiction.
3	**Central Pollution Control Board (CPCB)**	i. Co-ordinate with State Boards and Committees with reference to implementation and review of standards and guidelines and compilation of monitoring data. ii. Prepare consolidated annual review report on management of municipal solid wastes for forwarding it to Central Government along with its recommendations before the 15th of December every year. iii. Laying down standards on waste processing/ disposal technologies including approval of technology.

4	**State Pollution Control Board (SPCB)**	i. Monitor the compliance of the standards regarding ground water, ambient air leachate quality and the compost quality including incineration standards as specified under Schedule II, III & IV. ii. Issuance of authorization to the municipal authority or an operator of a facility stipulating compliance criteria and standards. iii. Prepare and submit to the CPCB an annual report with regard to the implementation of the rules.

5. Management of municipal solid wastes :

1. Any municipal solid waste generated in a city or a town, shall be managed and handled in accordance with the compliance criteria and the procedure laid down in **Schedule-II.**
2. The waste processing and disposal facilities to be set up by the municipal authority on their own or through an operator of a facility shall meet the specifications and standards as specified in **Schedules III** and **IV.**

6. Annual Reports .

The State Boards and the Committees shall prepare and submit to the Central Pollution Control Board an annual report with regard to the implementation of these rules by the 15th of September every year in **Form-IV**.

1. The Central Pollution Control Board shall prepare the consolidated annual review report on management of municipal solid wastes and forward it to the Central Government alongwith its recommendations before the 15th of December every year.

7. Accident Reporting

When an accident occurs at any municipal solid wastes collection, segregation, storage, processing, treatment and disposal facility or landfill site or during the transportation of such wastes, the municipal authority shall forthwith report the accident in **Form-V** to the Secretary in-charge of the Urban Development Department in metropolitan cities, and to District Collector or Deputy Commissioner in all other cases.

Schedule I

Implementation Schedule

s.no	Compliance Criteria	Schedule
1	Setting up of waste processing and disposal facilities	By 31.12.2003 or earlier
2	Monitoring the performance of waste processing and disposal facilities	Once in six months
3	Improvement of existing landfill sites as per provisions of these rules	By 31.12.2001 or earlier
4	Identification of landfill sites for future use and making site (s) ready for operation	By 31.12.2002 or earlier

Schedule -II

Management of Municipal Solid Wastes

S.No	Parameters	Compliance criteria
1.	**Collection of municipal solid wastes**	1. Littering of municipal solid waste shall be prohibited in cities, towns and in urban areas notified by the State Governments. To prohibit littering and facilitate compliance, the following steps shall be taken by the municipal authority, namely i. Organising house-to-house collection of municipal solid wastes through any of the methods, like community bin collection (central bin), house-to-house collection, collection on regular pre-informed timings and scheduling by using bell ringing of musical vehicle (without exceeding permissible noise levels); ii. Devising collection of waste from slums and squatter areas or localities including hotels, restaurants, office complexes and commercial areas; iii. Wastes from slaughter houses, meat and fish markets, fruits and vegetable markets, which are biodegradable in nature, shall be managed to make use of such wastes; iv. Bio-medical wastes and industrial wastes shall not be mixed with municipal solid wastes and such wastes shall follow the rules separately specified for the purpose; v. Collected waste from residential and other areas shall be transferred to community bin by hand-driven containerised carts or other small vehicles; vi. Horticultural and construction or demolition wastes or debris shall be separately collected and disposed off following proper norms. Similarly, wastes generated at dairies shall be regulated in accordance with the State laws; vii. Waste (garbage, dry leaves) shall not be burnt; viii. Stray animals shall not be allowed to move around waste storage facilities or at any other place in the city or town and shall be managed in accordance with the State laws. 2. The municipal authority shall notify waste collection schedule and the likely method to be adopted for public benefit in a city or town. 3. It shall be the responsibility of generator of wastes to avoid littering and ensure delivery of wastes in accordance with the collection and segregation system to be notified by the municipal authority as per para 1(2) of this Schedule.
2.	**Segregation of municipal solid wastes**	In order to encourage the citizens, municipal authority shall organise awareness programmes for segregation of wastes and shall promote recycling or reuse of segregated materials. The municipal authority shall undertake phased programme to ensure community participation in waste segregation. For this purpose, regular meetings at quarterly intervals shall be arranged by the municipal authorities with representatives of local resident welfare associations and non-governmental organizations.
3.	**Storage of municipal solid wastes**	Municipal authorities shall establish and maintain storage facilities in such a manner as they do not create unhygienic and insanitary conditions around it. Following criteria shall be taken into account while establishing and maintaining storage facilities, namely :- i. Storage facilities shall be created and established by taking into account quantities of waste generation in a given area and the population densities. A storage facility shall be so placed that it is accessible to users; ii. Storage facilities to be set up by municipal authorities or any other agency shall be so designed that wastes stored are not exposed to open atmosphere and shall be aesthetically acceptable and user-friendly; iii. Storage facilities or bins shall have easy to operate design for handling, transfer and transportation of waste. Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black; iv. Manual handling of waste shall be prohibited. If unavoidable due to constraints, manual handling shall be carried out under proper precaution

		with due care for safety of workers.
4.	**Transportation of municipal solid wastes**	Vehicles used for transportation of wastes shall be covered. Waste should not be visible to public, nor exposed to open environment preventing their scattering. The following criteria shall be met, namely:- i. The storage facilities set up by municipal authorities shall be daily attended for clearing of wastes. The bins or containers wherever placed shall be cleaned before they start overflowing; ii Transportation vehicles shall be so designed that multiple handling of wastes, prior to final disposal, is avoided.
5.	**Processing of municipal solid wastes**	Municipal authorities shall adopt suitable technology or combination of such technologies to make use of wastes so as to minimize burden on landfill. Following criteria shall be adopted, namely:- i The biodegradable wastes shall be processed by composting, vermin-composting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes. It shall be ensured that compost or any other end product shall comply with standards as specified in Schedule-IV; ii Mixed waste containing recoverable resources shall follow the route of recycling. Incineration with or without energy recovery including pelletisation can also be used for processing wastes in specific cases. Municipal authority or the operator of a facility wishing to use other state-of-the-art technologies shall approach the Central Pollution Control Board to get the standards laid down before applying for grant of authorisation.
6.	**Disposal of municipal solid wastes**	Land filling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, land-filling shall be done following proper norms. Landfill sites shall meet the specifications as given in Schedule III.

Schedule III
Specifications for Landfill Sites

- **Site Selection**
- **Facilities at the Site**
- **Specifications for land filling**
- **Pollution prevention**
- **Water Quality Monitoring**
- **Ambient Air Quality Monitoring**
- **Plantation at Landfill Site**
- **Closure of Landfill Site and Post-care**

Schedule IV
Standards for Composting, Treated Leachates and Incineration

The Bio-Medical Waste (Management and Handling) Rules, 1998

The Central Government hereby notifies the rules for the management and handling of bio-medical waste.

1. SHORT TITLE AND COMMENCEMENT:

These rules may be called the Bio-Medical Waste (Management and Handling) Rules, 1998.

2. APPLICATION:

These rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio medical waste in any form.

3. DUTY OF OCCUPIER:

It shall be the duty of every occupier of an institution generating bio-medical waste which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called to take all steps to ensure that such waste is handled without any adverse effect to human health and the environment.

4. TREATMENT AND DISPOSAL

1. Bio-medical waste shall be treated and disposed of in accordance with Schedule I, and in compliance with the standards prescribed in Schedule V.
2. Every occupier, where required, shall set up in accordance with the time-schedule in Schedule VI, requisite bio-medical waste treatment facilities like incinerator, autoclave, microwave system for the treatment of waste, or, ensure requisite treatment of waste at a common waste treatment facility or any other waste treatment facility.

5. SEGREGATION, PACKAGING, TRANSPORTATION AND STORAGE

1. Bio-medical waste shall not be mixed with other wastes.
2. Bio-medical waste shall be segregated into containers/bags at the point of generation in accordance with Schedule II prior to its storage, transportation, treatment and disposal. The containers shall be labeled according to Schedule III.
3. If a container is transported from the premises where bio-medical waste is generated to any waste treatment facility outside the premises, the container shall, apart from the label prescribed in Schedule III, also carry information prescribed in Schedule IV.
4. Notwithstanding anything contained in the Motor Vehicles Act, 1988, or rules there under, untreated biomedical waste shall be transported only in such vehicle as may be authorized for the purpose by the competent authority as specified by the government.
5. No untreated bio-medical waste shall be kept stored beyond a period of 48 hours
6. Provided that if for any reason it becomes necessary to store the waste beyond such period, the authorized person must take permission of the prescribed authority and take measures to ensure that the waste does not adversely affect human health and the environment.

6. PRESCRIBED AUTHORITY

1. The Government of every State and Union Territory shall establish a prescribed authority with such members as may be specified for granting authorization and implementing these rules. If the prescribed authority comprises of more than one member, a chairperson for the authority shall be designated.
2. The prescribed authority for the State or Union Territory shall be appointed within one month of the coming into force of these rules.
3. The prescribed authority shall function under the supervision and control of the respective Government of the State or Union Territory.
4. The prescribed authority shall on receipt of Form 1 make such enquiry as it deems fit and if it is satisfied that the applicant possesses the necessary capacity to handle bio-medical waste in accordance with these rules, grant or renew an authorization as the case may be.
5. An authorization shall be granted for a period of three years, including an initial trial period of one year from the date of issue. Thereafter, an application shall be made by the occupier/operator for renewal. All such subsequent authorization shall be for a period of three years. A provisional

authorization will be granted for the trial period, to enable the occupier/operator to demonstrate the capacity of the facility.

6. The prescribed authority may after giving reasonable opportunity of being heard to the applicant and for reasons thereof to be recorded in writing, refuse to grant or renew authorization.
7. Every application for authorization shall be disposed of by the prescribed authority within ninety days from the date of receipt of the application.
8. The prescribed authority may cancel or suspend an authorization, if for reasons, to be recorded in writing, the occupier/operator has failed to comply with any provision of the Act or these rules : Provided that no authorization shall be cancelled or suspended without giving a reasonable opportunity to the occupier/operator of being heard.

