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DIRECTOR

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UNIT - I

BASIC CONCEPTS

The Earth is the only planet known to have life on it. The Earth is believed to be formed from a cloud of gas and dust around 4.6 billion years ago. Its surface was probably molten (hot and liquid) for many years after its formation. Gradually, it cooled down to finally form the present day sperical planet. The uppermost layer of the Earth is known as its crust followed by two more layers: the
05 mantle and the core. The thickness of the crust varies from 35 to 60 kilometers from the deepest of the oceans to the highest of mountains. All the life forms dwell the crust layer since the inner layers are hotter and inhabitable by life forms. The first living organism appeared on the Earth at about 3.5
31 billion years ago. Very special conditions that existed on Earth billion years ago led to the origin of life forms that were very simple and made up of single cells. Multi-cellular or more complex organisms, such as plants and animals, evolved later on. As a result, a large variety of plants and animals exist today on the Earth. Life could originate and flourish on the Earth because it has all the materials
60 required by the life forms. Furthermore, all living organisms present in a definite locality tend to interact with each other for their survival. For example, bees feed on flower nectar and in turn help the plants in their propagation by carrying pollen grains from one flower to other on their legs. Thus, a living organism and its surroundings are in constant interaction with each other. The aggregate of
77 external conditions that influence the life of an individual in called **"ENVIRONMENT"**. The environment ultimately determines the quality and survival of life. For example, in a desert, only thorny plants and palm trees are available whereas in areas having tropical climate are rich in vegetation. Similarly, when the fish population in a lake decreases the number of migratory birds who come for their food also decreases. Thus, the quality of life of a given species (group) is dependent on the physical (abiotic) conditions of its surroundings and the co-inhabiting living community (biotic). Now, we can
96 say that environment has two components: biotic and abiotic. The relationship between and among the biotic (microbes, plants and animals) and the abiotic (soil, air and water, etc.) are under the purview of the branch of science called **"ENVIRONMENTAL SCIENCE"** or **"ECOLOGY"** (Greek: ***oikos*** means house; ***logos*** means study).

125 1.1 Scope and Importance of Environmental Studies

In traditional rural societies, socioeconomic decision-making was based on deep insights into the complex interactions between social, economic, demographic and physical factors, gained by experience over generations and permeating all facets of social life: socioeconomic structures and processes, culture, tradition, religions and myths. Environmental management, developed by trial and error over generations, was thus being performed on an empirical basis, with feedbacks taken into account and secondary and tertiary impacts weighed in decision-making. It was self-evident that one generation should not favor itself at the expense of its successors and the population was kept

in balance with the carrying capacity of the land on which it lived. People were managing resources efficiently and rationally, in close co-operation with each other. For example, previously in rural north India all the women gather at a common fire place (***sânjhâchulâ)*** to make *roties*, thereby limiting firewood consumption. Similarly, people used to sow lentils and grams after harvesting rice to restore soil fertility.

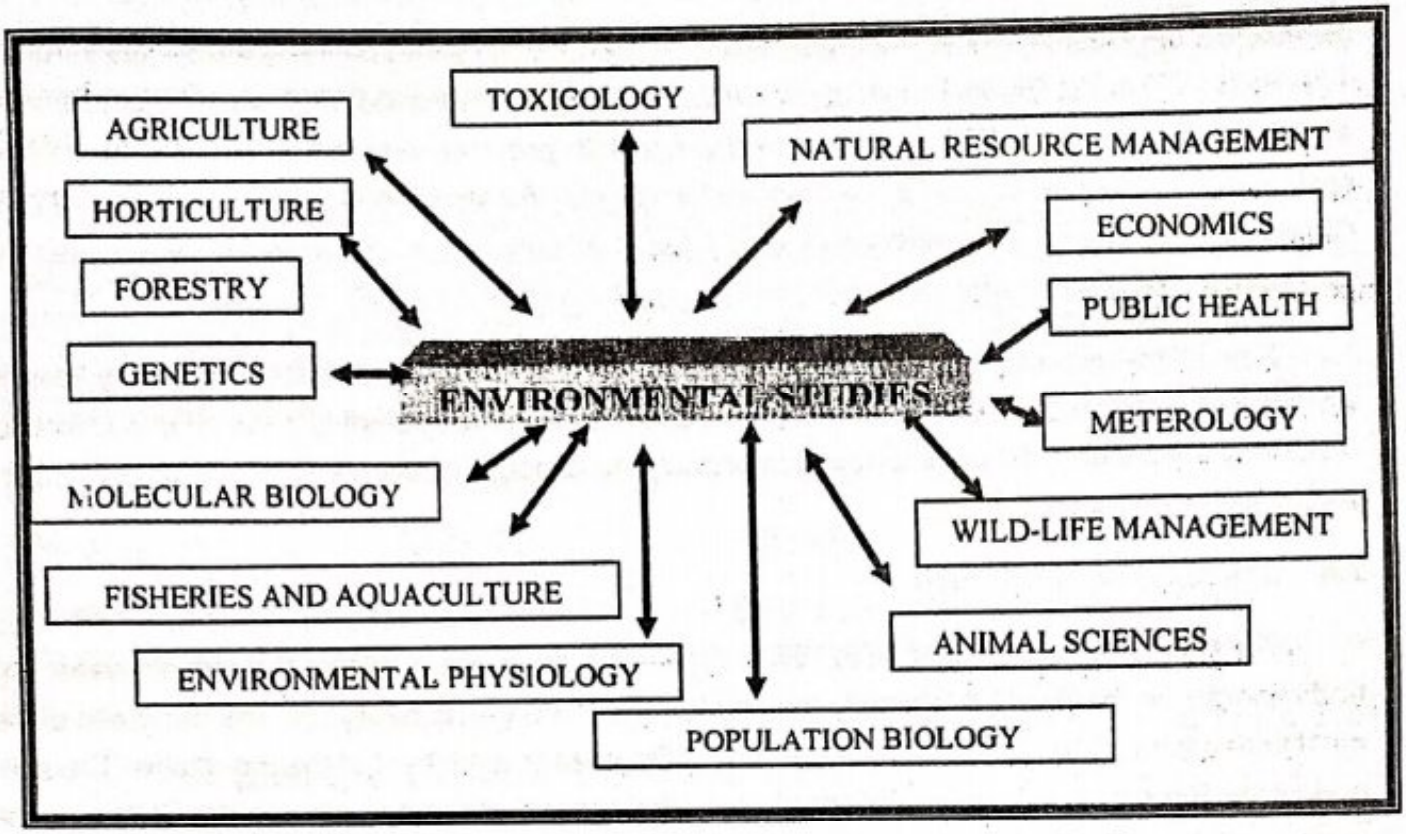
In the rapid modernization process, such empirical knowledge of the interrelationships has frequently been disregarded. As a consequence, the interaction of man and environment has tended to produce important unintended dysfunctional consequences such as poverty, unemployment, explosive growth of urban slums, environmental degradation and irrational management of natural resources. Thus, to a large extent, are borne by people who are not in a position to influence the socioeconomic decisions that initiate, affirm and reinforce them. The balance needs to be redressed and means found to optimize positive systemic consequences. Thus, the scope of environmental science encompasses the biology of organisms, populations, communities and their functional processes occurring in natural habitats like ponds, lakes, oceans and land and off course their preservation by judicious management through sustainable development.

1.2 The Multidisciplinary Nature

No matter how sophisticated our technology becomes, society will always require from the environment fertile soil, clean air, pure water, a stable climate, and an ozone umbrella to shield us from harmful radiation. The fragile and delicate ecological checks and balances that have sustained life since its origin are only now beginning to be understood. But much remains to be learned; for example we can predict with certainty the orbital characteristics of a weather satellite, yet ironically, we are often unable to predict with certainty tomorrow's weather. Therefore, understanding and sustaining the environment needs a multidisciplinary approach. The discipline of environmental studies is broadly classified into two major branches: environmental sciences and technology, and environmental policy and management. Scientific and technological portion deals with the understanding of nature as a whole like genetics and molecular biology help us in understanding how various species have been originated while toxicology tells us about the harmful effects of pesticides and industrial effluents etc. Knowledge on forestry and horticulture help us in preserving our green belt. Environmental policy studies and management take care of decision making for sustainable development. The basic aim of convergence of these diverse fields is to live and let others live happily.

1.3 The Need for Public Awareness

Environmental deterioration is not only a cause for concern in India but also the world over. Ignorance, myths and superstitions are the basic cause for degradation of the environment. For example, people believe that cities are polluted by industrial exhausts where as the fact is ill-maintained and overcrowding automobiles are the major contributors. Older people and persons living in rural



[Multidisciplinary nature of environmental studies]

areas still believe that disease, famine, flood or drought are due to curse of Gods or evil spirits not due to infection or destruction of environment. The knowledge of importance of a healthy environment is only limited to the elite group. Most of the people who are illiterate or live below poverty line are unaware about environmental matters. Faulty planning such as clearing forests for setting industries and not replenishing it with plantation leads to its degradation. Thus, the need for public awareness is a must for preserving our environment.

The concept of sustainability was brought to prominence in 1987 by the Brundtland Report, which argued that 'humanity has the ability to make development sustainable - to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs' (The World Commission on Environment and Development, 1987). Sustainable development was defined as the process of development in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. The Report stressed the need for immense efforts to inform and engage the public in order to reverse unsustainable policies and practices. 'Sustainability' principles are increasingly included in policy and law covering all aspects of society's endeavor. All professions in the future will need to operate within the context of sustainable development. Increasingly, there will be not only 'moral virtue' but market advantage by being proactive in relation to meeting sustainability goals.

Other international reports have emphasized the need for education in order to achieve

sustainable development. The International Workshop on Environmental Education, held in Rio de Janeiro in 1992 at the Global Forum associated with the United Nations Conference on Environment and Development (UNCED), recognized the need to promote education in order to achieve sustainability. The international agreement and action plan for sustainability, resulting from UNCED, Chapter 36 of Agenda 21, which deals with education, awareness and training, emphasizes the importance of environmental awareness for the populations of the world.

Education, including formal education, public awareness and training should be recognized as a process by which human beings and societies can reach their full potential. Education is critical for promoting sustainable development and improving the capacity of people to address environment and development issues.

1.4 Concept of Environment

The materials essential for all the living organisms are made available through air, water, soil and minerals on the Earth. It is mainly the crust of the Earth that is habitable. The thickness of the crust varies from 35 to 60 km from the deepest of the oceans to highest of the mountains. The solid part of the Earth's crust is called "**lithosphere**". The oceans, rivers and other water bodies on the surface of the Earth together constitute the "**hydrosphere**". The gaseous part is known as the "**atmosphere**". The light and heat received from the Sun is the main source of energy. All these together form the habitable part of the Earth. The entire life forms that inhabit the lithosphere, hydrosphere and atmosphere starting from microscopic one to human beings constitute the zone of life called "**biosphere**". All the four spheres are linked together in any one place and over the Earth as a whole to make the environment. Therefore, environment is the subtotal of living and nonliving components, influences and events surrounding a particular organism in this biosphere.

1.4.1 The Atmosphere

The atmosphere forms an insulating blanket around the Earth. Without it the temperature at the equator would rise to 180° F during the day and drop as low as -220° F at night. It burns up meteors that would bombard the surface of Earth from space. Without atmosphere there would be no sound and light. There would be no conventional long-distance radio communication. There would have been no lightning, clouds, wind, rain, snow or fire in absence of air. The surface of the Earth would be as blank and sterile as the Moon and other planets.

The atmosphere serves as a vital protective covering. It absorbs most of the cosmic rays from outer space and protects living beings from their effects. It absorbs most of the damaging ultra-violet radiations there by protects us from skin cancer like ailments. The atmosphere has been essential in maintaining the heat balance of the Earth. It absorbs infrared radiation emitted by the Sun. It also absorbs energy re-emitted from the Earth in the form of infrared radiation. Therefore, it serves as an important heat stabilizing function and prevents the tremendous temperature extremes which occur on planets and satellites lacking substantial atmosphere, thus inhibiting origin of life. The atmosphere

is divided into separate zones on the basis of temperature changes, namely, **troposphere, stratosphere, mesosphere and thermosphere**. The characteristics of various regions are summarized in table 1.

Table 1 : Major divisions of the atmosphere and their characteristics.

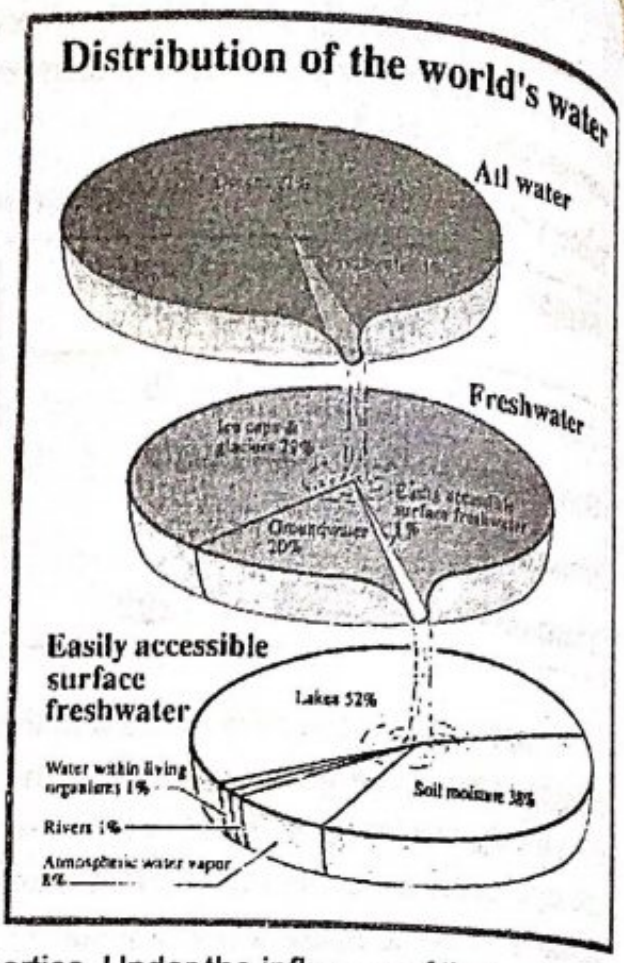
Region	Temperature range (°C)	Altitude range (km)	Significant elements found
Troposphere	-56 to 15	0 to 11	N_2, O_2, CO_2, H_2O
Stratosphere	-56 to -2	11 to 50	O_3
Mesosphere	-92 to -2	50 to 85	O_2^+, NO^+
Thermosphere	-92 to 1200	85 to 500	O_2^+, O^+, NO^+

Troposphere is the zone nearest to the Earth's crust (Greek ***tropein*** means to turn, rotate or change). One property that changes in the troposphere is the temperature which on an average drops 6.4°C per kilometer. The atmosphere's water vapour is essentially in the troposphere. The very cold layer at the top of the troposphere is known as the ***tropopause*** where the temperature in fairly constant. Its low temperature and resulting condensation of water to ice particles prevents water from reaching altitudes where it would dissociate by high energy ultraviolet light and allowing produced hydrogen to escape Earth's atmosphere. Beyond tropopause, is the stratospehere where the temperature remains unaltered or starts increasing with altitude. The increase in temperature in the stratosphere is due to the presence of ozone. Ozone is a heavier form of oxygen formed by short wave ultraviolet rays of the Sun which in turn absorbs harmful ultraviolet rays and converts them to heat. The ***stratopause*** marks the narrow zone at the top of the stratosphere where the temperature begins to fall again with increasing altitude as the next layer, the mesosphere is entered. The temperature falls with increasing altitude in this zone due to a decrease in the levels of the radiation-absorbing species, particularly ozone. Above the mesosphere lies the thermosphere which could be heated to 900°C, but the air has such a low density that it can hold very little heat. Any denser object in the thermosphere will be extremely hot in sunlight, but very cold at night. The outer most layer is sometimes referred to as magnetosphere since in this zone Earth's magnetic field is more influential. The thermosphere has no defined boundary and gradually feds into the interplanetary space.

1.4.2 The Hydrosphere

Hydrosphere (Greek ***hydro-*** means "water"), describes the collective mass of water found on, under, and over the surface of a planet. On Earth, the water cycle describes the methods of transport for water in the hydrosphere. This cycle includes water beneath the Earth's surface (ground water) and in rocks (lithosphere), the water in plants and animals (biosphere), the water covering the surface of the planet in liquid and solid forms, and the water in the atmosphere in the form of water vapor,

clouds, and precipitation. Of the total water on Earth, 97.4% is in oceans. Most of the Earth's fresh water (1.984%) is frozen in glaciers and in the polar ice caps. Other forms in which water is present on Earth are, water vapour (0.001%) in the atmosphere, ground water (0.592%), soil moisture (0.005%), rivers (0.0001%) and water content in the cells of living organisms (0.0001%). Thus, only a tiny fraction (0.01%) is available for use.



1.4.3 The Lithosphere

The lithosphere (Greek ***litho*** means "rocky") is the solid outermost shell of the planet. On the Earth, the lithosphere includes the crust and the uppermost layer of the mantle (the upper mantle or lower lithosphere) which is joined to the crust. The lithosphere is broken up into different plates known as tectonic plates. The distinguishing characteristic of the lithosphere is not composition, but its flow properties. Under the influence of the low-intensity, long-term stresses that drive plate tectonic motions, the lithosphere responds essentially as a rigid shell and thus deforms primarily through brittle failure. The tectonic motion is responsible for volcanic erruptions, continental drifts etc. resulting in change in the surface topography. The thickness of the lithosphere varies from around 1.6 km at the mid-ocean ridges to approximately 130 km beneath older continental crust. The thickness of the continental lithospheric plates is probably around 150 kilometers. As the cooling surface layer of the Earth's convection system, the lithosphere thickens over time. It is fragmented into relatively strong pieces, called tectonic plates, which move independently relative to one another. This movement of lithospheric plates is described as plate tectonics. There are two types of lithosphere: oceanic lithosphere/crust and continental lithosphere/crust.

1.4.4 The Biosphere

The biosphere is that part of a planet's outer shell—including air, land, surface rocks and water—within which life occurs, and which biotic processes in turn alter or transform. From the broadest geophysiological point of view, the biosphere is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, hydrosphere and atmosphere. Our planet Earth is the only place where life is known to exist. This biosphere is generally thought to have evolved beginning, through a process of biogenesis or biopoesis, at least some 3.5 billion years ago.

The term "biosphere" was coined by geologist Eduard Suess in 1875. While this concept has a geological origin, it is an indication of the impact of both Darwin and Maury on the earth sciences. The biosphere's ecological context comes from the 1920s, preceding the 1935 introduction of the term "ecosystem" by Sir Arthur Tansley. Vernadsky defined ecology as the science of the biosphere. It is an interdisciplinary concept for integrating astronomy, geophysics, meteorology, biogeography, evolution, geology, geochemistry, hydrology and, generally speaking, all life and earth sciences.

Some life scientists and earth scientists use ***biosphere*** in a more limited sense. For example, geochemists define the biosphere as being the total sum of living organisms (the "biomass" or "biota" as referred to by biologists and ecologists). In this sense, the biosphere is but one of four separate components of the geochemical model, the other three being ***lithosphere***, ***hydrosphere***, and ***atmosphere***. The narrow meaning used by geochemists is one of the consequences of specialization in modern science. Some might prefer the word ecosphere, coined in the 1960s, as all encompassing of both biological and physical components of the planet.

The Second International Conference on Closed Life Systems defined biospherics as the science and technology of analogs and models of Earth's biosphere; i.e., artificial Earth-like biospheres. Others may include the creation of artificial non-Earth biospheres; e.g., human-centered biospheres or a native Martian biosphere—in the field of biospherics.

1.5 Ecosystem

A system is an arrangement of matter so related as to form a whole (unit). The University and its constitutive colleges form a system for higher education, the alphabets and grammar rule form the system of a language, the digits 1 to 9 including 0 forms the number system. Thus, a system may consist of physical, chemical or biological components connected or related in such a manner as to act as an entire unit. An **ecosystem** is a system of relationships between animals, plants and their surroundings. A **community** is the term for the living organisms in an ecosystem.

1.5.1 Ecosystem Components

Components are subsystems of an ecosystem. How components are defined depend on how an ecosystem is viewed and what aspects are of interest. Usually there are three different components through which an ecosystem is viewed, namely, biotic component, abiotic component and functional processes.

1. ***Biotic components:*** It includes all the living organisms present in the system. Usually species are separated functionally, at a minimum into groups of producer species, consumer species and decomposers. Organisms, such as green plants, that produce their own food are called autotrophs (Greek: auto-self; trophy-to feed). The autotrophs, convert inorganic compounds into organic compounds with the help of sunlight by a process called photosynthesis (synthesis of food by light). They are called **producers** because all of the species of the ecosystem depend on them. The

organisms that can not make their own food (and need producers) are called heterotrophs. In an ecosystem heterotrophs are called **consumers** because they depend on others. They obtain food by eating other organisms. There are different levels of consumers. Those that feed directly from producers, i.e. organisms that eat plant or plant products are called **primary consumers**. For example, grasshopper that feed on grass is a primary consumer. Organisms that feed on primary consumers are called **secondary consumers**. Those who feed on secondary consumers are **tertiary consumers**. The grasshopper is then eaten up by a toad that acts as a secondary consumer and the snake as a tertiary consumer after eating the toad. Consumers are also classified depending on what they eat. Herbivores are those that eat only plants or plant products. Examples are grasshoppers, mice, rabbits, deer, beavers, moose, cows, sheep, goats and groundhogs. Carnivores, on the other hand, are those that eat only other animals. Examples of carnivores are foxes, frogs, snakes, hawks, and spiders. Omnivores are the last type and eat both plants and plant products (acting as primary consumers); and meat (acting as secondary or tertiary consumers). Examples of omnivores are:

- Bears —They eat insects, fish, moose, elk, deer, sheep as well as honey, grass, and sedges.
- Turtles — They eat snails, crayfish, crickets, earthworms, but also lettuce, small plants, and algae.
- Monkeys — They eat frogs and lizards as well as fruits, flowers, and leaves.
- Squirrels — They eat insects, moths, bird eggs and nestling birds and also seeds, fruits, acorns, and nuts.

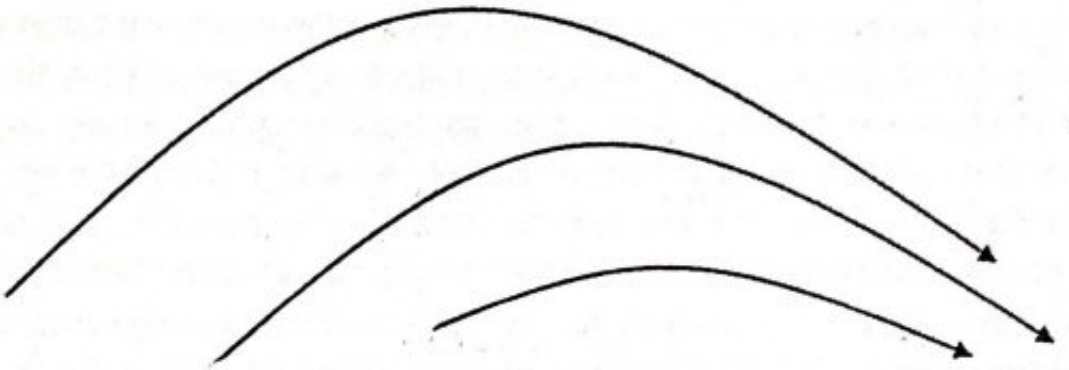
Decomposers are the microscopic bacteria and fungi that feed on the dead and decaying organisms. They break down the complex organic matter present in these dead organisms (plants and animals) into simple nutrients. These simpler nutrients are returned into soil and are again recycled by producers. They form an ecosystem called detritus or decomposer ecosystem.