7. AUTHORISATION

1. Every occupier of an institution generating, collecting, receiving, storing, transporting, treating, disposing and/or handling bio-medical waste in any other manner, except such occupier of clinics, dispensaries, pathological laboratories, blood banks providing treatment/service to less than 1000 (one thousand) patients per month, shall make an application in Form 1 to the prescribed authority for grant of authorization.
2. Every operator of a bio-medical waste facility shall make an application in Form 1 to the prescribed authority for grant of authorization.
3. Every application in Form 1 for grant of authorisation shall be accompanied by a fee as may be prescribed by the Government of the State or Union Territory.

8. ADVISORY COMMITTEE

The Government of every State/Union Territory shall constitute an advisory committee. The committee will include experts in the field of medical and health, animal husbandry and veterinary sciences, environmental management, municipal administration, and any other related department or organisation including non-governmental organizations. The State Pollution Control Board/Pollution Control Committee shall be represented. As and when required, the committee shall advise the Government of the State/Union Territory and the prescribed authority about matters related to the implementation of these rules.

9. ANNUAL REPORT

Every occupier/operator shall submit an annual report to the prescribed authority in Form 11 by 31 January every year, to include information about the categories and quantities of bio-medical wastes handled during the preceding year. The prescribed authority shall send this information in a compiled form to the Central Pollution Control Board by 31 March every year.

10. MAINTENANCE OF RECORDS

1. Every authorised person shall maintain records related to the generation, collect ' ion, reception, storage, transportation, treatment, disposal and/or any form of handling of bio-medical waste in accordance with these rules and any guidelines issued.
2. All records shall be subject to inspection and verification by the prescribed authority at any time.

11. ACCIDENT REPORTING

When any accident occurs at any institution or facility or any other site where bio-medical waste is handled or during transportation of such waste, the authorised person shall report the accident in Form I to the prescribed authority forthwith.

12. APPEAL

Any person aggrieved by an order made by the prescribed authority under these rules may, within thirty days from the date on which the order is communicated to him, prefer an appeal to such authority as the Government of State/Union Territory may think fit to constitute :

Provided that the authority may entertain the appeal after the expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.

SCHEDULE I

CATEGORIES OF BIO-MEDICAL WASTE

Option	Waste Category	Treatment & Disposal
Category No. 1	**Human Anatomical Waste** (human tissues, organs, body parts)	Incineration/deep burial*
Category No. 2	**Animal Waste** (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals colleges, discharge from hospitals, animal houses)	Incineration/deep burial*
Category No. 3	**Microbiology & Biotechnology Waste** (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biological, toxins, dishes and devices used for transfer of cultures)	Local autoclaving/microwaving/ incineration
Category No. 4	**Waste sharps** (used unused needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	Disinfection (chemical treatment/ autoclaving/micro-waving and mutilation/ shredding)
Category No. 5	**Discarded Medicines and Cytotoxic drugs** (wastes comprising of outdated, contaminated and discarded medicines)	Incineration/destruct ion and drugs disposal in secured landfills
Category No. 6	**Soiled Waste** (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood)	Incineration autoclaving/microwaving
Category No. 7	**Solid Waste** (Wastes generated from disposable items other than the waste sharps such as tubing's, catheters, intravenous sets etc).	Disinfection by chemical treatment/autoclaving/ microwaving and mutilation/shredding.
Category No. 8	**Liquid Waste** (waste generated from laboratory and washing, cleaning, house-keeping and disinfecting activities)	Disinfection by chemical treatment and discharge into drains.
Category No. 9	**Incineration Ash** (ash from incineration of any bio-medical waste)	Disposal in municipal landfill
Category No. 10	**Chemical Waste** (Chemicals used in production of biological into disinfection, as insecticides, etc.) drains for liquids and secured landfill for	Chemicals treatment and discharge into drains for liquids and secured landfill for solids

SCHEDULE II

COLOUR CODING AND TYPE OF CONTAINER FOR DISPOSAL OF BIO-MEDICAL WASTES

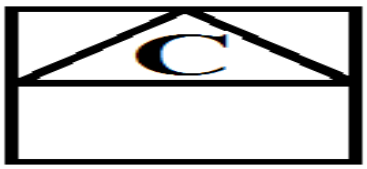
S.No.	COLOUR	TYPE OF CONTAINER	WASTE CATEGORY	TREATMENT
1	Yellow	Plastic Bags	Cat.1, Cat.2, Cat.3 & Cat.6	Incineration/deep burial
2	Red	Disinfected container/ Plastic Bag	Cat. 3, Cat.6 & Cat.7	Autoclaving/Microwaving/ Chemical Treatment
3	Blue/White Translucent	Puncture proof container/ Plastic Bag	Cat.4 &Cat.7	Autoclaving/Microwaving/ Chemical Treatment and destruction/shredding
4	Black	Plastic Bag	Cat. 5, Cat.9 &Cat.10	Disposal in secured landfill

Notes:

1. Colour coding of waste categories with multiple treatment options as defined in Schedule I, shall be selected depending on treatment option chosen, which shall be as specified in Schedule I.
2. Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
3. Categories 8 and 10 (liquid) do not require containers/bags.
4. Category 3 if disinfected locally need not be put in containers/bags.

SCHEDULE III

LABEL FOR BIO-MEDICAL WASTE CONTAINERS/BAG HANDLE WITH CARE



Note : Label shall be non-washable and prominently visible.

SCHEDULE IV

LABEL FOR TRANSPORT OF BIO-MEDICAL WASTE CONTAINERS/BAGS

SCHEDULE V

STANDARDS FOR TREATMENT AND DISPOSAL OF BIO-MEDICAL WASTES

1. STANDARDS FOR INCINERATORS:
2. All incinerators shall meet the following operating and emission standards
    a. **Operating Standards**
    b. **Emission Standards**
3. STANDARDS FOR WASTE AUTOCLAVING:
4. STANDARD FOR LIQUID WASTE:
5. STANDARDS OF MICROWAVING
6. STANDARDS FOR DEEP BURIAL

SCHEDULE VI

SCHEDULE FOR WASTE TREATMENT FACILITIES LIKE INCINERATOR/ AUTOCLAVE/ MICROWAVE SYSTEM

The Hazardous Wastes (Management and Handling) Rules, 1989

In exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules, namely:

1. Short title and commencement.

These rules may be called the Hazardous Wastes (Management and Handling) Rules, 1989.

2. Application.

These rules shall apply to hazardous wastes as specified in Schedule and shall not apply to-

1. Waste water and exhaust gases as covered under the provisions of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981) and rules made there under;
2. Wastes arising out of the operation from ships beyond five kilometers as covered under the provisions of the Merchant Shipping Act,. 1958 (\44 of 1958) and the rules made there under,
3. Radio-active wastes as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962) and rules made there under,

3. Responsibility of the occupier for handling of wastes.

1. The occupier generating hazardous wastes listed in column (2) of the Schedule in quantities equal to or exceeding the limits given in column (3) of the said Schedule, shall take all practical steps to ensure that such wastes are properly handled and disposed of without any adverse effects which may result from such wastes and the occupier shall also be responsible for proper collection, reception, treatment, storage and disposal of these wastes either himself or through the operator of a facility.

2. The occupier or any other person acting on his behalf who intends to get his hazardous waste treated by the operator of a facility under sub-rule (1), shall give to the operator of a facility, such information as may be specified by the State Pollution Control Board.

4. Grant of authorisation for handling hazardous wastes.

1. Hazardous wastes shall be collected, treated, stored and disposed of only in such facilities as may be authorised for this purpose.
2. Every occupier generating hazardous wastes and having a facility for collection, reception, treatment, transport storage and disposal of such wastes shall make an application in Form 1 to the State Pollution Control Board for the grant of authorisation for any of the above activities:

   Provided that the occupier not having a facility for the collection, reception, treatment, transport, storage and disposal of hazardous wastes shall make an application to the State Pollution Control Board in Form 1 for the grant of authorisation within a period of six months from the date of commencement of these rules.
3. Any person who intends to be an operator of a facility for the collection, reception, treatment, transport, storage and disposal of hazardous wastes, shall make an application in Form 1 to the State Pollution Control Board for the grant of authorisation for any of the above activities:

   Provided that the operator engaged in the business of the collection, reception, treatment, transport, storage and disposal of hazardous wastes shall make an application to the State Pollution control Board in Form 1 for the grant of authorisation within a period of six months from the date of commencement of these rules.
4. The State Pollution Control Board shall not issue an authorisation unless it is satisfied that the operator of a facility or an occupier, as the case may be, possesses appropriate facilities, technical capabilities and equipment to handle hazardous wastes safely.
5. The authorization to operate a facility shall be issued in Form 2 and shall be subject to conditions laid down therein.
6. a. An authorization granted under this rule shall unless sooner suspended or cancelled, be in force for a period of two years from the date of issue or from the date of renewal.

   b. An application for the renewal of an authorisation shall be made in Form l before its expiry.

   c. The authorisation shall continue to be in force until it is renewed or revoked.
7. The State Pollution Control Board, may, after giving reasonable opportunity of being heard to the applicant refuse to grant any authorisation.

5. Power to suspend or cancel an authorisation.

1. The Slate Pollution Control Board may cancel an authorisation issued under these rules or suspend it for such period as it thinks fit, if in its opinion, the authorised person has failed to comply with any of the conditions of the authorisation or with any provisions of the Act or these rules, after giving the authorised person an opportunity to show cause and after recording reasons therefor.
2. Upon suspension or cancellation of the authorisation and during the pendency of an appeal under rule 12, the State Pollution Control Board may give directions to the persons whose authorisation has been suspended or cancelled for the safe storage of the hazardous wastes, and such person shall comply with such directions.

6. Packaging, labeling and transport of hazardous wastes.

1. Before hazardous wastes is delivered at the hazardous waste site, the occupier or operator of a facility shall ensure that the hazardous wastes is packaged in a manner suitable for storage and transport and the labeling and packaging shall be easily visible and be able to withstand physical conditions and climate factors.
2. Packaging, labeling and transport of hazardous wastes shall be in accordance with the provisions of the rules issued by the Central Government under the Motor Vehicles Act, 1988 and other guidelines issued from time to time.

7. Inventory of disposal sites.

1. The State Government or a person authorised by it shall undertake a continuing programme to identify the sites and compile and publish periodically an inventory of disposal sites within the State for the disposal of hazardous wastes.

2. The State Government or a person authorised by it shall undertake an environmental impact study before identifying a site as waste disposal site in the State.
3. The State Government or a person authorised by it shall undertake a continuing programme to compile and publish an inventory of sites within the State at which hazardous wastes have at any time been stored or disposed of and such inventory shall contain, besides the location and description, information relating to the amount, nature and toxicity of hazardous wastes at each such site as may be associated with such site.

8. Records and returns.

1. The occupier generating hazardous waste and operator of a facility for collection, reception, treatment, transport, storage and disposal of hazardous waste shall maintain records of such operations in Form 3.
2. The occupier and operator of a facility shall send annual returns to the State Pollution Control Board in Form 4.

9. Accident reporting and follow-up.

Where an accident occurs at the facility or on a hazardous waste site or during transportation of hazardous wastes, the occupier or operator of a facility shall report immediately to the State Pollution Control Board about the accident in Form 5.

10. Import of hazardous wastes.

1. Import of hazardous wastes from any country to India shall not be permitted for dumping and disposal of such wastes. However, import of such wastes may be allowed for processing or re-use as raw material, after examining each case on merit by the State Pollution Control Board or by an officer authorised in this behalf.
2. The exporting country or the exporter as the case may be, of hazardous wastes shall communicate in Form 6 to the Central Government (the Ministry of Environment and Forests) of the proposed trans-boundary movement of hazardous wastes.
3. The Central Government shall, after examining the communication received under sub-rule (2) and on being satisfied that the import of such hazardous wastes is to be used for processing or reuse as raw material grant permission for the import of such wastes subject to such conditions as the Central Government may specify in this behalf and if, however, the Central Government is not satisfied with the communication received under sub-rule (2), may refuse permission t-o import such hazardous wastes.
4. Any importer importing hazardous wastes shall provide necessary information as to the type of hazardous wastes he is to import, in Form 6, to the concerned State Pollution Control Board/the Central Pollution Control Board in the case of Union Territories.
5. The State-Pollution Control Board shall examine the information received under the sub-rule (4) and issue such instructions to the importers as it considers necessary.
6. The Central Government or the State Pollution Control Board, as the case may be, shall inform the concerned Port Authority to take appropriate steps regarding the safe handling of the hazardous wastes at the time of off-loading the same.
7. Any person importing hazardous wastes shall maintain the records of the hazardous wastes imported as specified in Form 7 and the records so maintained shall be open for inspection by the State Pollution Control Board/the Ministry of Environment and Forests/the Central Pollution Control Board in the case of Union Territories or an officer appointed by them in this behalf.

11. Appeal.

1. An appeal shall lie, against any order of suspension or cancellation or refusal of an authorisation by the State Pollution Control Board to the State Government and to the Ministry of Environment and Forests in the case of the Central Pollution Control Board.
2. Every appeal shall be in writing and shall be accompanied by a copy of the order appealed against and shall be presented within thirty days of the order passed.

SCHEDULE

CATEGORIES OF HAZARDOUS WASTES

Waste Categories	Type of wastes	Regulatory Quantities
1	2	3
Waste Category No. 4	Mercury, Arsenic, Thallium and Cadmium bearing wastes.	5 kilogrammes per year the sum of the specified substance calculated as pure metal.
Waste Category No. 5	Non-halogenated hydrocarbons including solvent.	200 kilogrammes per year calculated as non-halogenated hydrocarbons.
Waste Category No. 6	Halogenated hydro-carbon including solvents	50 kilograms per year calculated as helogenated hydrocarbons.
Waste Category No. 7	Wastes from paints, pigments, glue, varnish and printing ink.	250 kilogrammes per year calculated as oil or oil emulsions.
Waste Category No.8	Wastes from Dyes and Dye intermediate containing inorganic chemical compounds.	200 kilogrammes per year calculated as inorganic chemicals.
Waste Category No. 9	Wastes from Dyes and Dye intermediate containing organic chemical compounds.	50 kilogrammes per year calculated as organic chemicals.
Waste Category No. 10	Waste oil and oil emulsions.	1000 kilogrammes per year calculated as oil and oil emulsions.
Waste Category No. 11	Tarry wastes from refining and tar residues from distillation or prolytic treatment.	200 kilogrammes per year calculated as tar
Waste Category No. 12	Sludgesarising from treatment of waste waters containing heavy metals, toxic organics, oils emulsions and spend chemical and inceneration ash.	irrespective of any quantity.
Waste Category No. 13	Phenols.	5 kilogrammes per year calculated as phenols.
Waste Category No. 14	Asbestos.	200 kilogrammes per year calculated asbestos.
Waste Category No. 15	Wastes from manufacturing of pesticides and herbicides and residues from pesticides and, herbicides formulation units.	5 kilogrammes per year calculated as pesticides and their intermediate products.
Waste Category No. 16	Acid/Alkaline/Slurry	200 kilogrammes per year calculated as Acids/Alkalies.
Wastes Category No.17	Off-specification and discarded products.	Irrespective of any quantity.
Wastes Category No.18	Discarded containers and Containers linears of hazardous and toxic wastes.	Irrespective of any quantity.

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN

Introduction

Definition of EIA

There are many definitions of EIA. The following are the sample of some of these definitions which indicate the nature of the process, including;

"an assessment of impacts of a planned activity on the environment" (United Nations)

"EIA is the systematic process of identifying the future consequences of a current or proposed action" (IAIA)

All of these definitions share the basic concepts of:

1. **EIA as a process.**
2. **EIA as a part of project planning.**
3. **EIA as a proactive way of addressing environmental concerns.**

Reasons for Using EIA

EIA has been developed as a result of the failure of traditional project appraisal techniques to account for environmental impacts. Many development projects in the past were designed and constructed in isolation from any consideration of their impacts on the environment, resulting in:

- higher costs,
- failure of projects,
- significant environmental change, and
- negative social effects

Aims of EIA

Despite differences in individual EIA systems throughout the world, the EIA process shares certain aims:

- **to provide decision-makers with analysis of the total environment** so that decisions can be made based on as nearly complete and balanced information as possible;
- **to assess and present intangible/unquantifiable effects** that are not adequately addressed by cost/benefit analysis and other technical reports;
- **to provide information to the public** on a proposal;
- **to formalise the consideration of alternatives to a proposal** being considered, in order that the least environmentally harmful means of achieving the given objective can be chosen;
- **to improve the design of new developments and safeguard the environment** through the application of mitigation and avoidance measures

Environmental Impact Assessment Principles and Process

Applying EIA...

EIA is considered as a project management tool for collecting and analyzing information on the environmental effects of a project. As such, it is used to:

- identify potential environmental impacts,
- examine the significance of environmental implications,
- assess whether impacts can be mitigated,
- recommend preventive and corrective mitigating measures,
- inform decision makers and concerned parties about the environmental implications,
- advise whether development should go ahead.

EIA Process...

EIA Benefits and Flaws

EIA generates huge benefits in selection of project location, process, design, development actions, and decision-making, however, in the current practice of EIA there are a number of flaws, shortcomings and deficiencies. The table below summarizes apparent benefits and flaws of the EIA.

Benefits	Flaws
Provides systematic methods of impact assessment	Time-consuming
Estimates the cost/benefit trade-off of alternative actions	Costly
Facilitates the public participation	Little public participation in actual implementation
Provides an effective mechanism for • coordination • environmental integration • negotiations • feed back	Unavailability for reliable data *(mostly in developing countries)*
Top-level decision making	Too focused on scientific analysis *(sometimes)*
Triggers an institutional building	Poor presentation of EIA report *(bulky volumes, scientific explanation, difficult to understand)*
Achieve a balance between the impact of developmental and environmental concern	Compliance monitoring after EIA is seldom carried out

The first phase of an environmental assessment is called an Initial Environmental Examination (IEE) and the second is Environmental Impact Studies (EIS) or simply detailed EIA.

a) **Initial Environmental Examination (lEE)**

IEE is carried out to determine whether potentially adverse environmental effects are significant or whether mitigation measures can be adopted to reduce or eliminate these adverse effects. The IEE contains a brief statement of key environmental issues, based on readily available information, and is used in the early (pre-feasibility) phase of project planning. The IEE also suggests whether in-depth studies are needed. When an IEE is able to provide a definite solution to environmental problems, an EIA is not necessary. IEE also requires expert advice and technical input from environmental specialists so that potential environmental problems can be clearly defined.

b) Environmental Impact Assessment (EIA)

EIA is a procedure used to examine the environmental consequences or impacts, both beneficial and adverse, of a proposed development project and to ensure that these effects are taken into account in project design. The EIA is therefore based on predictions. These impacts can include all relevant aspects of the natural, social, economic and human environment. The study therefore requires a multi-disciplinary approach and should be done very early at the feasibility stage of a project. In other words, a project should be assessed for its environmental feasibility.

EIA should therefore be viewed as an integral part of the project planning process. Unlike the environmental audit (EA), which is conducted on existing projects, the EIA is applied to new projects and the expansion aspects of existing projects. The phases of an EIA from screening to follow-up are illustrated in Figure 1 below.

Screening

EIA process kicks off with project screening. Screening is done to determine whether or not a proposal should be subject to EIA and, if so, at what level of detail. Guidelines for whether or not an EIA is required are country specific depending on the laws or norms in operation. Legislation often specifies the criteria for screening and full EIA. Development banks also screen projects presented for financing to decide whether an EIA is required using their set criteria.

The output of the screening process is often a document called an **Initial Environmental Examination or Evaluation** (IEE) (Section 4.1). The main conclusion will be a classification of the project according to its likely environmental sensitivity. This will determine whether an EIA is needed and if so, to what detail.

Scoping

The aim of EIA is not to carry out exhaustive studies on all environmental impacts for all projects. Scoping is used to identify the key issues of concern at an early stage in the planning process (Ahmed & Sammy, 1987). The results of scoping will determine the scope, depth and terms of reference to be addressed within the Environmental statement. Scoping is done to: *EIA* –

- Identify concerns and issues for consideration in an EIA
- Ensure a relevant EIA
- Enable those responsible for an EIA study to properly brief the study team on the alternatives and on impacts to be considered at different levels of analysis
- Determine the assessment methods to be used
- Identify all affected interests
- Provide an opportunity for public involvement in determining the factors to be assessed, and facilitate early agreement on contentious issues
- Save time and money
- Establish terms of reference (TOR) for EIA study

Scoping should be an ongoing exercise throughout the course of the project. The following environmental tools can be used in the scoping exercise

Checklists – Checklists are standard lists of the types of impacts associated with a particular type of project. Checklists methods are primarily for organizing information or ensuring that no potential impact is overlooked. They comprise list questions on features the project and environments impacts. They are generic in nature and are used as aids in assessment.