2. ***Abiotic components:*** Abiotic components, such as water and nutrient availability and utilization, soil structure and micro climate are important components to understanding and identifying an ecosystem.

3. ***Functional processes*** Functional processes address energy flows through the system, food chains, diversity pattern in time and space, nutrient and biochemical cycle, development and evolution, and at last, control or cybernetics.

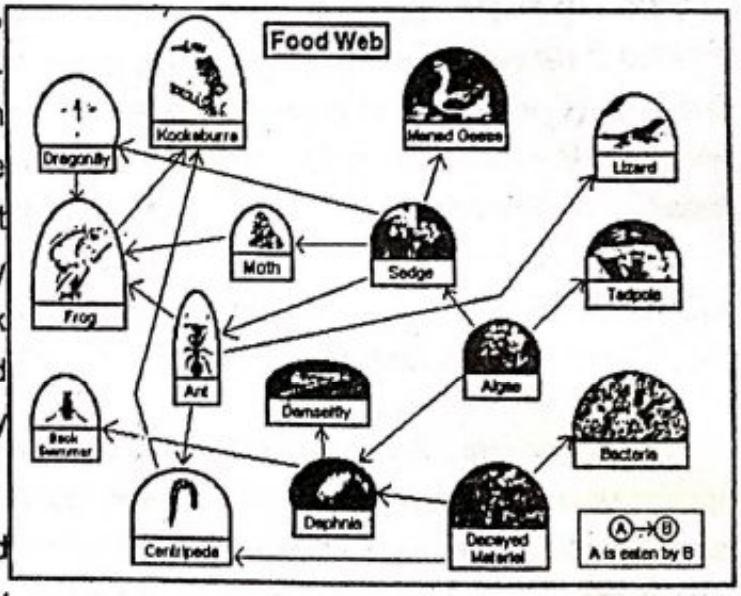
In an ecosystem, plants capture the Sun's energy and use it to convert inorganic compounds such as carbon dioxide and water into energy-rich organic compounds like glucose and liberate oxygen to the environment. This process is called photosynthesis. Plants also absorb minerals from soil such as magnesium or nitrogen. All these processes make the plant able to produce green leaves, or carrots, or strawberries, etc. Photosynthesis is only the beginning of a chain of energy conversions. There are many types of animals that will eat the products of the photosynthesis process. Examples

are deer eating shrub leaves, rabbits eating carrots, or worms eating grass. When these animals eat these plant products, food energy and organic compounds are transferred from the plants to the animals. These animals are in turn eaten by other animals, again transferring energy and organic compounds from one animal to another. Examples would be lions eating deer, foxes eating rabbits, or birds eating worms. This chain of energy transferring from one species to another can continue several more times, but it eventually ends. It ends with the dead animals that are broken down and used as food or nutrition by decomposing bacteria and fungi. The process of energy transformation from one level trophic level or nourishment level) of biotic component to another in the form of food is called a **food chain.**



Grass ⟶ Grasshopper ⟶ Toad ⟶ Snake ⟶ Saprophytic microorganism
Producers Primary Secondary Tertiary **Decomposer**
Consumers
[Food chain]

The concept of food chain looks very simple, but in reality it is more complex. Think about it. How many different animals eat grass? And from the how many different types of food does the snake eat? One doesn't find simple independent food chains in an ecosystem, but many interdependent and complex food chains that look more like a web exists and are therefore called **food webs**. In nature simple food chains are very rare.**[A generalized food web]**



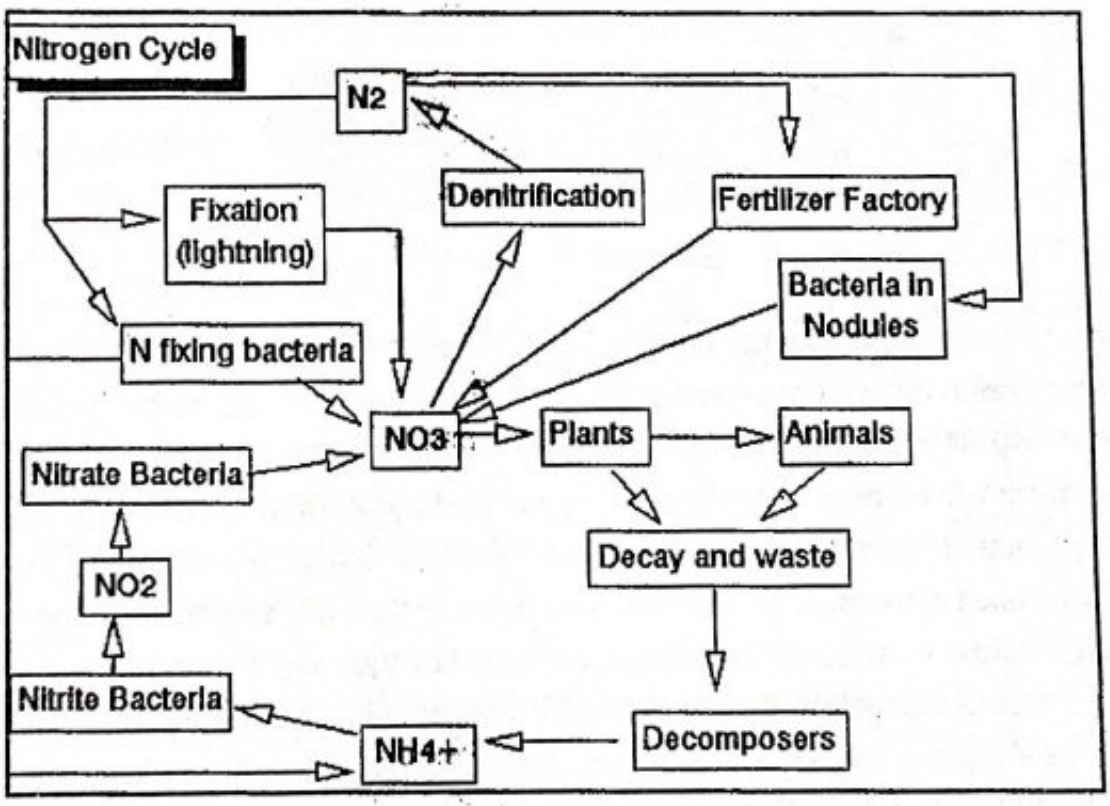
As is seen in the picture given below, food webs, with all their dependencies, can be very complex, but somehow nature balances things out so that food webs last a long time. Many species share the same habitat, their populations survive for many years, and they all live in a balanced state.

1.6 Nutrient cycling

All organisms whether bacteria, plants or human are made up of matter. They require about 4 elements for their growth and life processes. Out of the 40, the most vital ones that constitute the living body are hydrogen, carbon and oxygen whereas nitrogen, phosphorous, potassium, calcium, sulphur, iron and magnesium are of utmost importance for their functioning. These elements and their salts are togather called **nutrients**. These nutrients go on circulating between the organism and its environment in a circular path called **nutrient cycling.** The most well-known and important nutrient cycles, for example, include the carbon cycle, the nitrogen cycle, the oxygen cycle, the phosphorus cycle, and the water cycle. All the nutrients, or elements such as carbon, nitrogen, oxygen, phosphorus, used in ecosystems by living organisms operate on a **closed system**, which refers to the fact that these chemicals are recycled instead of being lost and replenished constantly such as in an open system. The energy of an ecosystem occurs on an **open system**; the sun constantly gives the planet energy in the form of light while it is eventually used and lost in the form of heat throughout the trophic levels of a food web. The Earth does not constantly receive more chemicals as it receives light. The only chemicals that the Earth contains are the chemicals that were formed during the creation of the Earth. Therefore, the planet does not "receive" more chemicals constantly, and the only way to obtain more chemicals or nutrients is from occasional meteorites from outer space that contain those elements. Because chemicals operate on a closed system, they cannot be lost and replenished unlike energy. These chemicals must be recycled throughout all of Earth's processes that use those chemicals or elements. These cycles include both the living biosphere, and the nonliving lithosphere, atmosphere, and hydrosphere. The fact that these chemicals cycle through both biotic and abiotic factors creates the name "biogeochemical cycle," in that the prefix "bio" stands for living and the prefix "geo" stands for the earth or abiotic, nonliving factors (chemical refers to the chemicals being recycled). The chemicals are sometimes held for long periods of time in one place. This place is called a **reservoir**, which, for example, includes such things as coal deposits that are storing carbon for a long period of time. When chemicals are held for only short periods of time, they are being held in **exchange pools**. Generally, reservoirs are abiotic factors while exchange pools are biotic factors. Examples of exchange pools include plants and animals, which temporarily use carbon in their systems and release it back into the air, soil or water. Carbon is held for a relatively short time in plants and animals when compared to coal deposits. The amount of time that a chemical is held in one place is called its **residence**.

Biogeochemical cycles always involve equilibrium states: a balance in the cycling of the element between compartments. However, overall balance may involve compartments distributed on a global scale. Let us consider an example of a nutrient cycle, i.e. nitrogen cycle. Nitrogen is very important molecule in that it is part of both proteins, present in the composition of the amino acids that make up proteins, as well as nucleic acids such as DNA and RNA, present in nitrogenous bases. The largest reservoir of nitrogen is the atmosphere, in which about 78% of nitrogen is contain

as nitrogen gas. Nitrogen gas is "fixed," in a process called nitrogen fixation only by certain bacteria. Nitrogen fixation combines nitrogen with oxygen to create nitrates. Nitrates can then be used by plants or animals (which eat plants or eat animals that have eaten plants). Nitrogen can be fixed either by lightning, industrial methods (such as for fertilizer), in free nitrogen-fixing bacteria in the soil, as well as in nitrogen-fixing bacteria present in roots of legumes (such as *Rhizobium*). Nitrogen-fixing bacteria use certain enzymes that are capable of fixing nitrogen gas into nitrates and include free bacteria in soil, symbiotic bacteria in legumes, and also cyanobacteria, or blue-green algae, in water. After being used by plants and animals, nitrogen is then disposed of in decay and wastes. Decomposers decompose the dead remains (detritus) of plants and animals; nitrogen is converted into ammonia, or nitrogen with 3 hydrogen atoms. Ammonia is toxic and cannot be used by plants or animals, but nitrite bacteria present in the soil can take ammonia and turn it into nitrite, nitrogen with two oxygen atoms. Although nitrite is also unusable by most plants and animals, nitrate bacteria changes nitrites back into nitrates, usable by plants and animals. Some nitrates are also converted back into nitrogen gas and released to the atmosphere through the process of denitrification, which is the opposite of nitrogen-fixing by certain denitrifying bacteria.



1.7 Energy Pathways

It has been described how energy and organic compounds are passed from one trophic level to the next. What was not mentioned is the efficiency of the transfer In a highly efficient transfer almost all of the energy would be transferred — 80% or more. In a low efficiency transfer very little energy would be transferred — less than 20%. In a typical food chain, not all animals or plants are eaten by the next trophic level. In addition, there are portions or materials (such as beaks, shells

change to maintain equilibrium. If the system does not succeed in reestablishing its balance, it may ultimately lead the system to stop functioning. Complex systems, such as a human body, must have homeostasis to maintain stability and to survive. These systems do not only have to endure to survive, they must adapt themselves and evolve to modifications of the environment.

1.8.1 Properties of homeostasis

Homeostatic systems show several properties:

- They are ultrastable: the system is capable of testing which way its variables should be adjusted.
- Their whole organization (internal, structural, and functional) contributes to the maintenance of equilibrium.
- They are unpredictable: the resulting effect of a precise action often has the opposite effect to what was expected.

Main examples of homeostasis in mammals are as follows:

- The regulation of the amounts of water and minerals in the body. This is known as osmoregulation. This happens in the kidneys.
- The removal of metabolic waste is known as excretion. This is done by the excretory organs such as the kidneys and lungs.
- The regulation of body temperature is mainly done by the skin.
- The regulation of blood glucose level, is maintained by the liver and the insulin secreted by the pancreas.

It is important to note that while organisms exhibit equilibrium, their physiological state is not necessarily static. Many organisms exhibit endogenous fluctuations in the form of circadian (period 20 to 28 hours), ultradian (period <20 hours) and infradian (period > 28 hours) rhythms. Thus even in homeostasis, body temperature, blood pressure, heart rate and most metabolic indicators are not always at a constant level, but vary predictably over time.

1.8.2 Mechanisms of homeostasis: feedback

When a change of variable occurs, there are two main types of feedback to which the system reacts:

- *Negative feedback* is a reaction in which the system responds in such a way as to reverse the direction of change. Since this tends to keep things constant, it allows the maintenance of homeostasis. For instance, thermoregulation. When body temperature rises, receptors in the skin and the hypothalamus sense a change, triggering a command, in turn, affects the correct

- In *positive feedback*, the response is to amplify the change in the variable. This has a destabilizing effect, so does not result in homeostasis. Positive feedback is less common in naturally occurring systems than negative feedback, but it has its applications. For example, in nerves, a threshold electric potential triggers the generation of a much larger action potential.

Sustainable systems require combinations of both kinds of feedback. Generally with the recognition of divergence from the homeostatic condition positive feedbacks are called into play, whereas once the homeostatic condition is approached, negative feedback is used for "fine tuning" responses. This creates a situation of "metastability", in which homeostatic conditions are maintained within fixed limits, but once these limits are exceeded, the system can shift wildly to a wholly new (and possibly less desirable) situation of homeostasis. Such catastrophic shifts may occur with increasing nutrient load in clear rivers suddenly producing a homestatic condition of high eutrophication and turbidity, for instance.

1.8.3 Ecological homeostasis

Ecological homeostasis is found in a ***climax community*** of maximum permitted biodiversity, given the prevailing ecological conditions. In disturbed ecosystems or sub-climax biological communities such as the island of Krakatoa, Indonesia after its major erruption in 1883, the established stable homeostasis of the previous forest climax ecosystem was destroyed and all life eliminated from the island. Years after the irruption, Krakatoa, went through a sequence of ecological changes in which successive groups of new plant or animal species followed one another, leading to increasing biodiversity and eventually culminating in a re-established climax community. This ***ecological succession*** on Krakatoa occurred in a number of sereal stages, in which a *"sere"* is defined as "a stage in a sequence of events by which succession occurs". The complete chain of seres leading to a climax is called a *"prisere"*. In the case of Krakatoa, the island as reached its climax community with eight hundred different species being recorded in 1983, one hundred years after the irruption which cleared all life off the island. Evidence confirms that this number has been homeostatic for some time, with the introduction of new species rapidly leading to elimination of old ones.

The evidence of Krakatoa, and other disturbed or virgin ecosystems shows that the initia colonisation by **pioneer or R strategy species** occurs through positive feedback reproductio strategies, where species are weeds, producing huge numbers of possible offspring, but investin little in the success of any one. Rapid boom and bust plague or pest cycles are observed with suc species. As an ecosystem starts to approach climax these species get replaced by more sophisticate climax species which through negative feedback, adapt themselves to specific environmen conditions. These species, closely controlled by **carrying capacity,** follow **K strategies** where speci produce fewer numbers of potential offspring, but invest more heavily in securing the reproduct success of each one to the microenvironmental conditions of its specific ecological niche. It beg with a pioneer community and ends with a climax community. This climax community occurs w become in equilibrium with the local environment.

Such ecosystems form nested communities or "heterarchies", in which homeostasis at on level, contributes to homeostatic processes at another holonic level. For example, the loss of leave on a mature rainforest tree gives a space for new growth, and contributes to the leaf litter and so humus build-up upon which such growth depends. Equally a mature rainforest tree reduces the sunlight falling on the forest floor and helps prevent invasion by other species. But trees too fall to the forest floor and a healthy forest glade is dependent upon a constant rate of forest regrowth, produced by the fall of logs, and the recycling of forest nutrients through the respiration of termites and other insect, fungal and bacterial decomposers. Similarly such forest glades contribute ecological services, such as the regulation of microclimates or of the hydrological cycle for an ecosystem, and a number of different ecosystems act together to maintain homeostasis perhaps of a number of river catchments within a bioregion. A diversity of bioregions similarly makes up a stable homeostatic biological region or biome.

In the **Gaia hypothesis**, James Lovelock stated that the entire mass of living matter on Earth (or any planet with life) functions as a vast homeostatic superorganism that actively modifies its planetary environment to produce the environmental conditions necessary for its own survival. In this view, the entire planet maintains homeostasis. Whether this sort of system is present on Earth is still open to debate. However, some relatively simple homeostatic mechanisms are generally accepted. For example, when atmospheric carbon dioxide levels rise, certain plants are able to grow better and thus act to remove more carbon dioxide from the atmosphere. When sunlight is plentiful and atmospheric temperature climbs, the phytoplankton of the ocean surface waters thrive and produce more dimethyl sulfide, DMS. The DMS molecules act as cloud condensation nuclei which produce more clouds and thus increase the atmospheric albedo and this feeds back to lower the temperature of the atmosphere. As scientists discover more about Gaia, vast numbers of positive and negative feedback loops are being discovered, that together maintain a metastable condition, sometimes within very broad range of environmental conditions.

1.9 Resources

Resources are materials that can be used to satisfy human needs. Because human needs are varied and extend from basic physical requirements, such as food and shelter, to spiritual and emotional needs that are hard to define, resources cover a vast range of items. The intellectual resources of a society – its ideas and technologies – determine which aspects of the environment meet that society's needs, and therefore become resources. For example, in the 19th century uranium was used only in the manufacture of coloured glass. Today, with the development of nuclear technology, it is a military and energy resource. Resources are often divided into human resources, such as labour, supplies, and skills, and natural resources, such as climate, forests, fossil fuels, and water. Natural resources are divided into non-renewable resources and renewable resources. Non-renewable resources include minerals such as coal, copper ores, and diamonds, which exist in strictly-limited quantities. Once consumed, they will not be replenished within the

supplies, timber, food crops, and similar resources can, if managed properly, provide a steady yield virtually forever; they are therefore replenishable or renewable resources.

1.9.1 Renewable Resources

A **renewable resource** is any natural resource that is depleted at a rate slower than the rate at which it regenerates. A resource must have a way of regenerating itself in order to qualify as renewable. **Resources such as trees, fish, oxygen, and fresh water are generally considered to be renewable resources as they can be continually reproduced. Fresh water from the Earth's recycling process, fresh air from the oxygen produced by plants and trees, and trees and fish which can reproduce themselves are renewable.** However, they can become non-renewable if used at a greater rate that the environment's capacity to replenish them. For example ground water may be removed from an aquifer at a greater rate than the sustainable recharge. Removal of water from the pore spaces may cause permanent compaction (subsidence) that cannot be reversed. Renewable resources may also include commodities such as wood and leather. Soil, water, forests, plants, and animals are all renewable resources as long as they are properly conserved. Solar, wind, wave, and geothermal energies are based on renewable resources.

1.9.2 Non-renewable Resources

A **non-renewable resource** is a natural resource that cannot be re-made or re-grown. Often Fossil fuels, such as coal, petroleum and natural gas are considered non-renewable resources, as they do not naturally re-form at a rate that makes the way we use them sustainable. This is as opposed to natural resources such as timber, which re-grows naturally and can, in theory, be harvested sustainably at a constant rate without depleting the existing resource pool. In this sense, all mined resources, stone, metals, uranium, and various other materials and minerals should be considered non renewable.

Natural resources, such as coal, oil, or natural gas, take millions of years to form naturally and therefore, cannot be replaced once it is consumed; it will eventually be used up. The main energy sources used by humans are non-renewable; renewable resources, such as solar, tidal, wind, and geothermal power, have so far been less exploited. Fossil fuels like coal, oil, and gas generate a considerable amount of energy when they are burnt (the process of combustion). Non-renewable resources have high carbon content because their origin lies in the photosynthetic activity of plants millions of years ago. The fuels release this carbon back into the atmosphere as carbon dioxide. The rate at which such fuels are being burnt is thus resulting in a rise in the concentration of carbon dioxide in the atmosphere, a cause of the greenhouse effect.

Inappropriate use of renewable resources can lead to their destruction, as for example the cutting down of rainforests, with secondary effects, such as the decrease in oxygen and the increase in carbon dioxide and the resulting greenhouse effect. Some renewable resources, such as wind or solar energy, are continuous; supply is largely independent of people's actions. Demands for resources

global climate change. Generally, rainfall declines in deforested areas and droughts become common. Deforestation contributes to global warming by releasing stored carbon into the atmosphere as carbon dioxide, which is a greenhouse gas.

Forest conservation and management programs should ensure : (i) sustainable supply of tree products and services to people and industry, and (ii) maintenance of long term ecological balance through protection, restoration and conservation of forest cover. Extensive planting of trees through **afforestation** programs is needed to save the diminishing forest cover. To achieve these goals the following forestry practices should be carefully integrated: (i) protection or conservation forestry, and (ii) production or commercial forestry.

Table.2 : Forest Cover in India (1999 Estimate)

Class	Area (km^2)	% Geograhic area	Canopy Cover (% of land)
Dense Forest	3,77,358	11.5	> 40
Open Forest	2,55,064	7.8	10 – 40
Mangrove	4,871	0.1	< 10
Scrub	5,896	1.6	< 10

Protection or conservation forestry involves protection of degraded forests to allow recoupment of their flora and fauna. Well stocked forests are managed scientifically for producing timber and other forest products without causing any negative environmental impact on the forest. Forest areas designated as national parks and sanctuaries are protected from human interference. On the other hand, **production** or **commercial forestry** aims to fulfil the commercial demand, without causing denudation of natural forests, through intensive plantation in available land. Production plantations of fast growing trees (e.g., *Eucalyptus*) are raised using modern forestry techniques. Social forestry and agroforestry programmes are also included in this category. **Social forestry** aims to plant trees and shrubs on all unused and fallow land to provide fuelwood, fodder, etc., thereby reducing pressure on existing forests. For example, unused farmland, community land, road and rail sides, etc. are planted with suitable indigenous and/or exotic tree species. **Agro-forestry** includes a variety of land uses, where woody species are grown in combination with herbaceous crops, either at the same time or in time sequence. For instance, **taungya system** involves growing agricultural crops between rows of planted trees (sal, teak). The well-known shifting cultivation or **jhum**, a traditional agro-forestry system widely practiced in the north-eastern region of our country, involves felling and burning of forests, followed by cultivation of crops for few years, and abandoning cultivation to allow forest re-growth.

1.9.3.2 Water Resources

Although our planet is full with water, only a small fraction of fresh ... available for human

biospheres and damage all living things for thousands of miles for many, many years. Nuclear contamination can last for longer than lifetimes.