Matrices - Matrix methods identify interactions between various project actions and environmental parameters and components. They incorporate a list of project activities with a checklist of environmental components that might be affected by these activities. A matrix of potential interactions is produced by combining these two lists (placing one on the vertical axis and the other on the horizontal axis). They should preferably cover both the construction and the operation phases of the project, because sometimes, the former causes greater impacts than the latter. However, matrices also have their disadvantages: they do not explicitly represent spatial or temporal considerations, and they do not adequately address synergistic impacts.

Networks – These are cause effect flow diagrams used to help in tracing the web relationships that exist between different activities associated with action and environmental system with which they interact. They are also important in identifying direct and cumulative impacts. They are more complex and need expertise for their effective use.

Consultations – With decision-makers, affected communities, environmental interest groups to ensure that all potential impacts are detected. However there can be danger in this when excessive consultation is done and some unjustifiable impacts included in the ToR.

Baseline data collection

The term "baseline" refers to the collection of background information on the biophysical, social and economic settings proposed project area. Normally, information is obtained from secondary sources, or the acquisition of new information through field samplings, interviews, surveys and consultations with the public. The task of collecting baseline data starts right from the period of project inception; however, a majority of this task may be undertaken during scoping and actual EIA.

Baseline data is collected for two main purposes

- To provide a description of the current status and trends of environmental factors (e.g., air pollutant concentrations) of the host area against which predicted changes can be compared and evaluated in terms of significance, and
- To provide a means of detecting actual change by monitoring once a project has been initiated

Only baseline data needed to assist prediction of the impacts contained in the ToR and scoping report should be collected.

Impact analysis and prediction

Predicting the magnitude of a development likely impacts and evaluating their significance is core of environmental assessment process (Morris & Therivel, 1995). Prediction should be based on the available environmental baseline of the project area. Such predictions are described in quantitative or qualitative terms.

1 Considerations in impact prediction

Magnitude of Impact: This is defined by the severity of each potential impact and indicates whether the impact is irreversible or, reversible and estimated potential rate of recovery. The magnitude of an impact cannot be considered high if a major adverse impact can be mitigated.

Extent of Impact: The spatial extent or the zone of influence of the impact should always be determined. An impact can be site-specific or limited to the project area; a locally occurring impact within the locality of the proposed project; a regional impact that may extend beyond the local area and a national impact affecting resources on a national scale and sometimes trans-boundary impacts, which might be international.

Duration of Impact: Environmental impacts have a temporal dimension and needs to be considered in an EIA. Impacts arising at different phases of the project cycle may need to be considered. An impact that generally lasts for only three to nine years after project completion may be classified as short-term. An impact, which continues for 10 to 20 years, may be defined as medium-term, and impacts that last beyond 20 years are considered as long-term.

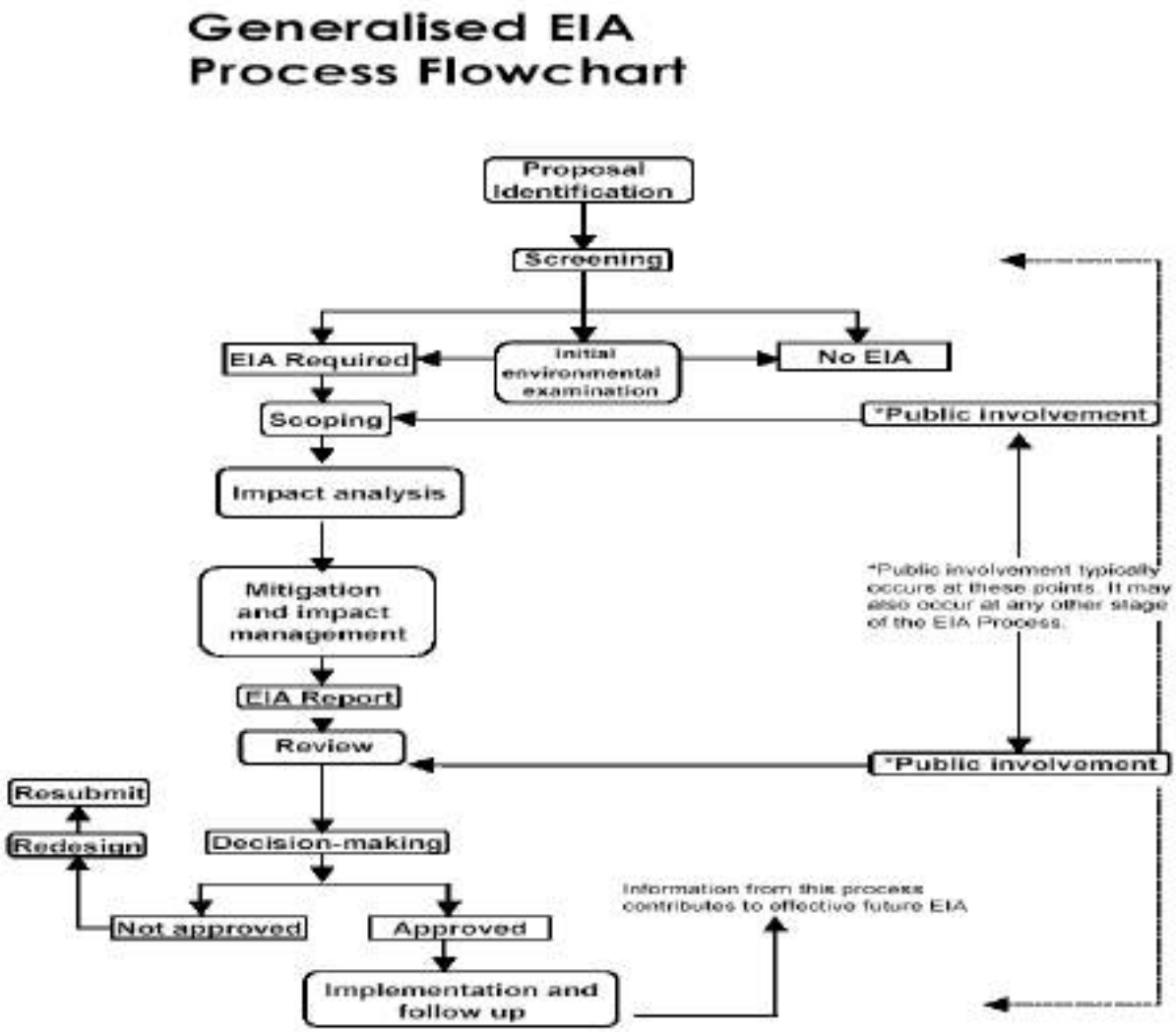
Significance of the Impact: This refers to the value or amount of the impact. Once an impact has been predicted, its significance must be evaluated using an appropriate choice of criteria. The most important forms of criterion are:

- Specific legal requirements e.g. national laws, standards, international agreements and conventions, relevant policies etc.
- Public views and complaints
- Threat to sensitive ecosystems and resources e.g. can lead to extinction of species and depletion of resources, which can result, into conflicts.
- Geographical extent of the impact e.g. has trans- boundary implications.
- Cost of mitigation
- Duration (time period over which they will occur)
- Likelihood or probability of occurrence (very likely, unlikely, etc.)
- Reversibility of impact (natural recovery or aided by human intervention)
- Number (and characteristics) of people likely to be affected and their locations
- Cumulative impacts e.g. adding more impacts to existing ones.
- Uncertainty in prediction due to lack of accurate data or complex systems. Precautionary principle is advocated in this scenario.

2 Impact prediction methodologies

Several techniques can be used in predicting the impacts. The choices should be appropriate to the circumstances. These can be based on:

- Professional judgment with adequate reasoning and supporting data. This technique requires high professional experience.
- Experiments or tests. These can be expensive. Past experience
- Numerical calculations & mathematical models. These can require a lot of data and competency in mathematical modelling without which hidden errors can arise
- Physical or visual analysis. Detailed description is needed to present the impact.
- Geographical information systems,
- Risk assessment, and
- Economic valuation of environmental impacts



5 Analysis of alternatives

Analysis of alternative is done to establish the preferred or most environmentally sound, financially feasible and benign option for achieving project objectives.

The World Bank directives requires systematic comparison of proposed investment design in terms of site, technology, processes etc in terms of their impacts and feasibility of their mitigation, capital, recurrent costs, suitability under local conditions and institutional, training and monitoring requirements (World bank 1999). For each alternative, the environmental cost should be quantified to the extent possible and economic values attached where feasible, and the basic for selected alternative stated. The analysis of alternative should include a NO PROJECT alternative.

6 Mitigation and impact management

Mitigation is done to avoid, minimize or offset predicted adverse impacts and, where appropriate, to incorporate these into an environmental management plan or system. For each potential adverse impact the plan for its mitigation at each stage of the project should be documented and costed, as this is very important in the selection of the preferred alternative.

The objectives of mitigation therefore are to:

- find better alternatives and ways of doing things;
- enhance the environmental and social benefits of a project
- avoid, minimise or remedy adverse impacts; and
- ensure that residual adverse impacts are kept within acceptable levels

DESIGN OF MITIGATION MEASURES

Approach	Examples
Avoid	Change of route or site details, to avoid important ecological or archaeological features
Replace	Regenerate similar habitat of equivalent ecological value in different location.
Reduce	Filters, precipitators, noise barriers, dust, enclosures, visual screening, wildlife corridors, and changed time of activities
Restore	Site restoration after construction
Compensate	Relocation of displaced communities, facilities for the affected communities, financial compensation for the affected individuals etc.

7 Environmental Management Plan (EMP) & Environmental Monitoring

1. Environmental Management Plan (EMP)

An Environmental Management Plan (EMP) is a detailed plan and schedule of measures necessary to minimize, mitigate, etc. any potential environmental impacts identified by the EIA (World Bank 1999). Once the EIA the significant impacts have been identified, it is necessary to prepare an Environmental Management Plan.

An EMP should consist of a set of mitigation, monitoring and institutional measures to be taken during the implementation and operation of the proposed project to eliminate adverse environmental impacts, offset them or reduce them to acceptable levels. The EMP should also include the actions needed to implement these measures, including the following features:

- Mitigation based on the environmental impacts reported in the EIA, the EMP should describe with technical details each mitigation measure.
- The EMP should then include monitoring objectives that specifies the type of monitoring activities that will be linked to the mitigation measures. Specifically, the monitoring section of the EMP provides:
  - A specific description, and technical details, of monitoring measures that includes the parameters to be measured, the methods to be used, sampling locations, frequency of measurements, detection limits (where appropriate), and definition of thresholds that will signal the need for corrective actions;
  - Monitoring and reporting procedures to ensure early detection of conditions that necessitate particular mitigation measures and to furnish information on the progress and results of mitigation.
- The EMP should also provide a specific description of institutional arrangements i.e. who is responsible for carrying out the mitigating and monitoring measures (for operation, supervision, enforcement, monitoring of implementation, remedial action, financing, reporting, and staff training).
- Additionally, the EMP should include an estimate of the costs of the measures and activities recommended.
- It should consider compensatory measures if mitigation measures are not feasible or cost effective.
- EMP must be operative throughout the whole Project Cycle.

2 Environmental Monitoring

Environmental monitoring is the systematic measurement of key environmental indicators over time within a particular geographic area (World Bank, 1999). Monitoring should focus on the most significant impacts identified in the EIA. Various types of monitoring activity are currently in practice. The main types are briefly described below:

Baseline Monitoring: A survey should be conducted on basic environmental parameters in the area surrounding the proposed project before construction begins. Subsequent monitoring can assess the changes in those parameters over time against the baseline.

Impact Monitoring: The biophysical and socio-economical (including public health) parameters within the project area, must be measured during the project construction and operational phases in order to detect environmental changes, which may have occurred as a result of project implementation e.g. air emission, dust, noise, water pollution etc (European Commission, 1999).

Compliance Monitoring: This form of monitoring employs a periodic sampling method, or continuous recording of specific environmental quality indicators or pollution levels to ensure project compliance with recommended environmental protection standards.

Monitoring should be regular and performed over a long period of duration. Interruptions in monitoring may result in generating insufficient data to draw accurate conclusion concerning project impact.

The main aim of EIA monitoring is to provide the information required to ensure that project implementation has the least possible negative environmental impacts on the people and environment.

What to avoid in monitoring:

- Overestimation of data needed as this can lead to drowning in data without information.
- Under-estimation of time and cost for data analysis
- Weak coordination between the data collection with project time table and seasonal factors
- Ignoring requirements for baselines

8 Environmental Impact Statement (EIS)

The final EIA report is referred to as an Environmental Impact Statement (EIS). Most national environmental laws have specified what the content of EIS should have. Multilateral and bilateral financial institutions have also defined what should be contained in an EIS. Ideally, the content of an EIS should have the following:

Executive Summary

- Policy, Legal and Administrative Framework
- Description of the environment
- Description of the Proposed Project in detail
- Significant Environmental Impacts
- Socio-economic analysis of Project Impacts
- Identification and Analysis of Alternatives
- Mitigation Action/Mitigation Management Plan
- Environmental Management Plan
- Monitoring Program
- Knowledge gaps
- Public Involvement
- List of References
- Appendices including
    - Reference documents, photographs, unpublished data
    - Terms of Reference
    - Consulting team composition
    - Notes of Public Consultation sessions

9 Decision making

At each stage of EIA, interim decisions are made. These decisions influence final decisions made about the EIA.

The EIS is submitted to designate authority for scrutiny before the final decision. The authority, together with technical review panel determines the quality of EIS and gives the public further opportunity to comment. Based on the outcome of the review, the designated authority or lending institution will accept, reject or make further modifications to avoid future confrontation. If the EIS is accepted, an EIA license is issued and if otherwise, additional studies or recommendations are made before issuance of a license. The decision making process should be autonomous so that the outcome of the review is seen as fair enough. The duration of this process is usually set in the EIA legal framework.

10 Effective EIA follow-up

In practice, an EMP, which is submitted with the EIS report, should be used during implementation and operation of the project. The link between EIA process and project implementation stage is often weak especially in developing countries (Welford, 1996). Despite this, they may still be no better than intentions unless an independent check is made to ensure that the developer is acting as intended.

These weaknesses could be attributed to:

- Deficiencies in environmental management plans prepared during the EIA.
- Deficiencies in monitoring and enforcing compliance through use of legal instruments and financial penalties (most EIAs end after environmental clearance has been received from the environmental management authority).
- Timing of some projects especially in developing countries are implemented several years after the EIA and the EMP. In such scenarios, an update of the EIA should be done and a new EMP developed.

ISO 14001:2004 and other Environmental Management Systems (EMS) can provide the link between the EIA and environmental management requirements after the EIA (during project implementation, operation and decommissioning).

5. PUBLIC CONSULTATION AND DISCLOSURE (PC&D)

1 PC&D from a legal perspective

There is an upsurge in attention paid to PC&D in recent years with increase in environmental awareness. Most international and national environmental legislations are now making specific and detailed provisions for public participation and disclosure. Multilateral financial agencies like the World Bank and bi-lateral aid agencies show parallel interest in ensuring that the public is involved in the EIA process (Mutemba, 1999).

These provisions usually guarantee enforcement of utility commitments to public involvement in environmental decision-making. For example the Kenyan environmental legislation recognizes individual right to a clean and healthy environment. To this end, the environmental management and coordination act provides administrative mechanism for addressing public consultations and grievances.

2 Designing PC&D program

There is no one-size-fits-all approach to public participation (U.S. Department of Commerce**,** 1994). There are, however, certain issues that arise in designing any highly effective public participation program. The PC&D planning team should:

- Have a clearly defined expectation for what team hopes to accomplish with the public.
- Do stakeholder identification and mapping based on their interests and influences.
- Target those segments of the public most likely to see themselves as impacted by the decision (stakeholders)
- Be well integrated into the decision-making process
- Involve interested stakeholders in every step of decision-making, not just the final stage
- Provide alternative levels of participation based upon the public‟s level of interest and reflecting the diversity of those participating

- Provide genuine opportunities to influence the decision
- Take into account the participation of internal stakeholders as well as external stakeholders

Since stakeholder involvement requires additional expenditure, it is important to find the most cost effective way of integrating stakeholder involvement in the project life cycle. This is also necessary because it will avoid creating "stakeholder fatigue" and incurring unnecessary expenditure. The table above shows how and when the stakeholders should be involved.

Adequate consultation takes time and resources and cost money especially if the project is being implemented in remote location with biological and cultural diversity. The EIA team must therefore make adequate budget provisions to meet these costs. Sufficient time must also be allocated within the EIA time frame.

PUBLIC PARTICIPATION IN PROJECT CYCLE

Project Cycle	EIA Component	Public Participation Activity
Pre-Feasibility	Environmental Screening	Identifies public groups and begins initial contact with groups.
	Initial Environmental Examination (IEE)	Continue consultations – public provides input to IEE report
	Scoping	Identifies major issues for Scoping and TOR using public input and makes plan for public involvement.
Feasibility	Environmental Impact Assessment (EIA)	The public reviews and comments on draft EIA study report. The public provides input to design and survey.
Detailed Survey and Design	Integration of Environmental Mitigation Measures	Detailed design made available to the public.
Construction and Operation	Environmental Monitoring	The public provides input to post-evaluation of impacts and mitigation measures.

3. Public participation techniques

There are techniques for getting information TO the public (one-way e.g. press releases newsletters etc), getting it FROM the public (one-way e.g. polls, survey, questionnaire) and EXCHANGING information (interaction between the proponent and the public e.g. public hearing, workshops, meetings, advisory groups/task forces etc). When selecting a technique, it is always wise to build on existing communication channels that are familiar with the community or public involved. There is no public participation technique that will work in all circumstances. When people talk about highly successful public participation programs they are talking about programs where the techniques matched the purpose of the program, reached the interested stakeholders, and resulted in a clear linkage between the public participation process and the decision-making process.

It is worth noting that "making a decision" in public participation is not a single moment in time, but an accumulation of many smaller decisions. There are decisions being made at every step in the consultation process regardless of the technique.

4. Monitoring and evaluation of PC&D

Most EIA projects usually have no monitoring systems of PCs built into their structure. Monitoring and Evaluation (M&E) assess the quality of public consultations in the EIA process. Techniques for monitoring and evaluating PCs include confirmation that participants understood the consultation content (correct language, level of technicality), and assessment of stakeholders" opinions of PC effectiveness and PC impact on project design and implementation. Through appropriate use of M&E, public consultation strategies can be adjusted during the project cycle to improve stakeholder participation, information dissemination strategies, and mechanisms for integrating participant feedback into project design and implementation.

TOWARDS SUSTAINABLE FUTURE

SUSTAINABLE DEVELOPMENT

Environmental, economic and social well-being for today and tomorrow

Sustainable development has been defined in many ways, but the most frequently quoted definition is from *Our Common Future*, also known as the Brundtland Report:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". It contains within it two key concepts:

- *the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of **limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*

Meaning of sustainable development

Sustainable means 'that can be kept going or maintained'. Development means "the action or process of growing or cause of gradual growth. **Concept of sustainable development** is therefore, commonly understood as that development which meets the need of the present generation without compromising the needs of the future generations.

The world is not going to come to an end with us and hence we do not need to eat way all the resources in the name of development just because we can. Sustainable growth in context of environment means having common elements of covering the well-being of the society of human beings, the well-being of the environment and the well being of environment and sustainability over time.

Sustainable development is based on some principals. They are as follows:

1. Equality

Equality is essential for a sustainable development. This concept promotes equality between ages, genders, classes, races, continents and countries.

2. Social Development

Concept of sustainable development emphasizes on not only economic development, but also on social development and the need to conserve our environment and natural resources too.

3. Inclusive approach

Any growth that is exclusive is not right. *Sustainable development* has to be inclusive. It is based on the improved quality of life for everyone, mainly the deprived and the poverty-stricken people of the world.

4. Human-Environment Harmony

It understands that the needs of human beings and the requirements of the environment are interdependent and acknowledges this fact.

5. Co-operation

Sustainable development is possible only if the developed world and the developing world's co-operate and the former support the latter in their endeavors whenever they can, through subsidies, for instance.

Why do we need sustainable development?

The human population is rising day by day. Their demands too are on rise. There is a need of natural resources to meet these demands. What we have done till now is followed an economic growth pattern that is short-term. In the process, we have misused the resources of nature and exploited them recklessly. As a result, we are short of these resources. The Earth that we live on is not capable of providing for the resources to meet our accelerating needs. We face the consequences if this imbalance in the form of climate changes in our everyday life. The magnitude of such challenges might just accelerate for our

future generation. Hence we need a development plan that's long term, even if slow and gives us time to replace the resources we consume through measures like planting a tree, etc. This is not only for our own good; we also need this for the sake of our future generation as well as to maintain a healthy environment.