1.9.3 Natural Resources

As has been discussed any component of the natural environment that can be utilized by man to promote his welfare is considered as a **natural resource**. The natural resource can be a substance, an energy unit, or a natural process or phenomenon. Amongst the earth's resources, the following contribute significantly to human welfare: (I) Forest, (ii) Water, (iii) Mineral and, (iv) Food.

1.9.3.1 Forest Resource

Approximately one-third of the earth's total land area is covered by forests. The forests are storehouse of biodiversity and provide important environmental services to mankind. These services originate from the following key functions of forests. *(i) Productive functions*, include production of wood, fruits and a wide variety of compounds, such as resins, alkaloids, essential oils, latex, etc. *Protective functions*, include conservation of soil and water; prevention of drought, shelter against wind, neat, radiation and noise. *(iii) Regulative functions*, involve absorption, storage and release of gases (carbon dioxide and oxygen), water, mineral elements and radiant energy. Such regulative functions improve atmospheric and temperature conditions, and enhance the economic and environmental value of the landscape. Forests effectively regulate floods and drought, and the global biogeochemical cycles, particularly of carbon.

At the beginning of the twentieth century, about 30 per cent of land in India was covered with forests. But by the end of the twentieth century, the forest cover was reduced to 19.4 per cent. This is considerably less than the optimum 33 per cent forest area recommended by the National Forest Policy (1988) for the plains, and at least 67 per cent for the hills. Of the existing forests, less than two-third are dense forests, and the rest are open degraded forests. Today, per capita forest area available in India is 0.06 ha, which is much below the average for the world (0.64 ha per person). World's forest cover has been shrinking rapidly, especially in the developing countries located in tropics. While the temperate forests have lost only 1 per cent or less of its area, the tropics have lost more than 40 per cent of the forest cover due to deforestation. The main causes of deforestation are expansion of agriculture, urbanization, industrialization, excessive commercial use of timber, fuel wood, other forest products and cattle grazing. The current deforestation rate in tropics is estimated to be more than 10 million ha per year. If this rate of deforestation continues, it is feared that remaining tropical forests may disappear within a century. Forests, particularly on mountains, provide considerable protection from floods by trapping and absorbing precipitation, and slowly releasing it later. When the forest is removed, the amount of runoff water flowing into rivers and streams increases several fold. Deforestation results in increased soil erosion and decreased soil fertility. In drier areas, deforestation can lead to the formation of deserts. Deforestation (clearing of existing forests) causes the extinction of plant, animal and microbial species. It also threatens indigenous people, whose culture and physical survival depends upon the forests. Deforestation also induces regional and

controlling floods. (ii) Desalinisation of seawater and saline groundwater, making it fit for drinking a other purposes. Diversion of water bodies through canals to increase the natural supply of water i particular area. (iii) Regular dredging and desiltation of water bodies.

1.9.3.3 Mineral Resources

The minerals occur naturally in the Earth's crust, however, their distribution is not even. Minera can be metallic, e.g., iron, copper, gold, etc. or non-metallic, e.g., sand, stone, salt, phosphates, e Minerals essential to our industrialized society and daily life are non-renewable resources. Due the increase in industrialization, the consumption of minerals has increased tremendously all ov the world. The minerals now in short supply (e.g., silver, copper, mercury, tungsten, etc.) will proba be exhausted within next 20 to 100 years. Even the minerals which are relatively plentiful, e.g., iro and aluminium, will become extremely expensive because of the depletion of large, rich and easi accessible deposits of those metals. The sea is a storehouse of many valuable minerals. Mo abundant elements in seawater are sodium, chlorine, magnesium and bromine, that are commercia extracted from sea-water. Mining of phosphorite nodules can meet the shortage of phosphate fertiliz

Extraction (i.e., mining), processing and disposal of minerals have negative effects o environment. Mining not only disturbs and damages the land, but also pollutes the soil, water and a The land that has been destroyed due to mining is known as derelict land or mine spoil. Su derelict lands can be reclaimed or restored to a semi-natural condition by re-vegetation to preve further degradation, and also to make the land productive for other purposes.

Mineral conservation measures involve their recycling and reuse. In recycling, used discarded items are collected, remelted and reprocessed into new products, e.g., iron scra aluminium cans, etc. Some minerals present in products can be recycled, e.g., gold, lead, nic steel, copper, aluminium, silver, zinc, etc.; however, minerals in other products are lost thr normal use, such as paints containing lead, zinc or chromium. During reuse, used products collected and used over and over again, e.g., reuse of glass bottles. The benefits of reuse greater than those of recycling. All products, however, may not be reused. Recycling and reusin only renew the mineral resources, but also help in: (i) saving unspoiled land from the disrupt mining, (ii) reducing the amount of solid waste that must be disposed, and (iii) reducing e consumption and pollution. The substitution of more abundant minerals for scarce mineral prove useful, provided environmental implications are kept in mind. In recent years, plastics, cer high strength glass fibres and alloys have been substituted for scarcer materials like steel, t copper in many industries. Although substitution can extend our mineral supplies, it is not a s of the problem. To maintain the extended supply of minerals for a lo decrease their mineral consumption by becoming repairable should be encouraged to industries may also

consumption. More so, the distribution of fresh water is geographically uneven, varying greatly from country to country and even within a country from one region to another. About 84 per cent of the total global evaporation occurs from ocean surface and 16 per cent from land surface. At any given time, the amount of moisture in the air is only enough to meet a total rainfall requirement of 10 days. Thus, there is very fast movement of water from ocean and land into the atmosphere, and an average residence time of water in the air is only about 10 days. About 77 per cent of the total rainfall on earth is received on the sea surface (as against 84 per cent evaporation from this segment) and 23 per cent on land (16 per cent share of total evaporation to the atmosphere). There is a net gain of 7 per cent rainfall water on land, and this excess is returned to the oceans by surface runoff through rivers and sub-surface water flows. On global basis, the hydrological cycle is perfectly balanced as the total annual evaporation matches with annual precipitation.

On global basis, the water use has increased 4-8 per cent per year since 1950, and the consumption rate varies among countries. Worldwide, approximately 70 per cent of total water use is accounted by agriculture, only about 1.1 per cent is used for domestic and municipal supplies, and the rest is consumed by various industries, such as cement, mining, pharmaceutical, detergent and leather industry, etc.

About 40 per cent of the world's population lives in arid or semi-arid regions. These people spend substantial amounts of time, energy and effort in obtaining water for their domestic and agricultural uses. To meet the needs of the huge population, surface waters (ponds, lakes, rivers, etc.) are overdrawn. Due to over-use of surface water, the nearby wetlands may dry up. When more groundwater is removed for human use than can be recharged by rainfall or snow-melt, the groundwater may also dry out. Excessive irrigation in semi-arid and arid regions can cause salt accumulation in the soil, due to which crop productivity may decline. The continuous depletion of groundwater along the coastal regions often leads to the movement of saline sea water into freshwater wells, spoiling their water quality. Estuaries become more saline and consequently less productive when surface waters are overdrawn. Heavy rainfall results in rapid runoff from areas having exposed soil, particularly on mountain slopes. This not only causes soil erosion, but puts lowland areas at extreme risk of destruction due to flooding. Uncontrolled soil erosion results in sedimentation of waterways that can harm fisheries.

Main approaches for conservation of water are: (i) Reducing agricultural water wastage by increasing efficiency of irrigation. By the traditional method of irrigation, plants absorb less than 50 per cent of the water applied to the soil, the rest is lost. (ii) Reducing water wastage in industry by recycling the used water. (iii) Reducing domestic water wastage by constructing waste water treatment plants and recycling the treated water. (iv) Rainwater harvesting by employing practices to store rainwater and recharge groundwater. (v) Afforestation and protection of watersheds to improve water economy. Some important water management approaches to provide a sustainable supply of high quality water are : (i) Construction of dams and reservoirs to ensure year-round supply of water and,

made by rich nations are causing concern that the present and future demands of industrial societies cannot be sustained for more than a century or two, and that this will be at the expense of the developing world and the global environment. Other authorities believe that new technologies will be developed, enabling resources that are now of little importance to replace those being used up.

Sometimes, renewable resources may be non-renewable. Some of the examples are given in the following;

Plants and Animals - When plant and animal species become extinct.

Fresh water - When fresh groundwater gets used up and no rain falls, sometimes for years. (More then 3/4ths of underground water is non-renewable, as replenishing it would take centuries or more - Ecological Society of America). When chemical spills are so toxic that the water and surrounding soils are polluted for a lifetime (human lifetime). And think about population growth - as some 30-70 million people are being added to our planet every year who will have water needs.

Trees - When a forest of trees is cut indiscriminately, it can change the soil and the climate of the ecosystem so new trees cannot grow, plants die, and animals lose their habitat and die or leave the area. A natural forest has a variety of trees, plants, and lifeforms. A natural forest *creates* climate. These ecosystems evolved over a very, very long period of time and through many geologic and climatic changes. Should humans, then, be allowed to buy whole ecosystems for the purpose of destroying them - for money? That is what happens when a forest is clearcd.

Oxygen/Clean Air - When forests and plants (on land and in our ocean waters) are destroyed or die from acid rain and pollution, they can no longer absorb carbon dioxide from the air, nor release oxygen into the atmosphere. When rivers are polluted by chemicals and erosion, oxygen is depleted from the water and living things die.

Land/Soil - When land is overgrazed or the nutrients in the soil used up from improper farming practices, the soil cannot renew itself and plants and crops cannot grow. Crop rotation is one way to help maintain soil fertility. When natural vegetation is removed from land to clear it for construction projects, mining operations or farmland, the plants and trees are no longer there to absorb rainwater and protect the soil from wind. Erosion occurs and the soil is washed away or soil particles are blown away in the winds. (see Grasslands page regarding the Dust Bowl)

Fish - When land is cleared of vegetation in watershed areas that drain into rivers, lakes, streams, estuaries, etc., soil erodes into the water and the silt smothers the fish and plant life. When pollutants drain into these waters, the toxins kill aquatic life and the pollutants can be carried through the water far distances.

Biospheres of living things - When pollution destroys an area, like the devastating Exxon Valdez oil spill and the Chernobyl nuclear accident. Environmental disasters such as these affect whole

Table-3 : Some Important Mineral Elements and their Uses

Mineral	Uses
Aluminium	Structural material, packaging
Chromium	Chrome plate, steel alloys
Copper	Alloys material in gold jewellery, silverware, brass and bronze, electric wiring, pipes, cooking vessels
Gold	*Jewellery, dentistry, alloys*
Iron	Primary component of steel
Lead	Pipes, battery electrodes, pigments
Manganese	Alloy steels, disinfectants
Nickel	Coins, alloys, metal plating
Platinum	*Jewellery, equipments, industrial catalyst*
Potassium	Fertilizer, glass, photography
Silver	Jewellery, vessels, photography, alloy
Uranium	Nuclear bomb, electricity, tinting glass
Tin	Cans/containers, alloys
Zinc	Brass, electrodes, medicine
Phosphorus	Medicine, fertilizers, detergent
Sulphur	Insecticide, rubber types, medicine
Mercury	Thermometer, dental inlays, electric switches
Mica	Electrical insulator

1.9.3.4 Food Resources

About three-fourth of earth's surface is occupied by oceans and is a den of biodiversity. Marine algae vary greatly in form and range from one-celled microscopic flagellates to giant kelps, which attain a length of 100 to 150 metres. Green, blue, red and brown algae are common in oceans. Since ancient times, algae have been widely used as human food. In many countries, animals are still regularly fed on fresh or processed seaweed (e.g., *Laminaria* and *Fucus*). Marine algae have been used as manure in many countries because of their high nutrient content. Balanced fertilizer can be made by mixing sheep manure, fish and shells with seaweeds. Red algae (e.g., *Gracilaria* and *Gelidium*) are used for the extraction of commercially important agar. Agar has wide applications in food and pharmaceutical indsutries. From the point of view of human use, fish, molluscs, crustaceans

and mammals are important among the animals found in the ocean. Marine fish provide considerable amount of food throughout the world. Besides, fish are used for the manufacture of many other edible products, like fish glue, fish meal, fish oil, fish protein and vitamins. Economically important fish can be grouped into two categories, namely **demersal fish** found at the sea-bottom, and **pelagic fish** floating free in the water column. Important molluscs from commercial point of view are the mussel, oyster, clam, etc. Many types of mollusks are used as food. Some crustaceans like prawn, lobster and crabs are used as food. India ranks first among the prawn producing countries of the world.

1.10 Role of an Individual in Conservation of Natural Resources

Mahatma Gandhi, when asked if he hoped India to reach the same standard of living as Britain, replied, ***"It took Britain half the resources of the planet to achieve this prosperity. How many planets will a country like India require?"*** If the people living in the third world lived as materialistically and wastefully as people in the industrialized countries, our planet would have already been destroyed. For complex problems, there is no single or simple solution, particularly when the problem is a chronic one. But recognition of the existence of the problem in itself will facilitate in thinking about the ways and means to solve it. Ultimately, it is the collective effort of the government, people and the concerned and determined individuals that would lead to find a solution to these problems. Environmental preservation and protection is no exception to this. India has witnessed various ecological struggles for social justice and sustainable development. It may not be out of context to describe of some of these struggles and the individuals associated with them.

1.10.1 Chipko Movement: The construction of the Tehri Dam, building of roads and factories started destroying the fragile forest of the Himalayan range which represents a quarter of India's forest reserves. The rate of depletion of the forests in this area was so great that this mighty mountain chain could become barren by the first half of the next century. Concerned with ecological balance and the livelihood of the people of Uttarkhand in the state of Uttar Pradesh, **Sundarlal Bahuguna**, an eminent Gandhian, along with a band of dedicated volunteers and women clung on to the trees to save them from felling. This movement known as 'Chipko' (Hindi: clung) is a grassroots movement that received national and international attention in the 1980s. Sundarlal Bahuguna still continues his struggle against the construction of the Tehri Dam and questions the economic viability of large dams which affect the environmental rights of the people for a viable living environment in the context of the wanton destruction of the ecosystem that perpetuates. It was highlighted that the Tehri dam is a highly dangerous venture, technically unfeasible, a geotechnical blunder, economically unsound and environmentally disastrous. It is claimed that even if this dam does not fail in the meantime, the useful life of its reservoir can no longer be more than 25 to 30 years. Why it is necessary to invite hazards for some short lived imaginary benefit and submerge thousands of acres of valuable forest and agricultural land under water, uprooting more than a quarter million people from their parental home and wasting 3000 crores of rupees?

1.10.2 Appiko Movement: The *Appiko movement*, a people's movement to "embrace" the trees in order to save the precious tropical forests, was launched in 1980s to save the Western Ghats in South-West India. The path of non-violent action was basic to both Chipko and Appiko, but the Appiko movement had its own character. The movement resulted in long nonviolent marches through the forest areas, hunger strikes, court battles and Satyagrahas policy. It introduced the concepts of preservation of tropical forests, restoration of the greenery of the hills and rational utilisation of the forest resources. In another context, **Dr. Mustafa Tolba**, Executive Director of UNEP has rightly pointed out that "Neo-classical economy does not give a price tag to the tree when it is standing in the forest. It gives the price tag only when you destroy the tree, and sell it as a log of wood. It does not give a price tag to the fish when it is in the coastal area, it gives it only when you harvest the fish and have it on the market - then you have a price tag..." (Our Planet, The Magazine of the United Nations Environment Programme, Vol. 4, No. 6 1992).

1.10.3 Struggles against Aquaculture: In India, we have some of the large lakes like Chilka lake in Orissa and Kolleru lake in Andhra Pradesh. Hundreds of villages depend upon these lakes for their drinking water. In the late 1980s and 1990s, the economic greed and capitalist expansion concentrated on 'aquaculture', in different parts of the coastal regions of India. The shrimp cultivation looked very lucrative and large scale investments were started by the big companies. It affected the ecosystem and destroyed the sources of drinking water of both ground and lakes. Land-grabbing started. The traditional life of the villagers was greatly disrupted, depriving them even of drinking water. In the Chilka lake of Orissa, great agitation started to preserve the livelihood of the people and it even threatened the international migration of birds. The Chilka is the life support system for traditional fishermen. But commercial interests have usurped the lake, depleting it of its resources. The ecological struggles spilled over into prolonged court battles. One redeeming feature of the existence of the 'Public Interest Litigation' (PIL), in India is the judiciary sided with the ecological struggles on many occasions.

1.10.4 Judicial Activism: In 1995, one spirited lawyer **Mahesh Chandra Mehta**, sought to relocate 1200 polluting industries away from Delhi. This one man's effort received the help of the judiciary in removing more than a 1000 offending units from Delhi.

Narmada Bachao Movement: The Save Narmada (Narmada Bachao) movement is a long one. The river Narmada flows through the states of Madhya Pradesh, Maharastra and Gujarat and the river water has to be shared by these states. A series of dams were under construction. The Sardar Sarovar Dam on the river Narmada resulted in a big controversy as it would lead to massive displacement of the people and adverse effect on ecology. **Ms. Medha Patkar** has been struggling for the last two decades opposing the construction of the dam. She led non-violent struggles, undertook hunger strikes and tried to create national and international opinion on the futility of the Big Dams. It is a struggle for justice wherein the affected people are involved. Noted Gandhians, social activists and intellectuals extend a helping hand in the struggle. The court battles, agitation and counter

agitation created quite a stir and opinions are sharply divided. Some argue that development should get a precedent over other considerations. On the other hand, the environmentalists raise fundamental questions about the very process of development and its long term impact on the whole region. Thus, the ecological struggles are specific, but the issues they raise and the impact they produce are far reaching. They question the very basis of development and insist on a people-centred approach rather than mere economic gain. They lay emphasis on viewing the whole problem in a different context which gives primacy to the people and environment.

UNIT – II

ELEMENTARY APPROACH TO ENVIRONMENTAL POLLUTION

The word "pollution" is known to every one. In fact the word is used by us every day several times in the context of our surroundings. Several definitions can be put forth to explain the term pollution. Simply, pollution can be defined as contamination of the Earth's environment with man made agents or substances that imbalance ecological equilibrium of the Earth thereby interfere with health of living organisms or the natural functioning of ecosystem of our environment. There are six major types of pollution. They are;

1. Air pollution
2. Water pollution
3. Noise pollution
4. Land pollution
5. Radioactive pollution and
6. Thermal pollution

2.1 Types and Classification of air pollution

2.1.1 Layers and composition of atmosphere

Air is the ocean we breathe and supplies us with *oxygen* which is essential for our bodies to live. Earth's atmosphere is a layer of gases surrounding the planet Earth and retained by the Earth's gravity. The atmosphere has no abrupt cut-off. It slowly becomes thinner and fades away into space. There is no definite boundary between the atmosphere and outer space. Three-quarters of the atmosphere's mass is within 11 km of the planetary surface. In the United States, persons who travel above an altitude of 50.0 miles (80.5 km) are designated as astronauts. An altitude of 120 km (75 mi or 400,000 ft) marks the boundary where atmospheric effects become noticeable during re-entry. The Karman line, at 100 km, is also frequently used as the boundary between atmosphere and space. The temperature of the Earth's atmosphere varies with altitude; the mathematical relationship between temperature and altitude varies between the different atmospheric layers:

- **Troposphere**: The troposphere is the lowest layer of the atmosphere starting at the surface going up to between 7 km at the poles and 17 km at the equator with some variation due to weather factors. The troposphere has a great deal of vertical mixing due to solar heating at the surface. This heating warms air masses, which then rise to

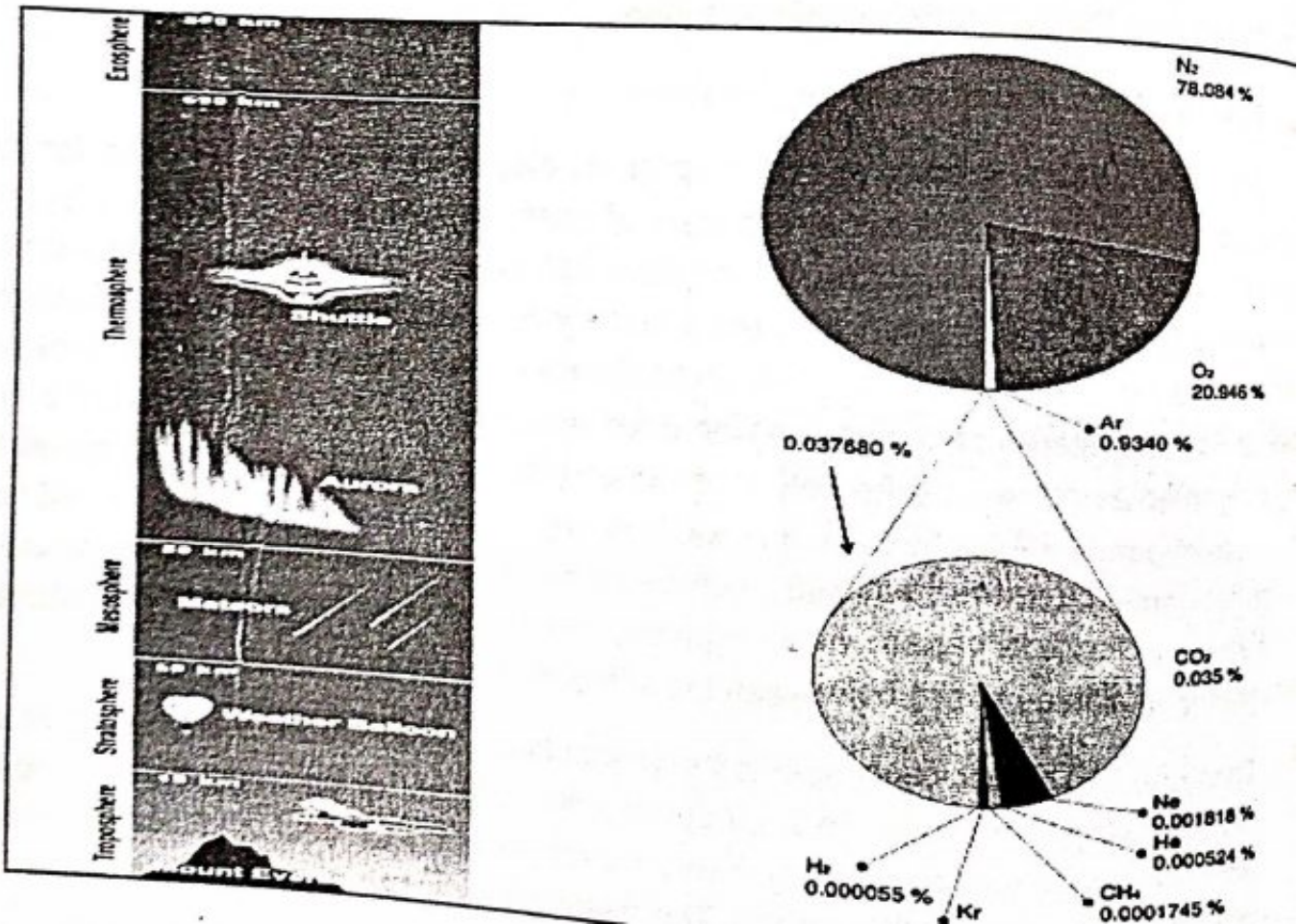
release latent heat as sensible heat that further buoys the air mass. This proc
continues until all water vapor is removed. In the troposphere, on average, temperat
decreases with height due to expansive cooling.

- **Stratosphere**: from that 7–17 km range to about 50 km, temperature increasing w
height.
- **Mesosphere**: from about 50 km to the range of 80 km to 85 km, temperature decreas
with height.
- **Thermosphere**: from 80–85 km to 640+ km, temperature increasing with height.

The boundaries between these regions are named the tropopause, stratopause, a
mesopause. The average temperature of the atmosphere at the surface of earth is 14 °C

Atmospheric regions are also named in other ways:

- **Ionosphere** – the region containing ions: approximately the mesosphere a
thermosphere up to 550 km.
- **Exosphere** – above the ionosphere, where the atmosphere thins out into space. Th
is the last major atmosphere. ("*Exo*" means "*outside*" in Greek.)



- **Magnetosphere** – the region where the Earth's magnetic field interacts with the solar wind from the Sun. It extends for tens of thousands of kilometers, with a long tail away from the Sun.
- **Ozonosphere or Ozone layer** – approximately 10 - 50 km, where stratospheric ozone is found. Even within this region, ozone is a minor constituent by volume.
- **Upper atmosphere** – the region of the atmosphere above the mesopause.
- **Van Allen radiation belts** – regions where particles from the Sun become concentrated.

The Earth's atmosphere contains various gases, water vapor and suspended particles. The dry air of atmosphere is composed of four major gases namely, nitrogen, oxygen, argon and carbon dioxide that account for more than 99.5%. Other gases found in traces in the air include helium, methane, krypton, hydrogen, carbon monoxide, nitrous oxide (N_2O), nitrogen dioxide (NO_2), ammonia, ozone, sulfur dioxide and hydrogen sulfide. The lower part of the atmosphere (Up to about 12 km) also contains water vapor at a concentration ranging from 0.01 to 5.0%. This vapor is mainly contributed by evaporation from the hydrosphere.

2.1.2 **Air pollution:** Human activities can release substances into the air, some of which can cause problems for humans, plants, and animals. This phenomenon of making the air foul is called air pollution. As per the World Health Organization (WHO) criteria, air pollution refers to "*... the substances put into the air by the activity of mankind into concentrations, sufficient to cause harmful effects to his health, vegetables, property or to interfere with the enjoyment of his property ....*". According to Indian Standards Institution "*... air pollution is the presence in ambient atmosphere of substances generally resulting from the activity of man, in sufficient concentration, present for sufficient time and under circumstances which interfere significantly with the comfort, health or welfare of a person or with the full use or enjoyment of his property*". Pollution also needs to be considered *inside* our homes, offices, and schools. Some of these pollutants can be created by indoor activities such as smoking and cooking. We spend about 80-90% of our time inside buildings, and so our exposure to harmful indoor pollutants can be serious. It is therefore important to consider both indoor and outdoor air pollution. Basing up on the polluting material air pollution can be of the following types:

i) **Particulate Matter (Soot) pollution:** One type of air pollution is the release of particles into the air from burning fuel for energy, for example, diesel exhaust. Some authorities believe that even the burning of wood and charcoal in fireplaces and barbeques can release significant quantities of soot into the air. The particles are very small pieces of matter measuring about 0.01 to 20 microns (1 micron = 1000^{th} of a millimeter). This type of pollution is sometimes referred to as "black carbon" pollution. The exhaust from burning fuels in automobiles, homes,

and industries is a major source of pollution in the air. Suspensions of very small solid particulates in a gas is called aerosol. Depending on nature and size, particulate pollutants are:

1. **Dust:** Solid particles of 1-100 micron sand, coal and wood released by sand blasting, wood works and collieries.
2. **Fume**: Particles of less than 1 micron produced by condensation of metallic vapors and vapors of metal oxides during distillation and calcinations of metals.
3. **Mist:** Liquid particles of less than 10 micron in size, e.g., condensed sulfur dioxide at a temperature of 22°C.
4. **Spray:** Liquid particles under automization through mechanical disintegration, e.g., body sprays and room fresheners.
5. **Smoke:** Solid or liquid particles ranging fro 0.05 to 1.0 micron produced due to incomplete burning of hydrocarbon containing compounds, e.g., lead particles emitted from petrol.
6. **Nuclear materials:** Nuclear materials like isotope of carbon (^{14}C), Krypton (^{85}Kr), Strontium (^{90}Sr), Iodine (^{131}I) and Calcium (^{147}Ca), etc. released from nuclear reactor, chemical processing plants, hospitals and research laboratories.

ii) **Noxious gases and Smog pollution: Gases** such as sulfur dioxide, carbon dioxide, carbon monoxide, nitrogen oxides, and chemical vapors. Most abundant among the noxious gases is carbon dioxide. It is released from industries and chemical factories like sugar factory, steel plants, oil refineries, paper industry, etc. Next to it is carbon monoxide, mainly released from automobiles. In USA 70 million tons of carbon monoxide is released per year whereas in Delhi about 700 kg of carbon monoxide is loaded to air every day during peak traffic hours. Sulfur dioxide is produced by the burning of fuel containing sulfur, particularly low quality coal in thermal plants and low grade ores in copper, zinc and lead smelter plants, oil refineries and sulfuric acid plants. USA emits more than 90 million tons of sulfur dioxide per year whereas in India it was 6.76 million tons in the year 1979 that grew to 13.19 million tons in the year 2000. Next to carbon monoxide the most polluting gases are oxides of nitrogen. These are released from nylon industries, nitric acid industry, and automobiles (25-30 kg are produced per ton of petrol/diesel) as well as burning of coal (5-10 kg per ton of coal). In Kolkata 70 tons of oxides of nitrogen are produced per day. Other noxious gases are:

1. Hydrogen sulfide and organic sulfides released from natural gas industry, coke and paper industries and distillation plants for coal-tar, petroleum and rayon, etc.
2. Hydrogen fluoride released from ceramic industry, aluminum smelting and phosphate fertilizer plants

3. Aldehydes and organic acids produced due to incomplete oxidation of petrol and mobil.

All these noxious gases can take part in further chemical reactions once they are in the atmosphere, forming **smog** and acid rain. Cities are often centers of these types of activities, and many suffer from the effects of smog, especially during the warm months of the year.

Air pollution is dispersed differently, depending on the geographical location, temperature, wind and weather factors. However, sometimes pollution does not disperse, and can build up to dangerous levels. A **temperature inversion** occurs when air close to the Earth is cooler than the air above it. Under these conditions the pollution cannot rise and be dispersed. Cities surrounded by mountains also experience trapping of pollution. Inversion can happen in any season. Summer inversions are more likely to create smog. In summer, when sun shines, the gases exhausted from automobiles (such as oxides of nitrogen) combine to form ozone. Although the Earth needs ozone in the upper atmosphere, its effects at low altitudes are extremely harmful. Winter inversions are likely to cause winter smog when pollutants are trapped by a mass of cold air hovering over a city causing them to build up (especially sulfur dioxide, oxides of nitrogen and particles). Severe winter smog episodes frequently create health hazards in parts of Central and Eastern Europe in the densely populated areas namely, the Czech Republic, eastern Germany and Poland. Combustion processes, including residential heating, power production industry, are the main source of pollution.

iii) **Global air pollution**: The build-up of long-life pollutant compounds alters the composition, chemistry and dynamics of the atmosphere. It also lead to possible climatic changes and the depletion of the shield protecting against solar UV-radiation provided by the stratospeheric ozone layer. Europe's contribution to most man-made emissions of greenhouse gases and ozone-depleting compounds is disproportionately large in relation to its geographical area and population size.

2.1.3 Greenhouse Effect

Green houses are glass houses present in botanical gardens meant for the purpose to maintain a controlled environment to carry out experiments on plants. The glass walls allow sun light to enter into the green house and trap the resulting heat inside it. Similarly, certain gases in the atmosphere trap heat in the lower atmosphere (troposphere). This phenomenon has been referred to as the greenhouse effect.

Without the natural thermal insulation of the natural greenhouse effect, the earth would be covered by ice, and life as we know it would not exist. The amount of heat trapped in the troposphere depends mainly on the concentrations of heat-trapping greenhouse gases and the length of time they stay in the atmosphere. The major greenhouse gases are water vapor, Carbon dioxide, Ozone, Methane, Nitrous oxide, and Chlorofluorocarbons (CFCs).

Out of these the two predominant greenhouse gases are water vapor (controlled by the hydrologic cycle), and carbon dioxide (controlled by the global carbon cycle).

Water vapor: Water vapor added to the atmosphere by human activities has little effect on the greenhouse effect.

Carbon dioxide: The concentration of carbon dioxide is much smaller than that of water vapor. As a result, the fairly large input of carbon dioxide from human activities can significantly affect the amount of heat trapped in the atmosphere. The main causes of rise in carbon dioxide levels are burning of wood and fossil fuels (coal, oil, gas), decrease in photosynthesis, cutting trees for development, burning tropical rainforests to clear land for agriculture, wild fires, pollution killing photosynthetic algae and single-celled organisms in the oceans, acid rain destroying foliage, volcanic out-gassing, increase in respiration by increasing human and animal populations (?) and carbonated beverages(?).

Atmospheric levels of carbon dioxide, CFCs, methane, and nitrous oxides have risen significantly in recent decades. The total amount of CO_2 in the atmosphere has increased by about 25% since the beginning of the industrial revolution. The accumulation of carbon dioxide over the last century has added as much heat to the Earth's climate system as would a one half percent increase in the sun's energy output. Since the late 1800's, the mean global temperature has risen by about 0.3° - 0.6°C, and over the last 45 years, the temperature has increased by about 0.2 - 0.3°C. Recent years have been among the warmest on record. The increase in these greenhouse gases is projected to increase the earth's natural greenhouse effect and lead to **global warming**.

2.1.4 Global warming and Ozone layer depletion

The Earth is kept at a temperature that is comfortable for human animal and plant life. **Global warming** is the observed increase in the average temperature of the Earth's atmosphere and oceans in recent decades.

The Earth's average near-surface atmospheric temperature rose 0.6° ± 0.2° Celsius (1.1° ± 0.4° Fahrenheit) in the 20th century. The prevailing scientific opinion on climate change is that "most of the warming observed over the last 50 years is attributable to human activities". The increased amounts of carbon dioxide and other greenhouse gases (GHGs) are the primary causes of the human-induced component of warming. They are released by the burning of fossil fuels, land clearing and agriculture, etc.

The measure of the climate response to increased GHGs, climate sensitivity, is found by observational studies and climate models. Doubling of carbon dioxide in the atmosphere warms in the range 1.5-4.5°C (2.7-8.1 °F). Models referenced by the Intergovernmental Panel on Climate Change (IPCC) predict that global temperatures may increase by between 1.4

and 5.8 °C (2.5 to 10.5 °F) between 1990 and 2100. The uncertainty in this range results from both the difficulty of predicting the volume of future greenhouse gas emissions and uncertainty about climate sensitivity. Greenhouses are used extensively by botanists, commercial plant growers and dedicated gardeners, particularly in cold climates.

An increase in global temperatures can in turn cause other changes, including a rising sea level and changes in the amount and pattern of precipitation. These changes may increase the frequency and intensity of extreme weather events, such as floods, droughts, heat waves, hurricanes, and tornados. Other consequences include higher or lower agricultural yields, glacier retreat, reduced summer stream flows, species extinctions and increases in the ranges of disease vectors. Warming is expected to affect the number and magnitude of these events; however, it is difficult to connect particular events to global warming. Although most studies focus on the period up to 2100, warming (and sea level rise due to thermal expansion) is expected to continue past then, since carbon dioxide has a long average atmospheric lifetime.

The term **ozone depletion** is used to describe two distinct, but related, observations: a slow, steady decline, of about 3% per decade, in the total amount of ozone in the earth's stratosphere during the past twenty years; and a much larger, but seasonal, decrease in stratospheric ozone over the earth's polar regions during the same period. (The latter phenomenon is commonly referred to as the "**ozone hole**"). The detailed mechanism by which the polar ozone holes form is different from that for the mid-latitude thinning, but the proximate cause of both trends is believed to be catalytic destruction of ozone by atomic chlorine and bromine. The primary source of these halogen atoms in the stratosphere is photodissociation of chlorofluorocarbon (CFC) compounds, commonly called **Freons**, and bromofluorocarbon compounds known as **Halons**, which are transported into the stratosphere after being emitted at the surface. Both ozone depletion mechanisms strengthened as emissions of CFCs and Halons increased.

Since the ozone layer prevents most harmful UVB wavelengths (270- 315 nm) of ultraviolet light from passing through the Earth's atmosphere, observed and projected decreases in ozone have generated worldwide concern, leading to adoption of the Montreal Protocol banning the production of CFCs and halons as well as related ozone depleting chemicals such as carbon tetrachloride and trichloroethane (also known as methyl chloroform). It is suspected that a variety of biological consequences, including, for example, increases in skin cancer, damage to plants, and reduction of plankton populations in the ocean's photic zone, may result from the increased UV exposure due to ozone depletion.

2.1.5 Acid Rain

The falling of acids and acid-forming compounds from the atmosphere to Earth's surface is referred to as acid deposition. Acid deposition is commonly known as acid rain when it

occurs as the wet deposition of droplets of acids and acid-forming compounds. Normal precipitation is slightly acidic with a pH of 5.0 to 5.6. Because of acid deposition, typical rain in the eastern United States is now about ten times more acidic with a pH of 4.3. In some areas, rain is 100 times more acidic, with a pH of 3. Acid deposition can be a serious regional problem, particularly in areas downwind from coal-burning power plants, smelters, factories and large urban areas.

Acid deposition can have many harmful ecological effects in both aquatic and terrestrial systems. It can damage tree foliage directly and make trees more susceptible to other stresses such as cold temperatures, diseases, insects, droughts, etc. In lakes, acid deposition can kill fish and can promote the conversion of moderately toxic inorganic mercury compounds into highly toxic methylmercury. It also contributes to human respiratory diseases such as bronchitis and asthma.

2.2 Type and classification of water pollution

When toxic substances liberated by human activities enter lakes, streams, rivers, oceans and other water bodies, they get dissolved or lie suspended in water or get deposited on the bed. This results in the pollution of water whereby the quality of the water deteriorates, affecting aquatic ecosystems. Pollutants can also seep down and affect the groundwater deposits. Although natural phenomena such as volcanoes, storms, earthquakes etc. also cause major changes in water quality and the ecological status of water, these are not deemed to be pollution. Water pollution is a serious problem in the global context. It has been suggested that it is the leading worldwide cause of death and disease, and that it accounts for the deaths of more than 14,000 people daily. Two types of water pollutants exist.

1. **Point source**: Point sources of pollution occur when harmful substances are emitted directly into a body of water. Oil spills and direct disposal of industrial effluents to water bodies are the most common examples point source water pollution.
2. **Non-point source:** A non-point source delivers pollutants indirectly through environmental changes. An example of this type of water pollution is when fertilizer from a field is carried into a stream by rain, in the form of run-off which in turn affects aquatic life.

The technology exists for point sources of pollution to be monitored and regulated. Non-point sources are much more difficult to control. Pollution arising from non-point sources accounts for a majority of the contaminants in streams and lakes.

Water pollution has many pollutants coming from various sites. The most polluting of them are the city sewage and industrial waste discharged into the rivers. The facilities to treat waste water are not adequate in any city in India. Presently, only about 10% of the waste

water generated is treated; the rest is discharged as it is into our water bodies. Due to this, pollutants enter groundwater, rivers, and other water bodies. Such water, which ultimately ends up in our households, is often highly contaminated and carries disease-causing microbes. Agricultural run-off, or the water from the fields that drains into rivers, is another major water pollutant as it contains fertilizers and pesticides. Thus, basing upon the sources water pollution is of the following types:

1. Domestic sewage pollution: Domestic sewage refers to waste water that is discarded from households. Also referred to as sanitary sewage, such water contains a wide variety of dissolved and suspended impurities. It amounts to a very small fraction of the sewage by weight. But it is large by volume and contains impurities such as organic materials and plant nutrients that tend to rot. The main organic materials are food and vegetable waste, plant nutrient come from chemical soaps, washing powders, etc. the decomposition of organic materials lead to change the dissolved oxygen level in water which in tern affects the aquatic organisms. Domestic sewage is also very likely to contain **pathogens.** They can cause many illnesses that range from typhoid and dysentery to minor respiratory and skin diseases. Pathogens include such microorganisms such as bacteria, viruses, and protozoans. These pollutants enter waterways through untreated sewage, storm drains, septic tanks, runoff from farms, and particularly boats that dump sewage. Though microscopic, these pollutants have a tremendous effect evidenced by their ability to cause sickness. Thus, disposal of domestic waste water is a significant technical problem. The various substances that we use for keeping our houses clean like insect repellants/killers, floor cleaners add to water pollution as they contain harmful chemicals. In the past, people mostly used soaps made from animal and vegetable fat for all types of washing. But most of today's cleaning products are synthetic detergents and come from the petrochemical industry. Most detergents and washing powders contain phosphates, which are used to soften the water among other things. These and other chemicals contained in washing powders affect the health of all forms of life in the water. Sewage generated from the urban areas in India has multiplied manifold since 1947. Today, many people dump their garbage into streams, lakes, rivers, and seas, thus making water bodies the final resting place of cans, bottles, plastics, and other household products. Minicipal drains of Cuttack city discharges their wastes into the river Kathjori and Taladanda canal thereby polluting them.

2. Agricultural Run off pollution: The use of land for agriculture and the practices followed in cultivation greatly affect the quality of groundwater. Intensive cultivation of crops causes chemicals from fertilizers (e.g. nitrate) and pesticides to seep into the groundwater, a process commonly known as leaching. Routine applications of fertilizers and pesticides for agriculture and indiscriminate disposal of industrial and domestic wastes are increasingly being recognized as significant sources of water pollution. The high nitrate content in groundwater is mainly from irrigation run-off from agricultural fields where chemical fertilizers have been used indiscriminately.

3. Industrial effluents pollution: Waste water from manufacturing or chemical proc in industries contributes to water pollution. Industrial waste water usually contains and readily identifiable chemical compounds which may be organic, inorganic and biodegradable. . Thermal pollution (increase in water temperature) is another effect of indu pollution where heated effluents are discharged into the water bodies. During the last years, the number of industries in India has grown rapidly. But water pollution is concentra within a few sub-sectors, mainly in the form of toxic wastes and organic pollutants. Out a large portion can be traced to the processing of industrial chemicals and to the food produ industry. In fact, a number of large- and medium-sized industries in the region covered by Ganga Action Plan do not have adequate effluent treatment facilities. Most of these defaul industries are sugar mills, distilleries, leather processing industries, and thermal power statio Most major industries have treatment facilities for industrial effluents. But this is not the c with small-scale industries, which cannot afford enormous investments in pollution contr equipment as their profit margin is very slender. In our state, river Brahmani is one of t most polluted rivers in India, as it receives the effluents of the industries located Rauri and Talcher. Similarly, all the industries located in Choudwar ia discharges into the ri Birupa and the industries in Ganjam discharge their effluents into the river Rushikulya.

4. Ground water pollution: Underground water gets polluted by substances leaking fro the fertilizers and garbage heaps spread over the land. Disposal of wastes into abandone mine shafts and over pumping also pollute ground water. Ground water pollution is mo dangerous as its purification protocol is yet to develop.

5. Additional types of water pollution: Three last forms of water pollution exist in the form **of petroleum, radioactive substances, and heat**. Petroleum often pollutes water bodies i the form of oil, resulting from oil spills. These large-scale accidental discharges of petroleu are an important cause of pollution along shore lines. Besides the supertankers, off-shor drilling operations contribute a large share of pollution. One estimate is that one ton of oil spilled for every million tons of oil transported. This is equal to about 0.0001 percen Radioactive substances are produced in the form of waste from nuclear power plants, an from the industrial, medical, and scientific use of radioactive materials. Specific forms o waste are uranium and thorium mining and refining. The last form of water pollution is heat Heat is a pollutant because increased temperatures result in the deaths of many aquatic organisms. These decreases in temperatures are caused when a discharge of cooling wate by factories and power plants occurs.

2.2.1 Eutrophication

Eutrophication is the enrichment of an ecosystem with chemical nutrients, typically compounds containing nitrogen or phosphorus. Eutrophication is considered a form of pollution because it promotes plant growth, favoring certain species over others and forcing a change

in species composition. In aquatic environments, enhanced growth of choking aquatic vegetation or phytoplankton (that is, an algal bloom) disrupts normal functioning of the ecosystem, causing a variety of problems. Human society is impacted as well, for example, eutrophication decreases the resource value of rivers, lakes, and estuaries such that recreation, fishing, hunting, and aesthetic enjoyment are hindered. Health-related problems can occur where eutrophic conditions interfere with drinking water treatment. Although traditionally thought of as enrichment of aquatic systems by addition of fertilizers into lakes, bays, or other semi-enclosed waters (even slow-moving rivers), there is gathering evidence that terrestrial ecosystems are subject to similarly adverse impacts. Eutrophication was recognized as a pollution problem in European and North American lakes and reservoirs in the mid-20th century. Since then, it has become more widespread. Surveys showed that 54% of lakes in Asia are eutrophic; in Europe, 53%; in North America, 48%; in South America, 41%; and in Africa, 28%.

Eutrophication can be a natural process in lakes, as they age through geological time. Estuaries also tend to be naturally eutrophic because land-derived nutrients are concentrated where run-off enters the marine environment in a confined channel and mixing of relatively high nutrient fresh water with low nutrient marine water occurs. Human activities can accelerate the rate at which nutrients enter ecosystems. Runoff from agriculture and development, pollution from septic systems and sewers, and other human-related activities increase the flux of both inorganic nutrients and organic substances into terrestrial, aquatic, and coastal marine ecosystems (including coral reefs). Elevated atmospheric compounds of nitrogen can increase soil nitrogen availability. Chemical forms of nitrogen are most often of concern with regard to eutrophication because plants have high nitrogen requirements so that additions of nitrogen compounds stimulate plant growth (primary production). Nitrogen is not readily available in soil because gaseous form of nitrogen is very stable and unavailable directly to higher plants. Terrestrial ecosystems rely on microbial nitrogen fixation to convert nitrogen gas into other chemical forms (such as nitrates). However, there is a limit to how much nitrogen can be utilized. Ecosystems receiving more nitrogen than the plants require are called **nitrogen-saturated**. Over-saturated terrestrial ecosystems contribute both inorganic and organic nitrogen to freshwater, coastal, and marine eutrophication, where nitrogen is also typically a limiting nutrient. However, in marine environments, phosphorus may be limiting because it is leached from the soil at a much slower rate than nitrates, which are highly soluble.