How can we go about sustainable development?

For meeting our present needs as well as saving for our future generation, we need a proper and need-based, not greed-based consumption pattern. The following aspects are essential for the same.

1. **Sustainability:**
   This of course, is a priority and we should make sure that we are not mortgaging the choices of the future generation.
2. **Strengthening:**
   We should build on human capacities to develop and conserve at the same time.
3. **Sharing:**
   Equitable distribution of wealth and resources is vital for a sustainable development. Basic needs for all, without any discrimination should be ensured.
4. **Social responsibility:**
   Our consumption patterns should be guided by a sense of social responsibility. We should strive for such a consumption that does not compromise the well-being of others.

We should, therefore, avoid all such development patterns that will ignite environmental degradation resulting from economic decisions we make today and which jeopardizes the situation for our posterity. ***Concept of sustainable development*** is the right way to go.

Threats to the global community include:

- A widening **gap between rich and poor**, especially the extremes of wealth and poverty.
- Poverty: 1.3 billion people live in absolute **poverty** with incomes of $1 a day or less, according to the World Bank.
- ***Malnutrition*** affecting the *physical* and *mental* development of some 840 million people, according to the UN FAO.
- **World population** reaches 6 billion on 12 October 1999.
- Five hundred companies control 42 per cent of the **world's wealth**
- The turnover of the **world's ten largest companies** exceeds the combined GDP of its 100 smallest countries.
- Oil Company **Shell alone controls 160 million hectares** of land - 146 countries in the world control a smaller area.
- **Ten companies effectively control the world's food chain**
- ***Refugees*** receiving United Nations assistance has exceeded 20 million each year since 1994
- Global warming and *climate change* - the 1990s is the hottest decade since record keeping began
- The effects of **El Nino** and La Nina on climate
- Inability of the natural environment to absorb and reprocess mounting quantities of **toxic waste**.
- Pollution which is damaging the **habitat** on land, at sea and in our backyards; all life depends on habitat quality
- Air traffic is identified as a major cause of **greenhouse gases** and a contributor to climate change.
- Russia and the Ukraine have many **nuclear power plants**. Safety risks increase when nuclear workers' cannot be paid
- Demand for clean, fresh **water** worldwide is doubling every 21 years; most USA States have water resources **web sites**
- The hole in the **ozone layer**, which endangers life, is bigger than ever in 1998
- **Over fishing** of the oceans which is now threatening the whole web of marine life
- The **world's seas** are threatened by disputes, destruction, piracy, pollution and sewage
- **World grain production** struggles to maintain reserves and remains sufficient for less than 60 days use

- One quarter of the Earth's fisheries, forests and fresh water have been destroyed since 1970.
- Belief that economic recovery can be achieved by increasing demand for goods and scarce resources
- **Ageing** becomes an increasing problem in many countries as people over 65 represent more than 20% of the population
- **Apathy** and short term thinking is frequently **the most serious threat** of all
- Fears that the spread of **genetically modified organisms** (GMOs) will endanger ecosystems and human health
- Fears that Companies marketing GMOs will patent the seeds and preclude the use of free, non-GMO seeds
- Failing to realise that companies don't transform, people can and some do.

Opportunities!

Opportunities arise from tackling economic, social and ethical development together. With imagination, creativity and perseverance many solutions can be and are being found:

- Growing recognition that **community development** is the best way to find lasting, fair solutions that will be implemented
- Initiating over 2,000 **'Local Agenda 21** plans around the world and encouraging others, then implementing them
- Economic success does not have to destroy resources as **responsible companies** demonstrate
- Reducing **carbon emissions** can ease the threat of climate change and can save money
- Accepting that a **healthy natural environment** improves the quality of life for all
- It is **in the interest of businesses** of all kinds to get involved with sustainable development
- Recognising that it is in all our interests for poor people to meet basic needs and achieve **sustainable livelihoods**
- Reducing **resource and energy usage**, by factors of 4, 10 and even 50, are now possible
- Agreeing that **water conservation** and avoidance of waste is a priority everywhere
- **Conserving fish stocks** is now widely accepted as difficult but essential for maintaining the world fish catch
- Producing **healthier and tastier food**, grown using minimal quantities of chemical fertiliser and pest control
- Encouraging **organic farming** - the **Soil Association** in the UK aims for 50% per annum increase
- Building on the success of organic farming in countries like Austria, Sweden, Cuba and India
- Stimulating more widespread **ethical investments** by screening out and screening in relevant companies
- Encouraging sales of **Fair-trade goods** and green consumerism
- Harnessing **renewable energy** - the power of the sun, wind and water to provide non-polluting future energy resources
- Demand for **wind energy, solar cells** and **compact fluorescent light bulbs** are surging ahead
- Sustainable development applying **industrial ecology** and establishing eco-industrial parks is increasing in the USA
- Identifying and using technology that achieves improvements in resource usage by a **factor of ten**
- Developing **telecommunications** in new areas using mobile phones that require no cables
- **Ethical investments** for savings, insurance, mortgages, pensions and life policies are increasingly rapidly
- Banking with organisations that have no **Third World debts** no non-ethical business accounts
- Developing **strategic learning partnerships** to accelerate the learning about sustainable development
- **Educating people** to help them change their behaviour and break outmoded habits
- Working with people who are showing a willingness to **transform their thinking** and their behaviour.

These threats and opportunities form the basis for applying sustainable development:

- Taking initiatives to address the agenda for change and practical examples of working together
- Setting an example yourself by living lightly on the planet
- Making change happen by using models for change with effective leadership
- Contacting skilled people who can help organisations move towards sustainability
- Finding information such as tomorrow's companies, books and organisations that describe or devise solutions
- Appreciating the scope of sustainable development from *A to Z of SD* with 180 links to other web sites.

POPULATION EXPLOSION IN INDIA

Ever since the five billionth baby was born on **July 11**, 1987, it has been observed as **World Population Day**. For the developing countries like India, population explosion is a curse and is damaging to the development of the country and its society. The developing countries already facing a lack in their resources, and with the rapidly increasing population, the resources available per person are reduced further, leading to increased poverty, malnutrition, and other large population-related problems.

The literal meaning of population is *"the whole number of people or inhabitants in a country or region"*, and the literal meaning of population explosion is *"a pyramiding of numbers of a biological population"*. As the number of people in a pyramid increases, so do the problems related to the increased population. The main factors affecting the population change are the birth rate, death rate and migration. The birth rate is the ratio between births and individuals in a specified population and time (Miller, 253). The death rate is the ratio between the number of deaths and individuals in a specified population and time (Miller, 253). Migration is the number of people moving in (immigration) or out (emigration) of a country, place or locality. The population change is calculated by the formula:

***Population change** = (Births + Immigration) – (Deaths + Emigration)*

The recent increase in the world population has been caused due to the following major reasons:

1. The increase in birth rates due to medical improvements
2. The decrease in death rates due to better medical facilities and advancements in the field of medicine.
3. Immigration to better developed countries due to several reasons like better job opportunities, war, and natural causes like hurricanes, earthquakes, and so forth.

India, being a developing country, has had to face several economic and political challenges. One of the most important problems is the population explosion. According to, "India's population hit 1 billion in May 2000, increasing the urgency for the country to moderate its population growth." Some of the reasons for this population explosion are poverty, better medical facilities, and immigration from the neighboring countries of Bangladesh and Nepal. The population in India continues to increase at an alarming rate. The effects of this population increase are evident in the increasing poverty, unemployment, air and water pollution, and shortage of food, health resources and educational resources.

REASONS FOR INCREASE IN POPULATION:

I. **BIRTH RATE**

a.**Poverty**

India currently faces approximately "… 33 births a minute, 2,000 an hour, 48,000 a day, which calculates to nearly 12 million a year". Unfortunately, the resources do not increase as the population increases. Instead the resources keep decreasing, leading to making survival for a human being more and more competitive even for the basic necessities of life like food, clothing and shelter.

India currently faces a vicious cycle of population explosion and poverty. One of the most important reasons for this population increase in India is poverty. "More than 300 million Indians earn less than US $1 everyday and about 130 million people are jobless." The people, who have to struggle to make two ends meet, produce more children because more children mean more earning

hands. Also, due to poverty, the infant mortality rate among such families is higher due to the lack of facilities like food and medical resources. Thus, they produce more children assuming that not all of them would be able to survive. The end result is a mounting increase in the population size of India. Due to the increase in population, the problems of scarce resources, jobs, and poverty increases. Thus the cycle continues leading to an ever-increasing population that we see today. This cycle in fact might be considered as a positive feedback, in that the increase in one result in the increase of the other factor. As the poverty and the population both increase, the development of the country and the society seems even more far-fetched.

b.**Religious beliefs, Traditions and Cultural Norms**

India's culture runs very deep and far back in history. Due to the increased population, the educational facilities are very scarce. As a result, most people still strictly follow ancient beliefs "God said 'Go forth and produce' and we just went ahead and did exactly that." In addition, a lot of families prefer having a son rather than a daughter. As a result, a lot of families have more children than they actually want or can afford, resulting in increased poverty, lack of resources, and most importantly, an increased population.

Another one of India's cultural norms is for a girl to get married at an early age. In most of the rural areas and in some urban areas as well, families prefer to get their girls married at the age of 14 or 15. Although child marriage is illegal in India, the culture and the society surrounding the girls in India does not allow them to oppose such decisions taken by their family. For many, giving a girl child in marriage is done not by choice, but rather out of compulsion. The poor economic status of tribal villagers is attributed as one of the primary factors responsible for the prevalence of child marriages in India.

Due to the young age of these girls, they have more potential of bearing children, that is, since they start bearing children at a very early age, they can have more children throughout their lifetime. This results in the increase of the global fertility rate. Since these girls get married at a very early age, they do not have the opportunity to get educated. Therefore, they remain uneducated and teach the same norms to their own children, and the tradition goes on from one generation to the other.

II. **DEATH RATE:**

Although poverty has increased and the development of the country continues to be hampered, the improvements in medical facilities have been tremendous. This improvement might be considered positive, but as far as population increase is considered, it has only been positive in terms of increasing the population further. The crude death rate in India in 1981 was approximately 12.5, and that decreased to approximately 8.7 in 1999. Also, the infant mortality rate in India decreased from 129 in 1981 to approximately 72 in 1999. These numbers are clear indications of the improvements in the medical field. This development is good for the economy and society of India, but strictly in terms of population, this advancement has further enhanced the increase in population.