Many ecological effects can arise from stimulating primary production, but there are three particularly troubling ecological impacts: decreased biodiversity, changes in species

1. Decreased biodiversity: When an ecosystem experiences an increase in nutrients, primary producers reap the benefits first. In aquatic ecosystems, species such as algae experience a population increase. Algal blooms limit the sunlight available to bottom-dwelling organisms and cause wide swings in the amount of dissolved oxygen in the water. Oxygen is required by all respiring plants and animals and it is replenished in daylight by photosynthesizing plants and algae. Under eutrophic conditions, dissolved oxygen greatly increases during the day, but is greatly reduced after dark by the respiring algae and by microorganisms that feed on the increasing mass of dead algae. When dissolved oxygen levels decline to hypoxic levels, fish and other marine animals suffocate. As a result, creatures such as fish, shrimp, and especially immobile bottom dwellers die off. In extreme cases, anaerobic conditions ensue promoting growth of bacteria such as *Clostridium botulinum* that produces toxins deadly to birds and mammals. Zones where this occurs are known as dead zones.

2. New species invasion: Eutrophication may cause competitive release by making abundant a normally limiting nutrient. This process causes shifts in the species composition of ecosystems. For instance, an increase in nitrogen might allow new, competitive species to invade and out compete original inhabitant species. This has been shown to occur in New England salt marshes.

3. Toxicity: Some algal blooms, otherwise called "nuisance algae" or "harmful algal blooms" are toxic to plants and animals. Toxic compounds they produce can make their way up the food chain, resulting in animal mortality. Freshwater algal blooms can pose a threat to livestock. When the algae die or are eaten, neuro- and hepatotoxins (toxins of nervous system and liver) are released which can kill animals and may pose a threat to humans. An example of algal toxins working their way into humans is the case of shellfish poisoning. Biotoxins created during algal blooms are taken up by shellfish (mussels, oysters, prawns and lobsters), leading to these human foods acquiring the toxicity and poisoning humans. Examples include paralytic, neurotoxic, and diarrhoetic shellfish poisoning.

Nitrogen can also cause toxic effects directly. When this nutrient is leached into groundwater, drinking water can be affected because concentrations of nitrogen are not filtered out. Nitrate has been shown to be toxic to human babies. This is because bacteria can live in their digestive tract that convert nitrate to nitrite (NO_2). Nitrite reacts with hemoglobin to form methemoglobin, a form that does not carry oxygen. The baby essentially suffocates as its body receives insufficient oxygen.

Prevention and reversal: Eutrophication poses a problem not only to ecosystems, but to humans as well. Reducing eutrophication should be a key concern when considering future policy, and a sustainable solution for everyone, including farmers and ranchers, seems feasible. Cleanup measures have been mostly, but not completely, successful. Finnish phosphorus

removal measures started in the mid-1970s and have targeted rivers and lakes polluted by industrial and municipal discharges. These efforts, which involved removal of phosphorus, have had a 90% removal efficiency. Still, some targeted point sources did not show a decrease in runoff despite reduction efforts. Non-point pollution is the most difficult source of nutrients to manage. The following steps are recommended to minimize the amount of pollution that can enter aquatic ecosystems from ambiguous sources.

1. Riparian buffer zones: Studies show that intercepting non-point pollution between the source and the water is a successful mean of prevention. Riparian buffer zones have been created near waterways in an attempt to filter pollutants. Sediment and nutrients are deposited here instead of in water. Creating buffer zones near farms and roads is another possible way to prevent nutrients from traveling too far. Still, studies have shown that the effects of atmospheric nitrogen pollution can reach far past the buffer zone. This suggests that the most effective means of prevention is from the primary source.

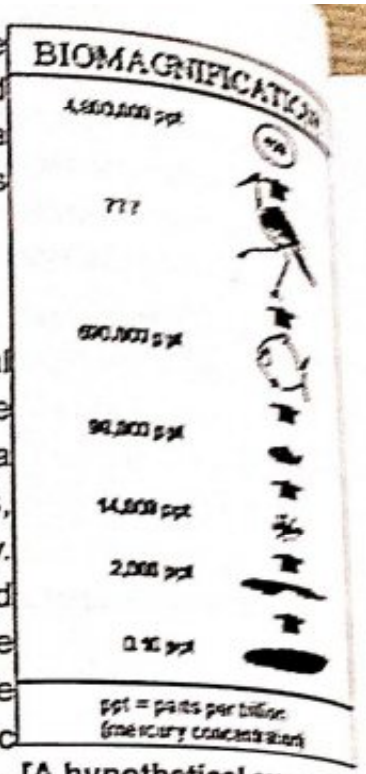
2. Prevention policy: Laws regulating the discharge and treatment of sewage have led to dramatic nutrient reductions to surrounding ecosystems, but it is generally agreed that a policy regulating agricultural use of fertilizer and animal waste must be imposed. In Japan the amount of nitrogen produced by livestock is adequate to serve the fertilizer needs for the agriculture industry. Thus, it is not unreasonable to command livestock owners to clean up animal waste—which when left stagnant will leach into ground water.

3. Nitrogen testing and modeling: Soil Nitrogen Testing (N-Testing) is a technique that helps farmers to optimize the amount of fertilizer applied to crops. By testing fields with this method, farmers saw a decrease in fertilizer application costs, a decrease in nitrogen lost to surrounding sources, or both. By testing the soil and modeling the bare minimum amount of fertilizer needed, farmers reap economic benefits while the environment remains clean.

2.2.2 Ecological magnification

Ecological or biological magnification (or biomagnification) is the buildup of certain substances in the bodies of organisms at higher trophic levels of food webs. Biomagnification encompasses the concept of bioaccumulation. Whereas bioaccumulation is the concentration of a substance in a single organism or trophic level, biomagnification is the compounding of concentration as one moves through the food chain or "up" through each trophic level. For example, though mercury is only present in small amounts in seawater, bioaccumulation builds it up in the fat tissue of herbivorus fish. Anything which eats these fish also consumes the higher level of mercury the fish have accumulated. This process explains why predatory fish such as swordfish and sharks have higher concentrations of mercury in their tissue. DDT was once used extensively as an insecticide. DDT builds up in the fatty tissues of organisms. Organisms at lower trophic levels accumulate small amounts. Organisms at the next higher

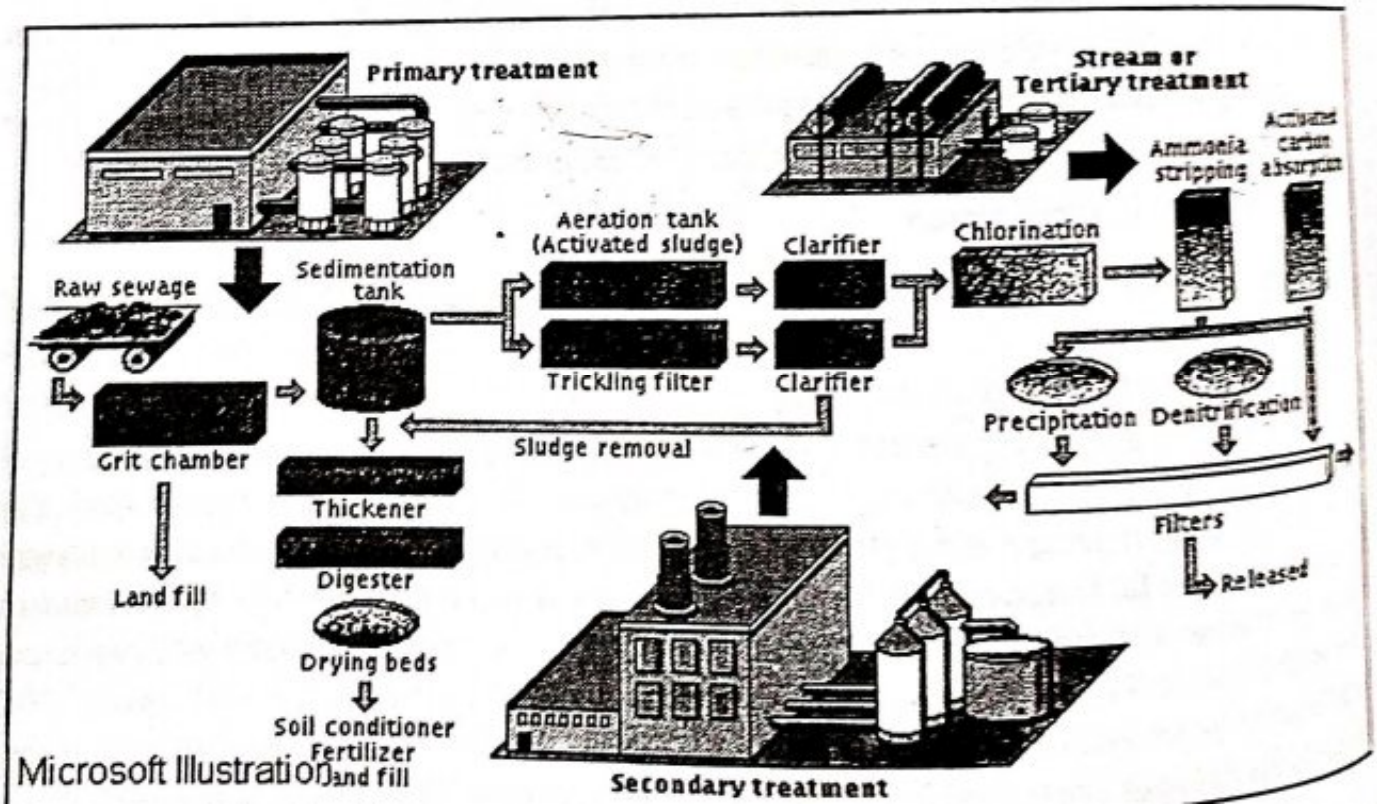
level eat many of these lower-level organisms and hence accumulate larger amounts. At the highest trophic levels the increased concentrations in tissues may become toxic. Accumulation of a substance only through contact with water is known as bioconcentration.



[A hypothetical example of the biomagnification of mercury]

2.2.3 Waste water treatment

Raw sewage includes waste from sinks, toilets, and industrial processes. Treatment of the sewage is required before it can be safely buried, used, or released back into local water systems. In a treatment plant, the waste is passed through a series of screens, chambers, and chemical processes to reduce its bulk and toxicity. The three general phases of treatment are primary, secondary, and tertiary. During primary treatment, a large percentage of the suspended solids and inorganic material is removed from the sewage. The focus of secondary treatment is reducing organic material by accelerating natural biological processes. Tertiary treatment is necessary when the water will be reused; 99 percent of solids are removed and various chemical processes are used to ensure the water is as free from impurity as possible.



Microsoft Illustration

Agriculture, including commercial livestock and poultry farming, is the source of many organic and inorganic pollutants in surface waters and groundwater. These contaminants include both sediment from erosion cropland and compounds of phosphorus and nitrogen that partly originate in animal wastes and commercial fertilizers. Animal wastes are high in oxygen demanding material, nitrogen and phosphorus, and they often harbor pathogenic organisms. Wastes from commercial feeders are contained and disposed of on land; their main threat to natural waters, therefore, is from runoff and leaching. Control may involve settling basins for liquids, limited biological treatment in aerobic or anaerobic lagoons, and a variety of other methods.

2.2.4 Purification of water

Water purification is the removal of contaminants from raw water to produce drinking water that is pure enough for human consumption or for the production of hydrogen. Substances that are removed during the process include bacteria, algae, viruses, fungi, minerals, and man-made chemical pollutants. Many contaminants can be dangerous—but depending on the quality standards, others are removed to improve the water's smell, taste, and appearance. A small amount of disinfectant is usually intentionally left in the water at the end of the treatment process to reduce the risk of re-contamination in the distribution system.

Many environmental and cost considerations affect the location and design of water purification plants. Groundwater is cheaper to treat, but aquifers usually have limited output and can take thousands of years to recharge. Surface water sources should be carefully monitored for the presence of unusual types or levels of microbial/disease causing contaminants. The treatment plant itself must be kept secure from vandalism and terrorism.

2.2.4.1 Stages in typical municipal water treatment

There are three principal stages in water purification:-

1. **Primary treatment** - Collecting and screening including pumping from rivers and initial storage
2. **Secondary treatment** - removal of fine solids and the majority of contaminants using filters, coagulation, flocculation and membranes
3. **Tertiary treatment** - polishing, pH adjustment, carbon treatment to remove taste and smells, disinfection, and temporary storage to allow the disinfecting agent to work.

A. Primary Treatment

1. **Pumping and containment** - The majority of water must be pumped from its source or directed into pipes or holding tanks. To avoid adding contaminants to the water, this

physical infrastructure must be made from appropriate materials and constructed so that accidental contamination does not occur.

2. **Screening** - The first step in purifying surface water is to remove large debris such as sticks, leaves, trash and other large particles which may interfere with subsequent purification steps. Most deep groundwater does not need screening before other purification steps.

3. **Storage** - Water from rivers may also be stored in bank-side reservoirs for periods between a few days and many months to allow natural biological purification to take place. This is especially important if treatment is by slow sand filters. Storage reservoirs also provide a buffer against short periods of drought or to allow water supply to be maintained during transitory pollution incidents in the source river.

4. **Pre-conditioning** - Many waters rich in hardness salts are treated with soda-ash to precipitate calcium carbonate out utilizing the common ion effect.

5. **Pre-chlorination** - In many plants the incoming water was chlorinated to minimize the growth of fouling organisms on the pipe-work and tanks. Because of the potential adverse quality effects, this has largely been discontinued.

B. Secondary treatment

There are a wide range of techniques that can be used to remove the fine solids, micro-organisms and some dissolved inorganic and organic materials. The choice of method will depend on the quality of the water being treated, the cost of the treatment process and the quality standards expected of the processed water.

1. pH adjustment - If the water is acidic, lime or soda ash is added to raise the pH. Lime is the more common of the two additives because it is cheaper, but it also adds to the resulting water hardness. Making the water slightly alkaline ensures that coagulation and flocculation processes work effectively and also helps to minimize the risk of lead being dissolved from lead pipes and lead solder in pipe fittings.

2. **Coagulation and flocculation** - Coagulation and flocculation are purification methods which work by using chemicals that effectively "glue" small suspended particles together so that they settle out of the water or stick to sand or other granules in a granular media filter. Many of the suspended water particles have a negative electrical charge. The charge keeps particles suspended because they repel similar particles. Coagulation works by eliminating the natural electrical charge of the suspended particles so they attract and stick to each other. The joining of the particles so that they will form larger settle able particles is called flocculation. The larger formed particles are called floc. The coagulation chemicals are added in a tank (often called a rapid mix tank or flash

mixer), which typically has rotating paddles. In most treatment plants, the mixture remains in the tank for 10 to 30 seconds to ensure full mixing. The amount of coagulant that is added to the water varies widely due to the different source water quality.

One of the more common coagulants used is aluminum sulfate, sometimes called **filter alum**. Aluminum sulfate reacts with water to form flocs of aluminium hydroxide.

Coagulation with aluminum compounds may leave a residue of aluminium in the finished water. This is normally about 0.1 to 0.15 mg/L. It has been established that Aluminium can be toxic to humans at high concentrations. Iron(II) sulfate or iron (III) chloride are other common coagulants. Iron(III) coagulants work over a larger pH range than aluminum sulfate but are not effective with many source waters. Other benefits of iron(III) are lower costs and in some cases slightly better removal of natural organic contaminants from some waters. Coagulation with iron compounds typically leaves a residue of iron in the finished water. This may impart a slight taste to the water, and may cause brownish stains on porcelain fixtures. The trace levels of iron are not harmful to humans, and indeed provide a needed trace mineral. Because the taste and stains may lead to customer complaints, aluminium tends to be favored over iron for coagulation. Cationic and other polymers can also be used. They are often called coagulant aids used in conjunction with other inorganic coagulants. The long chains of positively charged polymers can help to strengthen the floc making it larger, faster settling and easier to filter out. The main advantages of polymer coagulants and aids are that they do not need the water to be alkaline to work and that they produce less settled waste than other coagulants, which can reduce operating costs. The drawbacks of polymers are that they are expensive, can blind sand filters and that they often have a very narrow range of effective doses.

3. **Flocculation** - In flocculation coagulants are used but the resultant floc is settled out rather than filtered through sand filters. The chosen coagulant and the raw water is slowly mixed in a large tank called a flocculation basin. Unlike a rapid mix tank, the flocculation paddles turn very slowly to minimize turbulence. The principle involved is to allow as many particles to contact other particles as possible generating large and robust floc particles. Generally, the retention time of a flocculation basin is at least 30 minutes with speeds between 0.5 feet and 1.5 feet per minute (15 to 45 cm / minute). Flow rates less than 0.5 ft/min cause undesirable floc settlement within the basin.

4. **Sedimentation** -Water exiting the flocculation basin enters the sedimentation basin, also called a clarifier or settling basin. It is a large tank with slow flow, allowing floc to settle to the bottom. The sedimentation basin is best located close to the flocculation basin so the transit between does not permit settlement or floc break up. Sedimentation

basins can be in the shape of a rectangle, where water flows from end to end, or circ
where flow is from the center outward. Sedimentation basin outflow is typically over a
so only a thin top layer-furthest from the sediment-exits. The amount of floc that settles
of the water is dependent on the time the water spends in the basin and the depth of
basin. The retention time of the water must therefore be balanced against the cost of
larger basin. The minimum clarifier retention time is normally 4 hours. A deep basin
allow more floc to settle out than a shallow basin. This is because large particles
faster than smaller ones, so large particles bump into and integrate smaller particles
they settle. In effect, large particles sweep vertically though the basin and clean out
particles on their way to the bottom.

As particles settle to the bottom of the basin a layer of sludge is formed on the floor of
tank. This layer of sludge must be removed and treated. The amount of sludge that
generated is significant, often 3%-5% of the total volume of water that is treated. The co
of treating and disposing of the sludge can be a significant part of the operating cost of
water treatment plant. The tank may be equipped with mechanical cleaning devices that
continually clean the bottom of the tank or the tank can be taken out of service when the
bottom needs to be cleaned. An increasingly popular method of floc removal is by dissolved
air flotation. A proportion of clarified water, typical 5-10% of throughput is recycled and air
is dissolved in it under pressure. This is injected into the bottom of the clarifier tank where
tiny air bubbles are formed that in turn attach themselves to the floc particles and float them
to the surface. A sludge blanket is formed which is periodically removed using mechanical
scrapers. This method is very efficient at floc removal and reduces loading on filters
however it is unsuitable for water sources with a high concentration of sediment.

5. **Filtration** - After separating most floc, the water is filtered as the final step to remove
remaining suspended particles and unsettled floc. The most common type of filter is a
rapid sand filter. Water moves vertically through sand which often has a layer of activated
carbon or anthracite coal above the sand. The top layer removes organic compounds
including taste and odour. The space between sand particles is larger than the smallest
suspended particles, so simple filtration is not enough. Most particles pass through
surface layers but are trapped in pore spaces or adhere to sand particles. effective
filtration extends into the depth of the filter. This property of the filter is key to its operation:
if the top layer of sand blocked all particles the filter would quickly clog.

To clean the filter, water is passed quickly upward through the filter, opposite the normal
direction (called *backflushing* or *backwashing*) to remove embedded particles. Prior to
this, compressed air may be blown up through the bottom of the filter to break up the
compacted filter media to aid the backwashing process, this is known as *air scouring*.
This contaminated water can be disposed of, along with the sludge from the sedimentation

basin, or it can be recycled by mixing with the raw water entering the plant.

Some water treatment plants employ pressure filters. These work on the same principle as rapid gravity filters differing in that the filter medium is enclosed in a steel vessel and the water is forced through it under pressure.

6. Slow sand filtration may be used where there is sufficient land and space. These rely on biological treatment processes for their action rather than physical filtration. Slow sand filters are carefully constructed using graded layers of sand with the coarsest at the base and the finest at the top. Drains at the base convey treated water away for disinfection. Filtration depends on the development of a thin biological layer on the surface of the filter. An effective slow sand filter may remain in service for many weeks or even months if the pre-treatment is well designed and produces an excellent quality of water which physical methods of treatment rarely achieve.

7. Ultra-filtration membranes are a relatively new development which uses polymer film with chemically formed microscopic pores which can be used in place of granular media to filter water effectively without coagulants. The type of membrane media determines how much pressure is needed to drive the water through and what sizes of micro-organisms can be filtered out.

C. Tertiary treatment

Disinfection is normally the last step in purifying drinking water. Water is disinfected to destroy any pathogens which passed through the filters. Possible pathogens include viruses, bacteria, including *Escherichia coli*, *Campylobacter* and *Shigella*, and protozoans, including *G. lamblia* and other Cryptosporidia. In most developed countries, public water supplies are required to maintain a residual disinfecting agent throughout the distribution system, in which water may remain for days before reaching the consumer. Following the introduction of any chemical disinfecting agent, the water is usually held in temporary storage - often called a **contact tank** or **clear well** to allow the disinfecting action to complete.

1. **Chlorine-** The most common disinfection method is some form of chlorine or its compounds such as chloramine or chlorine dioxide. Chlorine is a strong oxidant that kills many micro-organisms. Because chlorine is a toxic gas, there is a danger of a release associated with its use. This problem is avoided by the use of sodium hypochlorite, which is a relatively inexpensive solid that releases free chlorine when dissolved in water. Handling the solid, however, requires greater routine human contact through opening bags and pouring than the use of gas cylinders which are more easily automated. Both disinfectants are widely used despite their respective drawbacks. A major

compounds in the water to form potentially harmful levels of the chemical by-pro
trihalomethanes (THMs) and haloacetic acids, both of which are carcinogenic.
formation of THMs and haloacetic acids is minimised by effective removal of as
organics from the water as possible before disinfection. Although chlorine is effect
killing bacteria, it has limited effectiveness against protozoans that form cysts in
(*Giardia lamblia* and *Cryptosporidium*, both of which are pathogenic).

2. Chlorine dioxide is another fast-acting disinfectant. It is, however, rarely used, bec
may create excessive amounts of chlorate and chlorite, both of which are regulated
allowable levels. Chlorine dioxide also poses extreme risks in handling: not only is it
toxic, but it may spontaneously detonate upon release to the atmosphere in an acci

3. *Chloramines'* are another chlorine-based disinfectant. Although chloramines are no
effective as disinfectants, compared to chlorine gas or sodium hypochlorite, they a
less prone to form THMs or haloacetic acids. It is possible to convert chlorine
chloramine by adding ammonia to the water along with the chlorine: The chlorine a
ammonia react to form chloramine. Water distribution systems disinfected w
chloramines may experience nitrification, wherein ammonia is used a nitrogen sou
for bacterial growth, with nitrates being generated as a byproduct.

4. Ozone is a relatively unstable molecule of oxygen which readily gives up one atom
oxygen providing a powerful oxidizing agent which is toxic to most water borne organism
It is a very strong, broad spectrum disinfectant that is widely used in Europe. It is a
effective method to inactivate harmful protozoans that form cysts. It also works we
against almost all other pathogens. Ozone is made by passing oxygen through ultraviol
light or a "cold" electrical discharge. To use ozone as a disinfectant, it must be create
on site and added to the water by bubble contact. Some of the advantages of ozon
include the production of relatively fewer dangerous by-products (in comparison t
chlorination) and the lack of taste and odor produced by ozonation. Although fewer by
products are formed by ozonation, it has been discovered that the use of ozone produce
a small amount of the suspected carcinogen Bromate. Another one of the mai
disadvantages of ozone is that it leaves no disinfectant residual in the water. Ozon
has been used in drinking water plants since 1906 where the first industrial ozonatio
plant was built in Nice, France. The U.S. Food and Drug Administration has accepte
ozone as being safe; and it is applied as an anti-microbiological agent for the treatment
storage, and processing of foods.

5. UV radiation is very effective at inactivating cysts, as long as the water has a low lev
of colour so the UV can pass through without being absorbed. The main drawback to th
use of UV radiation is that, like ozone treatment, it leaves no residual disinfectant in th
water. Because neither ozone nor UV radiation leaves a residual disinfectant in the wat

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it is sometimes necessary to add a residual disinfectant after they are used. This is often done through the addition of chloramines, discussed above as a primary disinfectant. When used in this manner, chloramines provide an effective residual disinfectant with very little of the negative aspects of chlorination.

D. Additional treatment options

1. **Fluoridation** -in many areas fluoride is added to water for the purpose of preventing tooth decay. This process is referred to as water fluoridation. Fluoride is usually added after the disinfection process. In the United States, fluoridation is usually accomplished by the addition of dihydrogen hexafluorosilicate, which decomposes in water, yielding fluoride ions.

2. **Water conditioning**: This is a method of reducing the effects of hard water. Hardness salts are deposited in water systems subject to heating because the decomposition of bicarbonate ions creates carbonate ions which crystallize out of the saturated solution of calcium or magnesium carbonate. Water with high concentrations of hardness salts can be treated with soda ash (sodium carbonate) which precipitates out the excess salts, through the common ion effect, as calcium carbonate of very high purity. The precipitated calcium carbonate is traditionally sold to the manufacturers of toothpaste. Several other methods of industrial and residential water treatment are claimed (without general scientific acceptance) to include the use of magnetic or/and electrical fields reducing the effects of hard water.

3. **Plumbo-solvency reduction**: In areas with naturally acidic waters of low conductivity (i.e surface rainfall in upland mountains of igneous rocks), the water is capable of dissolving lead from any lead pipes that it is carried in. The addition of small quantities of phosphate ion and increasing the pH slightly both assist in greatly reducing plumbo-solvency by creating insoluble lead salts on the inner surfaces of the pipes.

4. **Radium Removal**: Some groundwater sources contain radium, a radioactive chemical element, including many groundwater sources north of the Illinois River in Illinois. Radium can be removed by ion exchange, or by water conditioning. The back flush or sludge that is produced is, however, a low-level radioactive waste.

5. **Fluoride Removal**: Although fluoride is added to water in many areas, some areas of the world have excessive levels of natural fluoride in the source water. Excessive levels can be toxic. One method of reducing fluoride levels is through treatment with activated alumina.

E. Other water purification techniques

Other popular methods for purifying water, especially for local private supplies are listed

below. In some countries some of these methods are also used for large scale municipal
Particularly important are distillation (de-salination of seawater) and reverse osmosis.

1. **Boiling**: Water is heated hot enough and long enough to inactivate or kill microo
that normally live in water at room temperature. Near sea level, a vigorous roll
for at least one minute is sufficient. At high altitudes (greater than two kilom
5000 feet) three minutes is recommended. In areas where the water is "hard"
containing significant dissolved calcium salts), boiling decomposes the bicarbo
ions, resulting in partial precipitation as calcium carbonate. This is the "fur" that
up on kettle elements, etc., in hard water areas. With the exception of calcium,
does not remove solutes of higher boiling point than water and in fact increases
concentration (due to some water being lost as vapour). Boiling does not leave a
disinfectant in the water. Therefore, water that has been boiled and then stored
length of time may have acquired new pathogens.

2. Carbon filtering: Charcoal, a form of carbon with a high surface area, absorbs
compounds including some toxic compounds. Water passing through activated
is common in household water filters and fish tanks. Household filters for drinking
sometimes contain silver to release silver ions which have a bactericidal effect.

3. Distillation involves boiling the water to produce water vapor. The vapor contacts a
surface where it condenses as a liquid. Because the solutes are not normally vapor
they remain in the boiling solution. Even distillation does not completely purify
because of contaminants with similar boiling points and droplets of unapprised
carried with the steam. However, 99.9% pure water can be obtained by distilla
Distillation does not confer any residual and the distillation apparatus may be the
place to harbor Legionnaires' disease.

4. Reverse osmosis: Mechanical pressure is applied to an impure solution to force
water through a semi-permeable membrane. Reverse osmosis is theoretically the
thorough method of large scale water purification available, although perfect
permeable membranes are difficult to create. Unless membranes are well-maintai
algae and other life forms can colonize the membranes.

5. Ion exchange: Most common ion exchange systems use a zeolite resin bed to re
unwanted Ca^{2+} and Mg^{2+} ions with benign (soap friendly) Na^{+} or K^{+} ions. This
common water softener.

6. **Electrodeionization**: Water is passed between a positive electrode and a ne
electrode. Ion selective membranes allow the positive ions to separate from the
toward the negative electrode and the negative ions toward the positive electrode

purity deionized water results. The water is usually passed through a reverse osmosis unit first to remove non-ionic organic contaminants.

It is not possible to tell whether water is safe to drink just by looking at it. Simple procedures such as boiling or the use of a household charcoal filter are not sufficient for treating water from an unknown source. Even natural spring water—considered safe for all practical purposes—must now be tested before determining what kind of treatment is needed.

2.2.5 Water management and resources

Water management is a key link between balancing current and future water needs. With the ever-increasing pressure on human population, there has been severe stress on water resources. Therefore, the less water we withdraw, the les we upset the natural balance. The objective to water management is to make concrete efforts on the conservation and utilization of water on sustainable basis with a focus on

1. Development of clear vision and strategy for water conservation and its sustainable utilization at every level:
2. Promotion of suitable, cost effective and sustainable measures for conservation and utilization of water.
3. Minimization of water contamination.
4. Recycling of water

Sources of drinking water

1. **Deep groundwater**: The water emerging from some deep ground waters may have fallen as rain many decades or even hundreds of years ago. Soil and rock layers naturally filter the groundwater to a high degree of clarity before it is pumped to the treatment plant. Such water may emerge as springs, artesian springs, or may be extracted from boreholes or wells. Deep groundwater is generally of very high bacteriological quality (i.e., a low concentration of pathogenic bacteria such as *Campylobacter* or the pathogenic protozoa *Cryptosporidium* and *Giardia)* but may be rich in dissolved solids, especially carbonates and sulphates of calcium and magnesium. Depending on the strata through which the water has flowed, other ions may also be present including chloride, and bi-carbonate. There may be a requirement to reduce the iron or manganese content of this water to make it pleasant for drinking, cooking, and laundry use. Disinfection is also required. Where groundwater recharge is practiced, it is equivalent to lowland surface waters for treatment purposes.

2 **Shallow**

on the nature of the catchment. A variety of soluble materials may be present including potentially toxic metals such as zinc and copper. Arsenic contamination of groundwater is a serious problem in some areas, notably from shallow wells in Bangladesh and West Bengal in the Ganges Delta.

3. **Upland lakes and reservoirs**: Typically located in the headwaters of river systems, upland reservoirs are usually sited above any human habitation and may be surrounded by a protective zone to restrict the opportunities for contamination. Bacteria and pathogen levels are usually low, but some bacteria, protozoa or algae will be present. Where uplands are forested or peaty, humic acids can colour the water. Many upland sources have low pH which requires adjustment.
4. **Rivers, canals and low land reservoirs**: Low land surface waters will have a significant bacterial load and may also contain algae, suspended solids and a variety of dissolved constituents.
5. Atmospheric water generation is a new technology that can provide high quality drinking water by extracting water from the air by cooling the air and thus condensing water vapor.
6. Rainwater harvesting or fog collection which collect water from the atmosphere can be used especially in areas with significant dry seasons and in areas which experience fog even when there is little rain. Rain Water Harvesting is a way to capture the rain water when it rains, store that water above ground or charge the underground and use it later. This happens naturally in open rural areas. But in congested, over-paved metropolitan cities, we need to create methods to capture the rain water. It is a technique that has been used since antiquity.

2.2.6 Solid waste disposal and management

Since the beginning, humankind has been generating waste, be it the bones and other parts of animals they slaughter for their food or the wood they cut to make their carts. With the progress of civilization, the waste generated became of a more complex nature. At the end of the 19th century the industrial revolution saw the rise of the world of consumers. Not only did the air get more and more polluted but the earth itself became more polluted with the generation of non-biodegradable solid waste. The increase in population and urbanization was also largely responsible for the increase in solid waste. **Garbage or waste is classified in to four broad categories.**

- **Organic waste:** kitchen waste, vegetables, flowers, leaves, fruits.
- **Toxic waste:** old medicines, paints, chemicals, bulbs, spray cans, fertilizer and pesticide containers, batteries, shoe polish.
- **Recyclable:** paper, glass, metals, plastics.

Solid waste can be classified into different types depending on their source:

- Household waste is generally classified as municipal waste
- Industrial waste as hazardous waste
- Biomedical waste or hospital waste as infectious waste.

1. Municipal solid waste: Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is generated mainly from residential and commercial complexes. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste, in 1997 it was about 48 million tonnes. More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste. The existing landfills are neither well equipped nor well managed and are not lined properly to protect against contamination of soil and groundwater.

Over the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminium foils, plastics, and other such nonbiodegradable items that cause incalculable harm to the environment. In India, some municipal areas have banned the use of plastics and they seem to have achieved success. For example, today one will not see a single piece of plastic in the entire district of Ladakh where the local authorities imposed a ban on plastics in 1998. Other states should follow the example of this region and ban the use of items that cause harm to the environment. One positive note is that in many large cities, shops have begun packing items in reusable or biodegradable bags. Certain biodegradable items can also be composted and reused. In fact proper handling of the biodegradable waste will considerably lessen the burden of solid waste that each city has to tackle. There are different categories of waste generated, each take their own time to degenerate (Table 4).

2. Hazardous waste: Industrial and hospital waste is considered hazardous as they may contain toxic substances. Certain types of household waste are also hazardous. Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things e.g. gases. India generates around 7 million tonnes of hazardous wastes every year, most of which is concentrated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu. Household-waste that can be categorized as hazardous waste includes old batteries, shoe polish, paint tins, old medicines, and medicine bottles. Hospital waste contaminated by chemicals used in hospitals is considered hazardous. These chemicals include formaldehyde and phenols, which are used as disinfectants, and mercury, which is used in thermometers or equipment that measure blood

Table–4 Types of litter and the approximate time it takes to degenerate

Type of litter	Approximate time it takes to degenerate
Organic waste such as vegetable and fruit peels, leftover foodstuff, etc.	A week or two.
Paper	10–30 days
Cotton cloth	2–5 months
Wood	10–15 years
Woolen items	1 year
Tin, aluminium, and other metal items such as cans	100–500 years
Plastic bags	one million years?
Glass bottles	undetermined

pressure. Most hospitals in India do not have proper disposal facilities for these hazardous wastes. In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries. Direct exposure to chemical hazardous waste such as mercury and cyanide can be fatal.

3. Hospital waste: Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biologicals. It may include wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner. It has been roughly estimated that of the 4 kg of waste generated in a hospital at least 1 kg would be infected. Surveys carried out by various agencies show that the health care establishments in India are not giving due attention to their waste management. After the notification of the Bio-medical Waste (Handling and Management) Rules, 1998, these establishments are slowly streamlining the process of waste segregation, collection, treatment, and disposal. Many of the larger hospitals have either installed the treatment facilities or are in the process of doing so.

2.2.7 Effect of fertilizer and pesticide application in agriculture

Fertilizer provides nutrients— usually nitrogen, phosphorus, and potassium—to crops. In the proper quantity and proportion, these nutrients can help produce a healthy crop. If fertilizer is over-applied or the wrong combination of nutrients is added, plants may not fully absorb all the nutrients, resulting in excess chemicals. These [illegible] ground and surface [illegible] soil or filter

In 1984, the equivalent of over $16 billion was spent on pesticides worldwide. Over half of this money was spent on herbicides, and the U.S. contributed to nearly half the world's expenditures on herbicides-primarily on corn and soybeans. Herbicides were the major type of pesticide used in all countries except for some Central American and Asian countries where insecticides were predominantly applied. The U.S. spent one-third of all pesticide dollars, using more than three times as much pesticide as any other country. Japan and France ranked second and third, respectively.

2.2.8 Biological control of pest

Biological control is, generally, man's use of a specially chosen living organism to control a particular pest. This chosen organism might be a predator, parasite, or disease which will attack the harmful insect. It is a form of manipulating nature to increase a desired effect. A complete Biological Control program may range from choosing a pesticide which will be least harmful to beneficial insects, to raising and releasing one insect to have it attack another, almost like a "living insecticide".

2.2.8.3 The Three Main Approaches to Biological Control

Biological control uses naturally occurring predators, parasites and diseases to control pests. There are three main ways to use these natural enemies against unwanted insect pest populations.

Classical Biological Control (importation) involves traveling to the country or area from which a newly introduced pest originated and returning with some of the natural enemies that attacked it and kept it from being a pest there. New pests are constantly arriving accidentally or intentionally. Sometimes they survive. When they come, their enemies are left behind. If they become a pest, introducing some of their natural enemies can be an important way to reduce the amount of harm they can do.

Augmentation is a method of increasing the population of a natural enemy which attacks a pest. This can be done by mass producing a pest in a laboratory and releasing it into the field at the proper time. Another method of augmentation is breeding a better natural enemy which can attack or find its prey more effectively. Mass rearings can be released at special times when the pest is most susceptible and natural enemies are not yet present, or they can be released in such large numbers that few pests go untouched by their enemies. The augmentation method relies upon continual human management and does not provide a permanent solution unlike the importation or conservation approaches may.

Conservation of natural enemies is an important part in any biological control effort. This involves identifying any factors that limit the effectiveness of a particular natural enemy and changing them to help the beneficial species. Conservation of natural enemies involves either

reducing factors which interfere with the natural enemies or providing needed resources that help natural enemies.

Insects have devised many ways to eat other insects. Common bio-control agents include **parasitoids, predators, pathogens or weed feeders.**

Predators directly attack and devour their prey. For example, Ladybugs or Ladybird beetles, and in particular their larvae which are active between May and July, are voracious predators of aphids such as greenfly and blackfly, and will also consume mites, scale insects and small caterpillars. This predator can eat aphids equal to its own weight in a single day. Dragonflies are important predators of mosquitoes, both in the water, where the dragonfly nyads eat mosquito larvae, and in the air, where adult dragonflies capture and eat adult mosquitoes. Other useful garden predators include lacewings, Anthrocorid bugs, rove and ground beetles, aphid midge, centipedes, predatory mites, as well as megafauna such as frogs, toads, hedgehogs, slow-worms and birds. Cats and rat terriers kill field mice, rats, june bugs, and birds. Dogs chase away many types of pest animals. Dachshunds are bred specifically to fit inside tunnels underground to kill gophers and rabbits.

Parasitoids deposit an egg within another insect's body, from which a larva will emerge which will devour the host's innards. For example, a diverse range of wasps (Chalcid wasps parasitize eggs/larvae of greenfly, whitefly, cabbage caterpillars, scale insects and strawberry tortrix moth) lay their eggs on or in the body of an insect host, which is then used as a food for developing wasps. Parasitic wasps take much longer than predators to consume their victims, for if the larvae were to eat too fast they would run out of food before they became adults. Such parasites are very useful in the organic garden, for they are very efficient hunters, always at work searching for pest invaders. As adults they require high energy fuel as they fly from place to place, and feed upon nectar, pollen and sap, therefore planting plenty of flowering plants, particularly buckwheat, umbellifers and composites will encourage their presence.

Plants to regulate insect pests

Choosing a diverse range of plants for the garden can help to regulate pests in a variety of ways, including;

- Masking the crop plants from pests, depending on the proximity of the companion or intercrop.
- Producing olfactory inhibitors, odors that confuse and deter pests.

Acting as trap plants by providing an alluring food that entices pests away from crops.

- Serving as nursery plants, providing breeding grounds for beneficial insects.
- Providing an alternative habitat, usually in a form of a shelterbelt, hedgerow, or bee

bank where beneficial insects can live and reproduce. Nectar-rich plants that bloom for long periods are especially good, as many beneficials are nectivorous during the adult stage, but parasitic or predatory as larvae. A good example of this is the soldier beetle which is frequently found on flowers as an adult, but whose larvae eat aphids, caterpillars, grasshopper eggs, and other beetles.

A bacterial biological control which can be introduced in order to control butterfly caterpillars is *Bacillus thuringiensis*. This available in sachets of dried spores which are mixed with water and sprayed onto vulnerable plants such as brassicas and fruit trees. The bacterial disease will kill the caterpillars, but leave other insects unharmed. There are strains of *Bt* that are effective against other insect larvae. *Bt israelensis* is effective against mosquito larvae and some midges. A biological control being developed for use in the treatment of plant disease is the fungus *Trichoderma viride*. This has been used against Dutch Elm disease, and to treat the spread of fungal and bacterial growth on tree wounds. It may also have potential as a means of combating silver leaf disease.

2.2.8.1 Some Advantages of Biological Pest Control

Biological control methods can be used as part of an overall integrated pest management (IPM) program to reduce the legal, environmental, and public safety hazards of chemicals. In addition, it may be a more economical alternative to some insecticides. Some biological control measures can actually prevent economic damage to agricultural crops. Unlike most insecticides, biological controls are often very specific for a particular pest. Other helpful insects, animals, or people can go completely unaffected or disturbed by their use. There is less danger of impact on the environment and water quality.

2.2.8.2 Some Disadvantages of Biological Pest Control

Biological control takes more intensive management and planning. It can take more time, require more record keeping, more patience, and sometimes more education or training. Successful use of biological control requires a greater understanding of the biology of both the pest and its enemies. Many natural enemies are very susceptible to pesticides, and using them successfully in an IPM program takes great care. In some cases, biological control may be more costly than pesticides. Often, the results of using biological control are not as dramatic or quick as the results of pesticide use. Most natural enemies attack only specific types of insects - unlike broad-spectrum insecticides, which may kill a wide range of insects. Though often an advantage, this can also be a disadvantage.

POPULATION GROWTH AND EFFE... ...ATION

In nature, a variety of living organisms grow. They vary from unicellular life form... microbes to huge plants and animals. These organisms rarely grow as separated from... other. Invariably, organisms grow organized as populations, communities and ecosys... The properties of the population particularly that of human population are discussed ... following.

3.1 Basic concepts of demography

Demography means scientific study of changing number of births, deaths, dis... etc. in a population over a period of time. Population is generally a group of individuals ... particular species occupying particular area at a specific time. Two types of populations ... generally recognised. (a) Monospecific population: It is a population of individuals of ... species (b) mixed or polyspecific population. It is the population of individuals of more ... one species. However, ecologists refer polyspecific population as a community and the ... population is used for group of individuals of any kind of organism. To a generalist, popula... normally stands for human population.

The population of a species usually arises as a result of reproduction or may be due ... active transport of individuals or their passive transport by agencies like wind, water etc. ... these three means depends upon a variety of environmental factors and inherent ... characteristics of the species. The basic characteristics or concepts of the population ... depend on the following:

1) Population size and density
2) Dispersion
3) Age structure
4) Natality (Birth rate)
5) Mortality (death rate)
6) Migration
7) Life tables.

Of these, natality, mortality, migration and age structure are discussed below. Human population shows all the above trends in particular area and at a particular time.

Natality and mortality rates are related to birth and death rates respectively. Migration

rates are those related to movements of populations into country (emmigration) out of a country (emigration) or may be inside a country from one place to another (internal migration). Knowledge of all these are important to conclude on the population growth pattern.

When new individuals are born to add to the number of a particular species, it is then called natality. In human population it is equivalent to birth rate and is usually expressed as number of births per year per thousand persons in the population. It is quite distinct from population growth rate as it may be zero or positive but never negative. The maximum number of individuals that can be theoretically produced per individual under ideal environmental conditions is called potential or physiological natality. It is constant for a given population. The natality may be expressed as specific natality that refers to population increase under specific conditions. The natality rate of the population is expressed by B =Nn/t.

Where B = Birth or natality rate, Nn = Number of new borns and t = time. The specific natality over a period of time is b = Nn / NÄt Where b is the natality rate per unit time per individual in the population, Ät = Change in time or number of individuals.

Mortality denotes to the death of individuals over a period of time. In a population people may die due to various reasons such as malnutrition, disease old age. Mortality can be expressed as d= D/t Where d = mortality or death rate, D = Total number of deaths and t = time.

Migration is the movement of people to new abodes within the limits of the own country or across the border to another counts. International migration can affect the growth of population within a country, when population growth is calculated, the net immigration (which is negative if emigration is greater than immigration) is added to the population increased by births.

3.2 Population growth curves

A population has biological attributes unique to the group. Each individual has a life history which includes its birth, growth, differentiation and maintenance as an organism. The group attributes are natality, mortality, age ratio and genetic fitness. There are two basic patterns of population growth represented by 'J' and 'S' shaped growth curves.

3.2.1 J-shaped growth curve: This type of growth curve is seen among lower organisms like bacteria, fungi etc. As already discussed population growth can be determined by looking at the factors that tend to increase the number of individuals in that population, like birth and immigration and those factors that send to decrease the number like death and emigration.

For example, if a selected bacterium and all its descendants are allowed to grow and reproduce uninterruptedly, then the bacterial colony in a month would be larger than the

universe and it would be expanding outwards at the speed of the light. All popu
potential for explosive growth under optimal environmental conditions becaus
individuals can produce offspring.

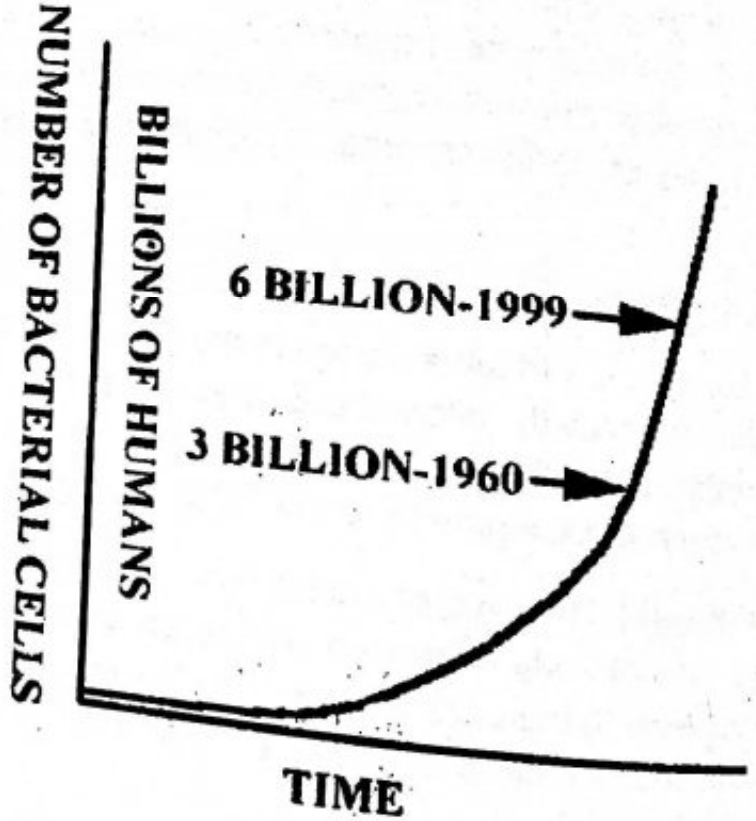
When births exceed the number of deaths, the population increases, for
population (N) has 1000 individuals, i.e. N = 1000, a birth (b) of 50 per year and de
of 15 per year, the annual rate of natural increase (r) in that population would be

$$r = b\text{-}d/N = 50\text{-}15/1000 = 0.035 = 3.5\%$$

The rate of natural increase does not show any change in the population size
immigration or emigration which may be assumed here to be equal. Populati
positive rate of natural increase grow large each year. The expected increase
calculated by multiplying the rate of natural increase (r) by the current population

$$I = rN$$

This formula shows that the population growth is exponential. If N is large, at
each year, I will be large. It indicates that population size increases by ever large
each year under favorable conditions. When graph is plotted for population size, t
curve will be 'J' shaped.