The average life expectancy of people in India has increased from 52.9 in 1975-80 to 62.4 in 1995-00. Although our near and dear ones would live longer, due to the increase in the population, the resources available per person would be much less, leading to a decrease in the curvature of the slope of development instead of a higher gradient. In addition, abortion is not allowed by several religions that are followed in India. In fact, in Islam, one of the leading religions of India, children are considered to be gifts of God, and so the more children a woman has, the more she is respected in her family and society. As a result, although the measures to control birth are either not available or known to the public, the facilities to increase birth through medical facilities are available.

III. **MIGRATION:**

In countries like the United States (U.S.), immigration plays an important role in the population increase. However, in countries like India, immigration plays a very small role in the population change. Although people from neighboring countries like Bangladesh, Pakistan and Nepal, migrate to India; at the same time Indians migrate to other countries like the U.S., Australia, and the U.K. During the 1971 war between India and Pakistan over Bangladesh, the immigration rate increased tremendously. However, currently the migration in India is –0.08 migrants per 1000 population, and

is decreasing further. This is definitely good for India. This way, the population might eventually come close to being under control and more people may get better job opportunities and further education. For example, the students in my university from India, like myself, have better chances for job opportunities and better education outside India than we would have had in India.

EFFECTS OF POPULATION EXPLOSION:

The current rate of population growth in India is 1.58% and the total fertility rate is 3.11. Although the total fertility rate has decreased, due to the increase in the total number of women between the ages of 15 and 44 (reproductive ages), the total number of births has increased. This has lead to the current enormous population size of approximately 1 billion. This has greatly hampered the development of the Indian economy. The amount of resources that could have been available to one person a few years ago now need to be shared between two people, which is not sufficient for either of them. The population increase has lead to air and water pollution, unemployment, poverty, lack of educational resources, and even malnourished women and children.

I. **Air Pollution:**

The technological development of India has lead not only to medical advancements, but also to an increase in the number of factories. That has lead to air and water pollution. More energy needs to be produced to power these factories. When fossil fuels - the world's major source of energy - are burnt, gases are added to the atmosphere. Many cities in India have crossed the limits of suspended particulate matter, sulfur dioxide, and other pollutants due to vehicular and industrial emissions.

As the population grows, more and more forests are cleared. The two most common reasons for deforestation are to make houses for increased number of people to live in, and to use wood as a fuel in the industries. As a result, the trees that help us in reducing the air pollution through the process of photosynthesis are not able to do so any more. Some of the diseases caused by air pollution are "respiratory diseases, asthma, chronic obstructive pulmonary disease, cardiovascular disease and cancer of the lung" (World Health Organization, Internet). Due to the tropical climate of India, air pollution also causes smog which may result in headaches, dizziness, breathing difficulties, or even mass illness due to carbon monoxide. This slow murder goes unnoticed because people die of diseases like cancer, asthma, and heart problems after long exposures to deadly air pollutants.

Air pollution, pollutants also have a deadly impact on our national heritage – the historical monuments that have made India proud for centuries. A classic example of the air pollution effect is the Taj Mahal in India.

Trying to save the monument might mean closing down several industries in the neighborhood. However, this means that several thousands of people would lose their jobs, resulting in eventual poverty. This again brings us to the same problem that is the root of all the problems – population increase.

One of the major issues that have lately been bothering environmentalists all over the world is global warming.

The effect on crops greatly hampers the economy of the country, especially for those farmers who solely depend on agriculture for their survival. For them, the loss of one crop would lead to a plunge into absolute poverty, and thus, the vicious cycle of poverty and population explosion continues. The effect of air pollution on the climatic conditions reveals that air pollution not only affects our environment, but it also greatly endangers the lives of everybody. This means that if the number of people increases the carrying capacity, the mere survival of human beings poses a threat to the lives of all human beings.

II. **Water Pollution:**

Water pollution is also one of the increasing problems due to the population explosion. Water is considered the essence of life. There is no life without water. One might think that 70% of the earth is covered with water, so, why worry about the water problem? In fact, 3 sides of the Indian subcontinent are surrounded by water. And there are several rivers, lakes, and other sources of water within the country as well. However the fact is that less than 3 percent of that water we see can be

used for human consumption and industrial uses. Nearly 10 percent of the world's population faces chronic freshwater shortage. This figure may rise if the population growth is uncontrolled. Increasing numbers of factories lead to various kinds of pollution, including water pollution. Water pollution also comes from pesticides used for agriculture. Some of the major types of pollutants are:

1.Petroleum products required for automobiles, cooking, and other such human activities.
2.Pesticides and herbicides used for agriculture by the Indian farmers.
3.Heavy metals from industries, automobiles' exhausts and mines.
4.Hazardous wastes.
5.Excessive organic matter like fertilizers and other organic matter used by farmers.
6.Sediments caused by soil erosion produced by strip mines, agriculture and roads.
7.Thermal pollution caused by deforestation.
8.As we can observe, the increased population size is leading to increased pollution, which in turn is leading to a more hostile environment for human beings themselves.

III. **Unemployment and Illiteracy:**

Suppose we forget about the environment, and only worry about ourselves. Nonetheless, with the increasing population, even that is not possible because with the increasing number of people, we have to share our resources with even more people. Resources of all types are limited, even employment, especially in India. India, being a developing country, has a limited number of jobs available. Due to the increasing number of people, the competition for the most menial jobs is also tremendous. In 1972-73, unemployment rates in rural areas were 1.2 for males and 0.5 for females, and in urban areas, it was 4.8 for males and 6.0 for females. This unemployment rate rose to 2.3 for males and 1.5 for females in rural areas and 4.9 for males and 8.2 for females in urban areas in 1998-99. With the increasing population, unemployment rates are bound to rise even further. Several highly educated people with Bachelors and Master's degrees in India sit at home, because they cannot find jobs.

Such unemployment and underemployment leads to corruption and exploitation of people by the richer classes of the society. This lack of resources further leads to lack of educational resources. Due to the unavailability of resources, parents cannot afford to educate their children to higher levels. Some parents simply cannot afford to teach their children further, and in some families, children need to work along with their parents in` order to bring food to the table.

According to the World Bank Group, "about 32 million primary school-age children, mostly girls or those from the poorest households and disadvantaged groups are not in school; more than half of rural students drop out before completing the primary cycle, and only one-third of females make it to the secondary level." In addition, "nearly half the population over 15 years old and about 60 percent of all women over 15 years old is illiterate." Also, basic education has become a commodity that acts on the basis of supply and demand. Basic education has become too expensive in India for a commoner to afford for his/her children. Lack of education further leads to even more unemployment. Due to these reasons, a major part of the population is either illiterate or has the most minimum education leading them to accept minimal work in which they cannot even support themselves.

Unemployment, or underemployment, further leads to poverty. This again starts the vicious cycle of poverty and population explosion discussed above. Poverty leads to an increase in the population, because poverty leads people to produce more children to increase the earning members of the family. This increases the population size of India, which further increases the unemployment rate and lack of educational facilities leading to poverty that started this whole cycle.

IV. **Food Resources**

Resources are always limited. And in a developing and highly populous country like India, resources are even scarcer. Population explosion results in the shortage of even the most basic resources like food. According to an article by World Bank Group, "…more than half of all children under the age of four are malnourished, 30 percent of newborns are significantly underweight, and 60 percent of women are anemic." Resources are limited everywhere. Thus, unless we can develop a technology that would enable us to live on just one grain of wheat, the population increase remains a serious

problem in India. India spends approximately $10 billion each year on malnutrition (World Bank Group), and even then the government of India cannot provide the everyday nutritional requirements to everybody in India. Something like food that most of us consider as a basic necessity, is a privilege for most of the children of India who are homeless because their parents cannot give them the basic necessities of life. If the population continues to increase at the rate it is currently increasing, then the future of India is what we see today on the street of the country.

REMEDIES

India is the first country in the world that has adopted family planning as the official policy. The family planning programme is comprised the following:

1. using various means of communications to persuade people to adopt the small family norm of one or two children;
2. making available family planning methods through different outlets in urban, semi-urban and rural areas;
3. establishing of family planning centres to make available the various services related to family planning;
4. financial assistance to acceptors and motivators of family planning methods like sterilisation;
5. making health services available to lower mortality among infants;
6. provision of nutrition, immunisation and other protective and preventive measures against diseases, *etc*;
7. promoting female education and employment;
8. arrangement for education in health and biology of reproduction;
9. promotion of delayed marriages;
10. creating greater awareness of opportunities for legal termination of pregnancies; and
11. more intensive research in family planning methods and practices.

Though the message of family planning has reached every nook and corner of country, yet the response, in terms of its adoption, especially among the low income groups, has not been very encouraging.

A proper population policy should be two-fold. *Firstly*, it should aim at a quick economic development. *Secondly*, it should aim at controlling the rate of multiplication of the existing population. In other words, while population should slain in its pace to enable production to catch up with it, production must, on its part, take strides not only to catch up with population but also to outstrip it.

CONCLUSION AND PERSONAL OPINION:

Birth control is extremely important in order to improve the life of the future generations in India in terms of better availability of resources and a better and clean world. Unless, we want our future generations to live the life of barbarians, it is imperative that we control the population explosion and thus control the usage of the available resources. We can start by educating the women of India in the basics of family planning. This can simply be done if just one educated person takes it into her/his stride to teach one other person – "Each one, teach one."

I wish for all the possible facilities to be readily available for my children. I want my future generations to live in India and cherish the beauty of the land, its monuments and rich culture that we Indians are so proud of, while living a happy sustainable life with all the basic amenities readily available without fighting for it or bargaining for it. I want my future generations to have a happy successful career and life, and at the same time, enjoy the beauty of nature in its fullest. I want my future generations to see and have the world as it was meant to be, and not what we have made it into.

CRAZY CONSUMERISM

Consumerism is economically appeared in the constant purchasing of new goods and services, with little attention to their true need, durability, product origin or the environmental consequences of manufacture and disposal. Consumerism is driven by huge amounts spent on advertising designed to create both a desire to follow trends and the resultant personal self-reward system based on acquisition.

Materialism is one of the end results of consumerism. Consumerism and consumption are at the core of many, if not most societies. The impacts of consumerism, positive and negative are very significant to all aspects of our lives as well as our planet.