[J-shape

This type of exponential growth occurs only under conditions of unlimited resources. Except under laboratory set up, no population can be expected to find resources unlimited for growth.

When resources are unlimited and the environmental conditions are ideal, a species can produce offspring at the maximum rate. This is called the biotic potential. Bacterial colonies, insects etc. can produce large number of offspring within a short time under favourable environmental conditions. For example, it has been observed that a cholera bacillus produces 4700,000,000,000,000,000,000 new cholera bacilli within 24 hours whereas animals like elephants, tigers and humans very less number of individual over a long period of time. Hence, the cholera bacillus has greater biotic potential but larger animals have low biotic potential.

The exponential growth of human population that is being witnessed in certain countries including India, does not mean that the resources are unlimited. But due to remarkable advances made in medicine and technology the death rate has been reduced appreciably and there has been steady increase in the quality of life. All these have contributed to the population explosion.

3.2.2 S-shaped growth curve: When the resources are limited and finite particularly the food and space, a habitat can not support a population beyond certain size. If the population grows beyond that limit, resource limitation shows its adverse effects on the population by increasing the death rates and decreasing birth rates. This will lead to decline of the population density down to the limit set by available resources in the habitat. The maximum number of individuals of a population called the carrying capacity (K). When carrying capacity is achieved, N = K, the r value will be Zero. In other words; the birth rate equals the death rates and the population is assumed to maintain a steady state equilibrium.

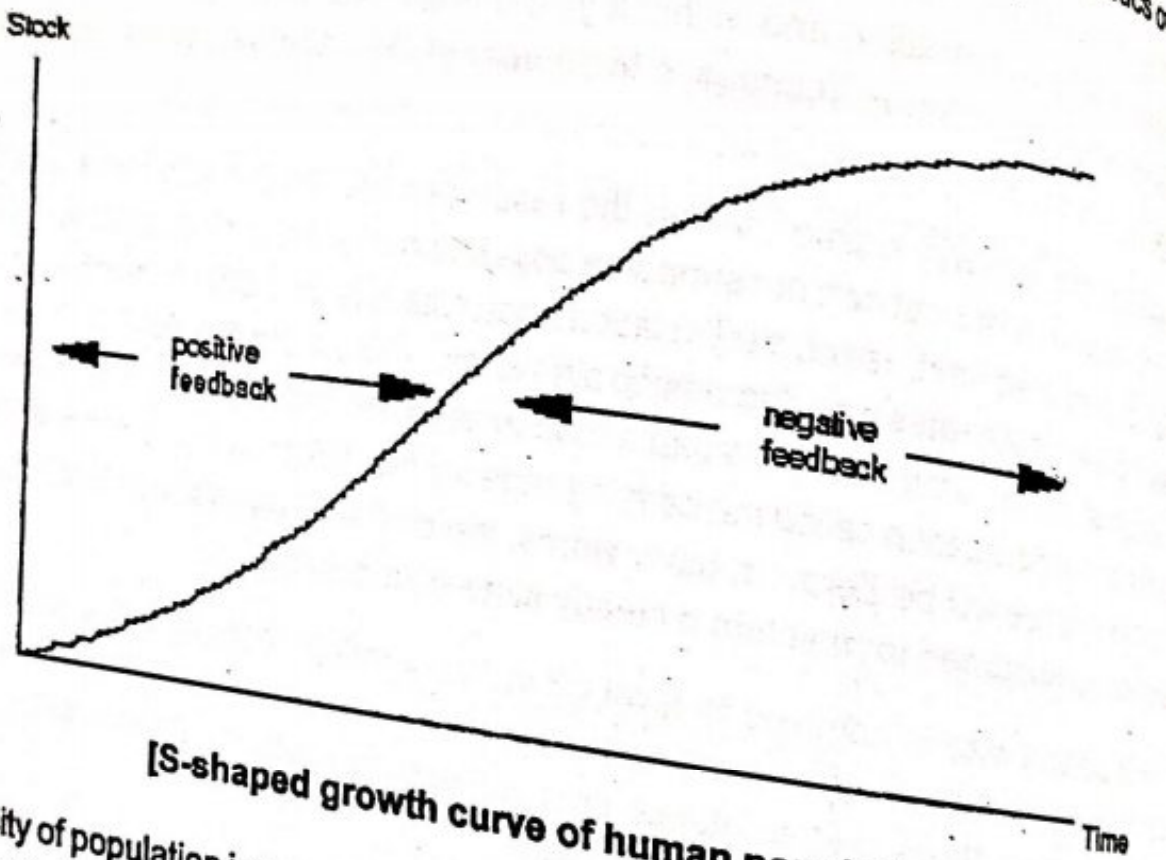
Population size is believed to level off at the carrying capacity of the individual. This shows that a particular environment can support a population of limited size. As population increases in size, there will be intense competitions for available space, food, energy etc. which in turn, will affect the population growth.

Let us assume a population with r value of 0.4 is expanding in a habitat with carrying capacity of 100. Here, the space, a vital resource for the population is 100 m^2. The initial population of 20 individuals has 5 m^2 individual space. After one year, the population size increases to 28 and now, the available space is 3.57 m^2 /individual. This resource gets progressively diminished with time, right from the beginning, affecting both birth rates and death rates. The effect can be shown as (K-N)/K.

The above equation shows the pattern of population growth under the conditions when resources are limited and when birth rates and death rates become density dependent. This

means that the birth rates decrease and death rates increase with increasing p
density. When population density is low i. e. N is small the value of (K-N)/K is close
the effect of population growth is negligible. When N increases and approaches the
capacity (K), the value of the fraction gets smaller and its effect in change of popula
is greater. When finally, the environment is saturated (N = K), the expression (K-N)
value of zero and which shows the population size does not change.

In this type of population growth pattern there is slow increase initially in the po
density followed by the steady exponential growth. After a period of time, the po
growth slows down due to increase in environmental resistance until a stabilization
reached and maintained. The environmental resistance includes predation, competi
resources, food shortage, disease, adverse climatic conditions and unsuitable habita
type of growth curve is called S-shaped or sigmoid curve and it is the characteristics o
populations.



[S-shaped growth curve of human population]

Density of population in a particular ecosystem is dependent on total resources availa
and per capita consumption. The quality of life is dependent on this and is expressed a

$$Q = \frac{\text{Total resources available X per capita consumption}}{\text{Population density}}$$

A habitat whatever big or small, it may be comprises of renewal
resources for maintaining dynamic equilibrium
The modern technology may help
of life.

3.3 Human population growth in developing and developed countries

Man appeared in the present form, i.e. Homo sapiens nearly 50,000 years ago some where in Africa. For a very long time, the total human population remained small. At the year, 1850, it had reached 1 billion mark and since then, grew very rapidly. By 1925, i.e. in 75 years it became 2 billion, then, in next 35, 15 and 10 years 1 billion each was added to the total population. The population of the world is now more than 6 billion. This shows that the human population is gradually stabilizing.

The population growth rates vary from nation to nation. Certain countries show very high population growth rates above 3 percent which means that the total population of that country will double in 23 years. On the other hand, some are not growing at all and a few even have declining populations.

If we will make a comparison of human population growth trends between developing and developed countries, certain disconcerting trends will come to the picture. Nearly 75 percent of the world's population is distributed in developing countries like Asia, Africa and Latin America, where the growth rate is 2.5 per cent. But the rest 25 per cent of the population who dwell in the developed countries have growth rate of only 1 per cent. There differences are important in terms of population added per year. Every year approximately more than 65 million people one being added to every year to the world population out of which nearly 54 million belong to developing countries and only 11 million in the developed countries.

The human population growth of the developed nations of Europe and America together with certain other affluent countries has a very slow growth over a very long period of time. This means that the birth rate and death rate during the time is roughly one. In those countries, again, as the death rates decreased due to better sanitation and health care in the late 17th and 18th century, the birth rates started to decline resulting in decrease of population. This type of decrease, first the death rates, resulting in birth rates, so that birth and death rates become roughly equal, results in very low or zero growth rates and is called demographic transition.

On the contrary in the developing and less developed countries that were colonies of European countries did not utilize benefits of the development. During the post second world era better sanitation and health care facilities although helped the most of the developing countries to reduce sharply the death rate, their birth rate did not decrease sufficiently. Thus, the population growth rate increased to above 2%, in some cases 3%, with doubling time of 24-35 years.

It has been also observed that the demographic transition in the developed countries proceeded simultaneously with other developments such as improved nutrition, health, education, communication, transport, higher income and industrialization. It raised the socio-

economic standards of these countries. Most of the developed countries took more
200 years under favorable circumstances to achieve demographic transition. Favora
denotes early industrialization when resources are plenty, market demands very high a
energy was readily available. The developing countries immediately after their freedo
could not get such environment to achieve the demographic transition to their convenien
Certain characteristics of developed and developing countries are given in the follow
table (Table –5).

Table–5 : Certain characteristics of developed and developing countries

Births per 1000 population (bpk), 1980 and 2001

	N	1980bpk	2001bpk
World	133	30.2	22.7
More Developed Countries (MDC)	34	15.1	11.9
Less Developed Countries (LDC)	99	36.1	25.9

Population age distribution (WHO Data)

	N	Pop 1990	Pop 2000	1990 Pop Age 60+	2000 Pop Age 60+	1990 Pop % age 60+	2000 Pop % age 60+
World	187	5,900,322	5,988,845	528,224	597,221	8.9%	10%
MDC	45	1,175,908	1,180,425	207,843	229,182	17.7%	19.4%
LDC	142	4,724,414	4,808,420	320,380	368,040	6.7%	7.7%

Data source: http://www.who.int/whr/2001/annex/en/
Data source: U.S. Census Bureau, International Data Base

3.4 Age structure: Populations are not only characterized by their size and growth rates but by their age structure and sex composition, by their birth, death and fertility by their distribution within the country and migration within and across the boundaries.

At each interval of time, new members are added to the population and previous members die completing their life cycles. Natural populations are a complex of individuals representing all age groups. It is, therefore, necessary to consider age distribution of populations while analyzing its composition.

The population may be divided into three age groups considering their reproductive potential: Pre-reproductive, reproductive and post-reproductive. The first group consists children and those in pre-pubertal phase and the last group includes the seniors. The reproductive capacity of a population depends on the size of the first group. Usually a fa growing population, has a large number of young individuals. A stationary population contai

a more even distribution of age groups and a declining population will have a larger population of old population who are in their post-reproductive stages.

The proportion of the young (between the age group of 0-14 years) to the rest of the population is also important. In the developing countries where many children are born and their proportion may be nearly 45 per cent of the total population of some countries. Such populations are termed as young populations. Besides, their high age dependency ratio, these populations must cope with excessive demands for health care, education and nutritious food, when they grow up, there will be severe competition for the jobs. The developed countries, on the other hand, have more number of people in the age group above 65 years. They also need more attention for healthcare but their job requirement is nothing.

The reproductive age group, i.e. 15-44 for the females is an important factor in the population growth. The habit of this age group influences greatly the population density of that particular country.

3.5 Population growth in India

India is the second most populous country in the world, next to China. One in every 6 persons on this planet lives in India. It occupies 2.4 per cent of the land mass of the entire world but 16 per cent of the world population live here. India is a land of physical, ecological, social, cultural and linguistic diversity. There are more than 18 major languages and 1652 dialects providing a varied spectrum of cultural and socio-economic diversity.

India's population density 319 persons per square km against 477 in Netherlands, 338 in Belgium and 335 in Japan. Within India, the disparities in population density are worth mentioning. An overwhelming part of the India's land mass has a population density of less than 250 persons per sq. km. These regions are: Jammu and Kashmir, Uttaranchal, Rajasthan, Madhya Pradesh, Andhra Pradesh, Parts of Karnataka, Gujurat the North-eastern states and in land of Orissa. Most parts of Pubjab, Western Maharastra, Coastal Orissa, Assam, Tamil Nadu and Eastern Gujurat have a population density ranging between 250 to 1000 persons per sq. km. The parts of the Indo-Gangetic plain have a density of over 1000 per sq. km. These data suggest that a population density of 250-500 persons per sq. km. Within which average figures for the country lies.

Growing population is a great challenge to India. As per the 2001 census, the population of India is more than 102 crores. It is growing at the rate of 2.11 per cent every year. Every year more than 17 million more heads are added to the Indian population. In every minute, more than 52 births occur here which shows that only in 8 months, it can reach to the population of Australia. At that rate a population of Singapore is added in 5 weeks and a Chandigarh is added every day. India's population officially crossed the mark of one billion at 12.56 pm IST) on May 11, 2000. The name of the baby was Aastha born at Safdarjung Hospital, New Delhi. The following table shows that the population growth pattern in India is exponential.

The following table (Table 6) shows that the increasing population of India puts considerable pressure on its natural resources and reduces the gains of the development. It is not that population control will automatically lead to development but development leads to a decrease in population growth rates.

Table – 6 : Population of India (1901-2001)

Census Year	Total population (Crores) aprox.	Annual exponential growth (%)
1901	24	—
1911	25	0.56
1921	25	(-) 0.03
1931	28	1.04
1941	32	1.33
1951	36	1.25
1961	44	1.96
1971	55	2.20
1981	68	2.25
1991	85	2.5
2001	102	2.5

India has often been described a rich land with poor people. A vast majorty of people are directly dependent on the natural resources of the country for their basic needs of food fuel, shelter and fodder. About 40 per cent of India's people still live below the poverty line Environmental degradatio9n has adversely affected the poor who depend upon the resources of their immediate surroundings. It is now widely recognised that population growth is a function of poverty.

It clearly shows that developing countries like India although got benefited from better health care and sanitation after the second world war and decreased the net death rates yet population explosion has posed a real challenge to them. The global concern for zero population growth rates is little or no relevance for many here.

3.6 Urbanization and its impact on the society

Urbanization means a process by which large number of people became permanent inhabitants of small areas which may be called as the

Nations recommendations, all the places with more than 20,000 people living close together may be called as urban. However, the countries compile their statistics on the basis of many different standards. For example, in United States, an urban centre is a place where more than 2500 people live. In India, urban areas include – (a) All areas which have minimum population is more than 5000 (b) All such places where atleast 75% male working population is engaged in occupations other than agriculture. (c) All places which have population density of more than 1000 persons per square km. (d) All municipalities, Corporations, Cantonments and notified town areas.

Urbanisation concept came into being in the post-industrial revolution era. Large number of people lived in particular area for a specific industrial work. Hence, the combination of technological and demographic developments leads to a momentous increase in the process of urbanization.

Today, certain cities support populations equal to what the total earth supported few hundred years back. For example, at the time of Christ, the world's population was about 250 million. Today, most of the cities have populations more than that. By 1650 AD, this population doubled to 500 million and it reached the billion mark by 1850. Populations of 2 billion and 4 billion were recorded in 1930 and 1975 respectively. By 2010 AD, the population on this earth is expected to double again and reach 8 billion. Urban centers have attracted a major portion of this population. In 1800 AD, only 2.4% of the world's population resided in places of 20,000 or more and only 1.7% in places of 1,00,000 or more. By 1960, 27.1% of world's population were living in places of 20,000 or more and 19.9% of people in places of 1 lakh or more. By 2000 AD, about 42% of the earths population were living in urban centers having population of 20,000 more and 25% in urban centers with population more than 1 lakh or more.

Growth in urban population is generally due to (a) Natural increase in the urban population (b) migration of people to the urban centers (c) Administrative enlargement of the urban local governments.

The rise in the number of urban centers has resulted in environmental degradation in a number of ways. These may be (1) Encroachment of agricultural and productive land mass for housing industries, roads and dams (2) depletion of the water resources due to increased demand on water (3) Pollution from industrial and other urban activity (4) emergence of slums, which have adverse effects on the adjacent areas. These points are elaborated in the following:

1. **Encroachments:** As towns and urban centres grow there were invasion of productive crop lands and rich forest. Hence, the land with all its biological resources get converted into dwelling places and are perennially lost. India had more than 42% of its total land mass as

the dense forests during the time of independence. But recent survey, shows that nearly 22 percent of its total land mass has only forests. It resulted in the loss of invaluable wildlife and other biotic resources which have maintained the ecological balance. The mushrooming concrete fungi have really adverse impact on the environment of the area.

2) **Loss of Water resources** - People living in large numbers in urban centers need enormous amount of water for their daily. Also, industries located in those areas need enough water for various purposes. But what can be the source of water in the urban centers. Either the river water or the underground water can be the source of water. Both the forms of available water sources have certain limitation. Since the Indian subcontinent experiences monsoon climate there is certain limitation for the amount of river water. Again, encroachments, siltations etc. reduce the area of river. Similarly, underground water table goes on declining as demand for it increases. Every body knowns cities like Chennai always run short of water for its urban population.

Loss of or depletion of water resources has deep impact on the flora and fauna of that particular urban centre and the adjoining areas. Many valuable plants and the animals subsisting on it are vanishing because of it.

3) **Building materials** - Construction of houses and other structures need huge of amount of building materials. These are either produced at that place or transported from some other place. These cause enormous amount of pollution since in the process of production and transportation a lot of hazardous pollutants are emitted. Again, for construction of those structures which produce, building material, good amount of space is needed. Many fertile land mass is getting lost because of this.

4) **Industries** – Industrial development goes hand in hand with urbanization. Metropolitan towns like Kolkata, Mumbai and Chennai are glaring examples. Nearly 60% of the industries in Maharashtra are located in Mumbai. As mentioned earlier, industries depend upon water resources hazily. Water requirement per tonne of produce in a crude oil refinsy is between 1-3m^3, it is 5-8 m^3 for dairy, 20-40 m^3 for textiles, 100-200 m^3 for steel and 200-400 m^3 for pulp and paper.

5) **Development of slums** – Slums represent one of the worst types of environmental degradation which develop simultaneously with development of urban centers. More than 19% of the India's urban population live in slums. It has been estimated that slum dwellers comprise 10% of the urban population in small and medium towns while more than 20% in cities with population is between a lakh and million and 31% for the mega cities. The slum dwellers live in an environment of inadequate living space, water supply, sanitation, sewerage facilities etc. This causes deterioration of the surrounding environment and human health.

6) **Water pollution** – The need of water in the urban areas causes water pollution. Huge amount of waste (solid or liquid) generated from the urban centers are dumped into the water bodies nearby. Since these can not be decomposed properly and some are non-biodegradable, water pollution is rampant in urban areas. Again sewage system of most of the urban centers in India is not full proof. Hence, that seeps into the ground water which is another major source in urban areas causing pollution.

7) **Air Pollution:** Industries, vehicular traffic are the two major causes of air pollution in towns and cities of the world. It results from the emissions of sulfur dioxide oxides of nitrogen, hydrogen sulfide and suspended particles like fly ash etc. All these cause considerable damage to the plants, animals and humans dwelling in that environment.

Impact of urbanization on the social and family structure:

Urbanization is the result of socio-economic process. Hence, it has a special kind of social system which has certain positive aspects and many negative sides also. Urban areas may have very good facilities like health care, transport, communication etc. But in the same area, very poor people live in unhealthy, unhygienic, filthy conditions. There are lots of sky scrapers in the urban areas with all modern amenities in it. Again, the poor live here in slums. Some of the social impacts of urbanization are detailed below.

1) **Rich and poor divide** :- As a large number people are reside in a specific O area, demands for resource increase manifold. Demand becomes more for houses, electricity, water, healthcare, education, recreation and entertainment. Everyone does not get all the facility equally and hence, there occurs a divide between the privileged and unprivileged. Privileged people get access to all the above facilities at their sweet will but the unprivileged struggle to get the same.

2) **Living space and nuclear family** : As urbanization increases and the population of the urban centres grow the per capital available space decreases. Hence, the traditional joint families break up and that leads to the nuclear families comprising the couple and their children. Each individual struggles for his well being and independent living. The aged parents and other dependents of the family are ignored which goes against the letter and spirit of our societal system.

3) **Occupational mobility**: When people live in urban centers, they are transferred from one centre to another at specific internals. Again, many people do not afford to live at their work places located at the urban centre because many economic and social reasons. They live in suburban centers and move long distances every day to reach their work places. Also, a category people move long distances for the sake of their business. Under these circumstances, the family life changes and every body try to adjust to this new kind of developments.

4) **Cultural and entertainment avenues**: Urbanization provides new entertain avenues of different types in Cinema houses, video parlors, exhibition gallery. At these places, people with variety of culture and traditions sit together and accommodate themselves to this neo-culture. It leads to the cultural hybridization in a country of much diversity like India.

3.7 Population control methods

Population growth is a natural phenomenon of our societal system. But the population explosion that has been experienced in our country after 1921 is very disturbing. Hence, programs are being implemented to bring the population growth to its replenishment level, i.e. 2%. The following measures are being implemented to bring about population control in India.

1) **Education** :- This measure is first and foremost in managing population growth, Kerala tops the list of literate states as almost every one of the state is literate. Here, the birth rate and death rate are the lowest. According 1992-93 economic survey, the infant mortality rate in the state is 17 per thousand, birth rate 18.1 and death rate 6 compared to the national average of 80, 29.3 and 9.8 respectively.

Therefore, the education will help the people who are in the reproductive age group to limit the size of their family. Print media, educational institutions and voluntary organizations can play a great role in achieving the target.

2) Age of the marriage :- It is a very important factor in population control. As per the Indian traditions, daughters are given marriage at an early stage before they are physically and mentally nature of have a child. Hence the marriage age in India for a girl is fixed at 18 and for a boy at 21. Any matrimony before that age is an offence in the eyes of law. Still many states of the Indian union the prescribed norm is flouted. But in certain sections of the society, marriageable age has been increased and population control has been achieved.