At present, children are being targeted in increasing consumption. Kid's markets are enormous and there are many products and foods geared towards children's. Parents on the one hand have hard time raising children; while on the other hand kid are being increasingly influenced by commercialism.

Today's consumption has the following impacts on the environment.

1. Depressant the environment resource base.
2. Aggravating inequalities in the resources and
3. Accelerating the environmental problems.

Every element of the production process of all materials has an impact on the global ecological balance. If the trends continue without change, today's problems of consumption and environment will lead to worst degraded environment.

The level of mass consumption beyond basics has been exponential and is now a fundamental part of many economics. Luxuries have been turned into necessities and entire cultural habits have been transformed accordingly. For example *In U.S as much as 12% of all products purchased by consumers are never used for any purpose and simply discarded into dustbin. This waste is approx. 10 tonne each year go as garbage. In last 200 years U.S has lost 50% of it wetlands, 90% of its northern old forest, 99% of its tall grass, up to 490 species of native plants and animals and another 9000 are at risk.*

Important issues around Consumerism

Are important issues around consumerism that needs to be understood? For example:

1. What are the different types of resources used for the products that we consume?
2. What are the impacts on the environment, society and individuals due to the process of production?
3. What are the impacts of certain form of consumption on the environment, on society, on individuals?
4. What are the basic necessary things and what are the luxurious things?
5. How do demands on items affect the requirements placed upon the environment?
6. How do consumption habits change as societies change?
7. How much of what we consume is influenced by their needs versus our needs?
8. What is the impact on poorer nations and people on the demands of the weather nations and people that are able to afford to consume more?
9. What is the material value influencing our relationships with other people?
10. What are the impacts that have on our personal values?

Every consumer must be clear that his actions, however small they may be, should not affect the environment and its components. Moreover, all of these parameters of consumerism and its connection to daily life are sensitively tied together through an ecological planetary necessity that is of paramount concern.

URBAN SPRAWL

Urbanisation is defined as *'the process of human population from rural areas to urban areas in search of better economic interests with better education, communication, health, civic facilities and other day to day needs'*.

Urbanisation is the dominant feature of 20th century. Now days, migration of people from rural areas has become a major trend. A century ago, about 10% of people were living in the urban areas. But now about 33% of people are living in urban areas. By 2020 about 50% of the people will be living in the urban areas.

The movement and migration of people from non-urban areas to urban areas is depending on many factors. However the most important problems or discomforts in rural areas are:

1. Poor economy.
2. Lack of modernization of agricultural sector.

3. Lack of job opportunities.
4. Poor market infrastructures.
5. Shortage of finance supporting institutions as a source of credit for small scale farmers.
6. Poor life style.
7. Poor health facilities.
8. Poor education facilities.
9. Poor transportation facilities.
10. Poor availability of energy.

ENVIRONMENTAL EDUCATION

Environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions.
The components of environmental education are:

- **Awareness and sensitivity** to the environment and environmental challenges
- **Knowledge and understanding** of the environment and environmental challenges
- **Attitudes** of concern for the environment and motivation to improve or maintain environmental quality
- **Skills** to identify and help resolve environmental challenges
- **Participation** in activities that lead to the resolution of environmental challenges

Environmental education does not advocate a particular viewpoint or course of action. Rather, environmental education teaches individuals how to weigh various sides of an issue through critical thinking and it enhances their own problem-solving and decision-making skills.

Environmental Education is More than Information about the Environment

Environmental Education	Environmental Information
• Increases public awareness and knowledge of environmental issues	• Provides facts or opinions about environmental issues
• Does teach individuals critical-thinking	• Does not necessarily teach individuals critical-thinking
• Does enhance individuals' problem-solving and decision-making skills	• Does not necessarily enhance individuals' problem-solving and decision-making skills
• Does not advocate a particular viewpoint	• May advocate a particular viewpoint

ENVIRONMENTAL ETHICS

Inquiry is defined as the attempt to discover truths about the world.
Philosophy is defined as the area if inquiry that attempts to discover truths involving fundamental concepts, such as God, mind, free will, knowledge, truth, right/wrong etc.
Ethics is a branch of philosophy that primarily discusses issues dealing with human behaviour and character. This attempts to establish a basis for judging right from wrong and good from bad.
Environment Ethics is the branch of ethics which is analysing about human use of Earth's limited resources. A growing trend has been to combine the study of both ecology and economics to help provide a basis for sustainable decisions on environmental use.Just as philosophers try to answer questions about reality, environmental ethicists attempts to answer the questions about reality, environmental ethics attempt to answer the questions of how human beings should relate to their environment, how to use Earth's resources, and how to treat other species, both plant and animal. Some of the conflicts that arise

from environmental policies deal with the rights of individuals versus those of the state, and the rights of private property owners verses those of a community.

Issues and Possible Solutions

In recent times, in the biosphere some problems related to the environment have increased. These problems, being systematic in scope, pose novel questions: what is the system which encompasses the biosphere? What are its important elements and how do they interact? Why are these problems arising now? Where are we within this system?

Natural sciences and engineering are important forces shaping our future. They exert both positive and negative influences upon our world. We all contribute to these changes. Humanity now faces the following interrelated problems:

- Environmental pollution.
- Over-population.
- Over-exploitation and increased consumption of non-renewable resources.
- Various problems due to improper distribution of money, food, housing, education, work, recreational opportunities and facilities etc.,
- Prejudice of people in class, culture, religion etc.
- War and
- Non-peaceful use of power.

The above problems are resulting from individual actions and reactions. Thus we, as individuals, are responsible for these problems. Consequently, one could argue that our current ethical system is not function adequately. This causes immediate need to re-examine our values and the ways in which these problems influence our lives.

Environmental ethics refers to a feeling of moral responsibility and personal conduct towards natural landscapes, resources, species and non-human organism for we depend on nature for our food supplies, sources of wood, medicine and energy as well as opportunities of recreation and tourism.

The science of ecology has shown us that Mother Nature is imperilled by deliberate anthropogenic activities (clearing of much of the world's tropical rain forest, depletion of ozone layer, accumulation of radioactive waste from nuclear power stations, climate change resulting from CO_2 emission, caused by fossil fuel burning and forest clearance). In reciprocation, human beings are affected by the way deal with nature. Therefore, it is imperative that human efforts must be aimed at protecting the earth's environment and remedying environmental degradation.

Nature, not only provides us with physical nourishment as a source of food and other necessities, it also nourishes our emotions, our temperament, our minds and our souls. Many environmental philosophers have emphasized the importance of wilderness experience to the human psyche. Anthropogenic environmental devastation can damage the well-being of human beings now and in the future as we are over dependent on a sustainable environment.

The environment philosophers are of the view that species protection is a moral duty. It is unethical to eliminate a rare insect species to increase the monetary value of such specimens already in the captivity of the collectors. Elimination of a particular species causes loss of genetic possibilities and disrespect to the natural or biological processes which makes possible the continuation of individual living things. We need to follow some distinct moral rules or duties for instance not to kill or otherwise harm the innocent, not to lie, to respect the rights of others, the observance/violation of which is intrinsically right/wrong regardless of consequences.

CONCEPT OF GREEN BUILDING

The concept of green building refers to a sustainable building that is eco-friendly, conserves water, energy and natural resources in the construction and maintenance of the buildings, produces less waste and provides ambient environment for its occupants.

A convention building uses different types of construction material such as sand and water from rivers, stones from the mountains, cement prepared from materials dug from the land. The manufacture of construction material releases a large amount of CO_2,that warms up the air and space.

By opting for green buildings over a conventional building, we help to conserve our environmental in the following three ways,

1. The surrounding natural environmental is preserved.
2. Improvement in the internal environment for the inhabitants of the building.
3. The eco-friendly building helps to preserve the environment at places far away from the building.

For instances, in order to accommodate thousands of people at particular place, a multi-storeyed complex has to be constructed in vas area. This site for developing such multi-storeyed structure should be selected in a manner such that local vegetation, wildlife, biodiversity and natural warm bodies etc., are left undisturbed.

Features of Green Building: A green building should have the following features:

1. **Land:** the design of the building should be in such a way that it should have sufficient green belt to provide good shade. The land surrounding the building should have plants and bushes that have mild but active fragrance.
2. **Water:** the natural water flow near the building should not be disrupted. Rainwater catchment devices can be installed on the roof to harvest the rainwater. The storage tanks store the rainwater which can be utilized immediately of directed into a bore well to replenish the water table. Other measures include installation of a drop irrigation system in gardens, plantation during wetter months, watering of plants in the early hours of morning and allowing the grass to grow taller in order to hold the soil moisture. Use of low-flush shower heads and low-flush toilets helps to conserve water. The grey water from the kitchens and laundry can be treated and reused for watering the plants.
3. **Energy:** non-conventional source of energy source be used as it is in great abundance and very cost-effective. It is and inexhaustible source of energy does not produce greenhouse gases or contribute to global warming along with generation of local employment opportunities. Saving energy is of utmost important for one power saving means on endless power price hikes and secondly saving energy means saving environment from unnecessary carbon emissions. Energy can be conserved, for instance, by replacing incandescent bulbs with energy saving compact florescent lamps.
4. **Light:** the interior lightening of the green building should be such that the occupants should feel as if they are in outdoor location.
5. **Air:** generally the indoor air pollutants are CO_2,N_2O,Pb, pesticides, household care products, perfumes, hair sprays, air fresheners, moth repellents, tobacco smoke and biological pollutants.
   All these pose a major threat to the health of young children and elderly. The indoor air quality in green building should be healthy and non-toxic indoor air pollution can be prevented with good hygiene and storage practices.
6. **Green World:** a research team at the Stanford University have discovered an alternate for wood by treating or seasoning hemp fibres and biodegradable plastic. This material was found to be as strong as wood and easily biodegradable.
   Microbes can decompose the wood substitute and produce methane gas. The gas thus released can be absorbed by another type of bacteria. The plastic can be recycled to create new wooden planks. Thus, this type of wood substitute helps to control deforestation and aid in the formation of rain-bearing clouds.
7. **Green cement:** The manufacture of cement by conventional process releases a large amount of CO_2 which contributes to global warming.
   The scientists have developed green cement from cement kiln dust and fly ash from coal plants which helps to cut down greenhouse gas emissions and flight climate change.
8. **Other Sustainable Materials:** this group includes materials consisting of renewable resources, locally available material, durable and reusable or recyclable material.