3) **Family Planning** :- This measure helps people limit their family size and

properly space the birth of the children. The program includes the knowledge of birth control measures information on sterilization. The common method of birth control are:

i) Sterilization of males and females as per their convenience and consent.

ii) Use of oral contraceptives.

iii) Use of intrauterine contraceptive devices for females.

iv) Use of prevention of fertilization devices by males like condoms. These birth control methods are detailed below :

1. **Mechanical Methods** : Condoms, cervical caps, diaphragms and intrauterine devices (IUCD) are all mechanical birth control devices. Condoms are rubber or plastic sheaths which are used by males. These are most common and easily availability or even supplied free of cost. Cervical caps are rubber or plastic nipples. Diaphragms are considered to be the female counterparts for condoms. Intrauterine devices are small, plastic objects that are placed in the uterus. They are made of variety of shapes which may be looks, coils, spirals, rings etc. Copper 'T' is placed in the uterus to prevent fertilization.

2. **Surgical methods** :- Sterilization and abortion are two surgical methods for birth control. (1) Male sterilization. The accepted method of sterilization of males is called Vasectomy. It is done surgically in the male reproductive organs (2) Female sterilization. This involves tying and cutting Fallopian tubes. It is called tubectomy (3) Abortion: It is now an accepted method of limit the size the family. It is technically called Medical Termination of Pregnancy (MTP).

3. **Chemical methods** :- Spermicides, birth control pills etc. constitute the chemical methods of birth control. Many agents can kill sperms, but those used must be mild, so they can not harm the user or the organ. Common spermicides are lactic acid, citric acid, boric acid, Potassium permanganate and Zinc sulfate. Most spermicides are mixed with foams and jellies.

4. **Natural methods** :- It depends on the natural rhythms of the Woman's body, rather than chemical, surgical and mechanical methods. Here, the females should have the knowledge of her ovulation period and then she can abstain from sex. It is also known that women do not conceive as long as lactation occurs and they practice breast feeding.

3.8 Communicable diseases:

To an environmentalist, health means harmonious equilibrium between man and his environment and disease is maladjustment of the human organism to the environment. Disease may be defined as any variation from the normal, which may be sufficiently permanent enough to cause physiological changes or morphological abnormalities resulting in premature death of a part or entire individual.

There are mainly two forms of diseases. 1) Non-communicable, (2) Communicable.

1) **Non-Communicable diseases** :- Here no disease causing organism is involved and the disease can not spread from one person to another merely by contact or any other method. These are called non-transmissible non-infectious diseases; e.g., Diabetes, Color blindness, Sun stroke.

2) **Communicable diseases** :- These are caused by biological agents. Whenever such an organism reaches a new healthy person, he suffers from the disease. The disease

causing organism is called pathogen and its transmission from one person to another is called infection. Ex.- Cholera, Plague, Typhoid, Conjunctivitis etc. Various kinds of plants and animal may function as the pathogens. Viruses, bacteria, protozoa, moulds, worms, mites etc. are established pathogens. These are also called transmissible, infectious diseases.

3.9 Transmission of Communicable diseases (Water born, air borne, food borne, Vector borne):

Communicable diseases are transmitted from the source of infection/reservoir to a susceptible host. The source of infection of the disease may be the human being, animal, object or substance from which an infection agent is transmitted to the host.

Reservoir may be any person, animal, plant, soil or substance or a combination of the above in which the infection agent may live actively or inertly until it reaches the target host. Sometimes, a part of the life cycle is completed in the reservoirs.

There are three types of reservoirs (a) Human, (b) Animal or plants (c) Nonliving things. A carrier is an infected person or animal that harbors specific communicable disease causing agents without showing clinical symptoms.

The transmission of Communicable disease occur in a number of ways. The routes of transmission may be.

Routes of Transmission

Direct transmission	**Indirect transmission**
Direct contact	Vehicle borns
Droplet infection	Water borne
	Vector borne
Contact with soil	Air borne
Bite of an animal	Fomite borne
Transplacentral	Unclean hands and fingers.

Direct transmission :

1. **Direct contact :-** This refers to transfer of infections agents from reservoir/source to a new host without intervention of an intermediate agency. This occurs during physical contacts like touching, kissing, sexual activities etc. All sexually transmitted diseases (STD), Acquired Immunodeficiency syndrome (AIDS), skin and eye disease come under these categories.

2. **Droplet infection :-** Droplets from saliva and nasal secretions come out during sneezing coughing, spitting, singing or talking. These droplets may cause disease in new hearts. Common cold, diphtheria, whooping cough and tuberculosis are transmitted by this method.

3. **Contact with soil :-** Disease agents present in the soil can infect new hosts. Hookworm larvae, tetanus, fungal diseases are examples.

4. **Bite or an animal :-** Bite of mad dogs causes the rabies disease. This is a viral diseases being carried by the dogs, cats etc.

5. **Transplacentral Disease :-** Agents can be transmitted from the mother to the child when it is still in the placenta. Syphilis, AIDS, Hepatitis, herpes can be transmitted in this manner.

Communicable diseases :- This is the method of indirect transmission of the diseases. The infections agent here is capable of surviving outside the primary host body. Traditional 5 F's are important in this method of transmission. They are flies, fingers, fomite, food and fluid. Besides, communicable diseases are transmitted in vehicles Vectors etc. Some of the agencies through which the communicable diseases are transmitted are given below:

Water borne :- Here, the disease is transmitted through the agency of water and food. These diseases are most common and frequent in a country like India. The reason is water is used by every one and the water is by it property is not stationary.

Poor sanitation and overcrowding favor the spread of water borne diseases. Outbreaks are mostly initiated by faecal contamination of water and food. The disease can be controlled by maintaining personal hygiene like washing hands before eating use of toilets, sanitary disposal of Sewage, drinking bpiled water and adequate chlorination of water.

Cholera is dangerous water borne disease caused by the bacterium *Vibrio cholerae*. Due to the disease, there occurs sudden diarrhea like loose motion, vomiting, dehydration, muscular cramps and urine suppression.

Typhoid is another important water borne disease whose natural reservoir is the human beings. It is caused due to the *Staphylococcus typhi* bacterium. The disease is due to improper faecal disposal. Provision for safe drinking water and sanitary disposal of excretion can help in managing the disease.

Beside many hazardous chemicals are transmitted though water in soluble form. Those may be minerals, metals, cyanides, pesticides, organic acids etc. which when taken along with drinking water cause various types of ailments or food poisoning.

Air borne diseases :- Diseases like chicken pox, tuberculosis, influenza, measles, pneumonia, asthma are mainly transmitted in the air. The disease causing pathogen can travel long distances in the air current retaining its vigor. When it comes in contact of the healthy host, the disease is caused. Now a days, the occurrence of heavy amount of dust particles in the air due to pollution help in the transmission of pathogenic organisms. Air pollution extent is particularly very high in the industrial areas and in the towns where there is sudden increase of vehicular traffic.

Food borne diseases :- Diphtheria, tuberculosis, internal diseases like typhoid, dysentery, hepatitis, leptoserosis and botulism are some of the communicable disease under this category. *Salmonella* increase in numbers after contamination of the food that affects the gastrointestinal tract. Such food borne diseases are called food poisoning. Also food poisoning is caused due to *Staphylococci* and *Clostridium.* Under aerobic condition, *C. botulinum* produces a fatal toxin and the disease is called botulism. Sometimes diseased animals when taken as food may cause infections particulars when the food stuff is improperly cooked ex- tape worm, bird flue.

Vector borne diseases :- Vectors are defined as the living carriers which can transmit the disease to a new host. Flies, mosquitoes, fleas, cockroaches, sucking lice, bugs, ticks, mites, mice rodents, chickens, bats may act as the vectors for various communicable diseases.

The vectors transmit the diseases by biting inoculation, regurgitation and contamination. Arthropod borne infections cause diseases like yellow fever (mosquito borne), Dengue (mosquito vector), Japanese encephalitis (mosquito-vector) malarial fever (mosquito vector) sand fly fever (sand fly vector). Japanese encephalitis virus affects several extra human hosts. Pigs are known to be the major vertebrate host for the disease. The pigs do not exhibit any external symptoms but harbor the virus which can come to the mosquitoes during their biting to the pigs and then get transmitted to the human hosts.

The vectors may cause transmission of diseases mechanically or may serve as the alternate host. When the disease causing pathogen is only carried through the vectors and no event of their life cycle is completed in the vector it is then called mechanical transmission. Many viral diseases are transmitted mechanically. However, in certain vector a definite part of the pathogens life cycle is completed. After that stage only, the pathogens can be effective in causing disease to the human being. Example – Malaria fever disease.

UNIT – IV

ENVIRONMENT AND SOCIETY

Earth and every living organism has specific surrounding or medium with which it continuously interacts and to which it is completed adapted. This surrounding is the natural environment Natural environment gives to our mind the scenario of landscape such as soil, water, desert or mountains. This can be further described in terms of physical influences such as differences in moisture, temperature, texture of the soil and biological influences. The environment is the sum total of living and nonliving components, influences and events surrounding the organism.

No organism can live along without interacting with other organisms as a necessary part of the environment. Among all living organisms human beings alone have the capacity to change their environment. He lives in a physical environment, to which he learns to adapt himself. The cultural environment influences the man and determines his actions to a great extent. Political, economic and religious institutions which are a part of culture, put constraints on the use of natural resources and the way in which they are exploited.

All over the world, the human beings have grouped themselves together to carryout their activities collectively. These groups of people have a definite organization. Their activities are cented around a set of common goals and they share common beliefs attitudes and mode of action. Such groups are called societies. Every society has its own cultural environment and individuals in a society are guided by cultures they live in. Thus, society and culture from the social environment of the man. In this unit, the effects of various institutions and activities of society upon the environment has been described.

4.1 Environmental economics :

A human being, from his birth till death, completely depends on the materials and energy drawn from the environment. It may be made available to him from the earths crust and its surface, atmosphere and water, when the materials extracted from the environment are not in desired usable forms, they are subjected to a processing which may be called as the technology. By application of energy and use of technology they are converted to useful products and services. It is really the case in every activity we perform, be it industry, agriculture, transport service or domestic uses. Hence, economic activities are carried out from exploitation of environment. Application of technology does not utilize the entire material inputs into the finished goods. Some amount of undesirable products or wastes is by products in the process. The proportion of desired product and the unwanted waste depends upon the quality of the materials.

The development of civilization has witnessed manifold increase in our needs and per capita extraction of materials. For example, in India, the industrial production has gone up by more than seven times and extraction of minerals has gone up by only 3 times. Every extraction and every discharge alters the environment. It means that the use technology which may be called an economic activity has, caused damage to the quality of the environment. In recent years the intensity of the disturbances and damages is constantly increasing thereby damaging the quality of the environment.

For thermal power, coal is being utilized as the material in thermal power stations. Here, fly ash is the waste product. Coal is extracted from the mines which are located in Bihar, Jharkhand or Orissa i.e. mostly from the eastern part of India. But thermal power generated may be some where in Delhi. This means that the coal is utilized at a place which is far of from its extraction site and fly-ash is generated there is huge quantities. It shows that the pollution is created at the place of its extraction due to production of dust and other types of particulate maters. It may even be the cause of the song here again, at the point of power generation fly ash is generated which is major cause of solid waste pollution.

Excessive waste generated is not a good indicator. It represents economic loss and therefore, associated with it is a hidden cost. Hence, environment economics aims to understand the extent of damage or likely to be caused to environment due to improper and unplanned exploitation of the environment.

5.2 Environmental ethics :

Some of the traditional superstitions still survive in the remote areas of our country which still covered with dense forests.

One such tradition is the worship of the spirits residing in the sal trees and the resultant ban on cutting of the tree until it reaches certain stage of life.

Another such tradition is the ban on the falling of any fruit bearing tree. Among the tribals, the cutting of a fruit bearing tree is a crime. These and other traditions prevented the wanton destruction of flora and fauna of the region. It was also ensured that destruction of vegetation for slash and burn plantation as well as killing of animals by hunting was kept to bare minimum. However, these practices did not come in the way of the livelihood of the tribals who collected ivory, wax, timber, hide, horn, honey, firewood and many other such forest products.

To give religions sanctity, fables were created about the goddesses of the forests or Banadevis. It was, during the time, believed that the Goddesses will be angry if kings can not protect the forests. Apart from encouraging vegetarian food habits, many religions propounded it is sacred to respect any life form.

Seeing the present day effect of the belief in holy rivers which encourages the people to dump the dead bodies to rivers, it is hardly possible to visualize that these beliefs at sometime helped the pollution of rivers for centuries together. In this respect it is important to note that nowhere in the *vedic* literature, it has been stated that dead bodies be burnt or should be thrown to the rivers. On the other hand, it is stated in few places, that one should not allow any solid waste to be thrown into the rivers.

Holy baths in the rivers were parts of many ancient traditions. The ritual holy bath after cremation required cremation grounds should be close to the river banks. Gradually, original *vedic* traditions of India got diluted and distorted beyond repair. Hence, the ethics that prevented cutting trees, protection of forests and maintaining the sanctity of the rivers were breached which resulted in accumulation of unwanted materials and obnoxious by products in hazardous proportions.

In order to sustain economic development of the nations, the ethics strongly projects to preserve the natural resources, both biological and physical. Conservation is the catch word which denotes planned management of man's surroundings to prevent its exploitation, destruction and neglect. Man's impact on nature started becoming evident when the prehistoric man perfected the art of hunting. With development of farming and animal husbandry, the man began to control the environment. He exploited the natural resources of earth to keep face with his increasing needs. Thus, there was rapid decline in the quality and quantity of the natural resources and increase of concern for their management and conservation. Conservation is a broad concept which involves not only scientific but ethical, moral, economic and political aspects as well. A generalized definition of conservation is maximization over time of the net social benefits in goods and services from the resources. Conservation may be the achievement of the highest sustainable quality of living for mankind by rational utilization of the environment protection of nature to enrich life of the man and the control or elimination of environmental pollution in its many manifestations. Conservation ethics advocates the practice that will perpetuate the resources of earth on which the man depends or in whose continued existence he takes interest.

4.3 Sustainable Earth Society:

The resources available to us from the planet earth are limited. Hence its capacity to support different forms of life is also limited. Population explosion, ozone layer depletion, global warming, generation of various types of wastes etc. are again posing more problems for our sustenance. All these problems have reached dangerous proportions because of our greed to extract more and more from our environment. But time has come to have a good understanding of the problem so that exploitation of the environment should be under manageable limits. The life is possible on this planet due to certain vital features. Hence,

those vital features are to be sustained so that the delicate balance between the life and the environment can be maintained.

World commission on Environment and Development has defined sustainable development as a process of change in which the exploitation of resources, the direction of investments, the orientation of technological developments and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. This concept provides a frame work for integration of environmental policies and development strategies having implicating at the international, national, regional and local level. The motto of sustainable development is that technological advancement should not endanger natural systems that support life on earth.

The sustainable earth society should stress on (1) Conservation or reduction of excessive resource use (2) recycling and reuse of materials (3) more use of renewable resources life solar energy rather than non-renewable resources such as petroleum and coal.

4.4 Environmental degradation and Women:

Women from the half of the population of the world. The concept of sustainable earth society can be made possible only when we can make our womenfolk conscious of the challenges due to environmental degradation. Primarily, Women in our rural areas are concerned with cooking and preparing food for the entire family. In most of our villages, there is no access for modern methods of cooking. Hence, the womenfolk depend entirely on the plants for firewood and presently, it is the major cause of destruction of the forests. Hence, Women should be apprised of the sustainable use of firewood and the young and growing plants may be spared during the collection of the firewood.

Women from the nucleus of our family system. Hence, there must be maximum stress for women education and role of women in environmental degradation. As discussed elsewhere, it should be remembered that the root cause of the environmental problems is the population explosion. Here, the women have the unique role in deciding the structure of the family.

Women have performed individually or in groups in saving the environmental degradation. Individuals like Medha Palkan or Arundhati Roy can be cited here as example and their role in Normada Bachao movement to save the human population from being completely wiped out.

The voluntary organizations started under the scheme of welfare extension projects to provide basic minimum service to women in craft centers, health centers and maternity centre which are particularly located in rural areas.

Under the leadership of the social activist, Sunderlal Bahuguna, the Mahila Mangal deals were formed in the Chamoli district of individual Uttar Pradesh. This movement was basically a people's movement with Women playing a deciding role where cutting of trees was resisted. The women here embraced the trees and asked the cutters to cut them first before doing the same to the trees. It had great impact on saving the degradatio0n of the environment of the area.

Maneka Gandhi (born 26 August 1956) is an Indian politician, an ardent animal rights activist, and a former journalist. She has been a Minister in four governments, and has authored a number of books in the areas of etymology, law and animal welfare. Maneka Gandhi is an estranged member of the Nehru-Gandhi Family. Gandhi is an environmentalist who brought to the mainstream the issue of animal rights in India. She was appointed chairwoman of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) in 1995. Under her direction, unannounced inspections of laboratories where animals are used for scientific research were conducted, and abominable conditions and cruelty were documented and exposed. The CPCSEA imposed restrictions that brought some of the abuse to a stop. She started the organization People for Animals in 1992 and it is the largest organization for animal rights/welfare in India. She is a vegan and has advocated a vegetarian lifestyle on ethical and health grounds. She also anchored a weekly Television program named *"Heads and Tails"* highlighting sufferings meted out to animals due to their commercial exploitation. She has also authored a book under the same title. Her other books were about Indian people names.

In many parts of the country, the Women Organizations have taken active role in sensitizing the people on the vices of alcoholism and drug addition. Keeping all these facts in view, the Government is providing all types of facilities for the empowerment of the women.

4.5 Role of NGOs and International agencies in Environmental Protection :

Non-Governmental Organizations (NGOs) or Voluntary Organizations can play a very important role on environmental protection. These agencies are tree from Government control and they can take their own decisions and can undertake activities at the appropriate time. They can have direct contact with the masses. These NGOs are spread all over the country, even in small villages, As these are close to the masses, they can communicate with the people in their own language. Also, the messages of the NGOs can be complementary to the local customs, traditions folk ants etc.

NGOs have played a great role in our country creating mass awareness towards the environmental protection. They have made people to be conceious of environmental problems which have been caused due to our neglect and uncontrolled exploitation of the natural resources.

NGOs have initiated many movements for environmental protection. 'Chipko' movement, Silent valley project', March Western Ghats movement etc. are a few examples of it. At present, a large number of non-Governmental agencies are active in the country in different areas of environment protection are Kerala Sastra Sahitya Parisad, Trichen, Daasoli Gram Swarajya Mandal, U.P., Gandhamardan Yuba Parisad and Gandhamardan Bachao Andolan Orissa, Orissa Krishak Samaj etc.

As described earlier, environment is not just pretty trees, threatened plants animals and ecosystem. It is literally the entity on which we all subsist and on which the entire agricultural and industrial development depends. Development without concern for the environment can only be short term one.

On a world scale, the global efforts to tackle environmental problems, UN conference on Human Environment at Stockholm (Sweden) in 1972 was pioneering one. Certain other international agencies and the roles played by these agencies are given below.

(1) Vienna convention for the protection of ozone layer was held on March, 1985. Under this framework the Montreal protocol on the substances that deplete the ozone layer was adopted in 1987.

(2) Born convention was held on 1979 on the conservation of migratory species of wild animals.

(3) Multilateral international institutions as World Bank, FAO, UNDP, UNIDO and EEC are providing financial and technical support for the protection of the environment.

The **United Nations Industrial Development Organization (UNIDO)**, French/Spanish acronym **ONUDI**, is a specialized agency in the United Nations system, headquartered in Vienna, Austria. The Organization's primary objective is the promotion and acceleration of industrial development in developing countries and countries with economies in transition. UNIDO works largely in developing countries, with governments, business associations and individual companies. Priority areas or "service modules" for projects are Industrial Governance and Statistics, Investment and Technology Promotion, Industrial Competitiveness and Trade, Private Sector Development, Agro-Industries, Sustainable Energy and Climate Change, Montreal Protocol, and Environmental Management. UNIDO was established as a UN programme in 1966 with headquarters in Vienna and became a specialized agency of the United Nations in 1985. In 2004, UNIDO established the UNIDO Goodwill Ambassador programme.

UNDP supports countries' efforts to protect the environment and manage their resources efficiently, and promotes cooperation among countries in tackling common environmental challenges. One of UNDP's core objectives is to help countries design environment and

energy policies that address the needs of the poor. Inadequate and unequal management of natural resources is a major impediment to the transformation of communities in the developing world. When natural resources are depleted, when pollution threatens the well-being of a country's population, the most vulnerable tend to be among the hardest hit. Poor households often depend on access to a diversity of natural resources for their livelihoods; they are often the most adversely affected by exposure to unsafe water, indoor air pollution, toxic chemicals and other health hazards.

Another international non-profit organisation is Greenpeace, with a presence in 40 countries across Europe, the Americas, Asia and the Pacific. As a global organisation, Greenpeace focuses on the most crucial worldwide threats to our planet's biodiversity and environment and campaign to;

- Stop climate change
- Protect ancient forests
- Save the oceans
- Stop whaling
- Say no to genetic engineering
- Stop the nuclear threat
- Eliminate toxic chemicals
- Encourage sustainable trade

1.6 Some grass root level environmental movements in Orissa and India:

Orissa is a state which abounds with rich forests and wealthy coast line. These are the treasures of biodiversity. Of late, attempts have been made to upset the treasure for certain developmental works and human settlements. To protect the natural ecosystems of the state, various environmental movements have been organized in the state.

The environmentalist, Late Banka Behari Das formed an Organization called Orissa Krushak Mahasangha. This organization fought for the protection reach biodiversity and original features of Chilka, World's largest brackish water lake. The farmers and the local fishermen supported the cause and it gained the magnitude of the mass movement. Because of this Govt. of Orissa formed Chilka Development Authority. It is responsible to maintain the fauna and flora, biodiversity and other characteristics of the lake. Because of the mass movement, the deteriorating condition of the lake, due to encroachments and other human interventions, was reduced and it, even, recently got 'Ramsar' award : This movement is still strong is maintaining forests of Orissa.

Gandhamardan Yuba Parisad and Gandhamardan Bachao Samiti are two grass-root

level organizations comprising the tribals of the area. Gandhamardan hill being the abode of many medicinal plants and other valuable forest resources, the organizations fought vigorously to save it from destruction by Bharat Aluminium Company (BALCO). Due to their efforts, bauxite mining at the place was stopped.

The Orissa environment Society is another grass roof level organization which is striving hard for maintenance of the protection of the environment. Because of its efforts, the union Government has recently declared Simlipal Tiger Reserve as the biosphere reserve.

Operation Kachhapa is one Non-Govt. Organization working for protection of the rare Olive Ridley sea turtles at Gahirmatha.

At the national level, many such grass root level environmental movements have taken place. The illiterate tribal women of the region were the torchbearers of the movement. The movement commenced in the year 1972 in the Tehri-Garhwal districts of Uttar Pradesh. The movement gathered nomentum in 1978 where the women of Advani village of Tehri Garwal had tied the sacred thread around the trees, hugged (Chipko) the trees, faced police firing in February, 1978 and later courted arrest. The movement continued under the leadership of Shri Sunder lal Bahuguna in various villages like Advani to save the trees from the greed of the timber mafia and proposed Tehridam Project. His plan for the movement was presented in UNEP meeting in London in June, 1982 where he argued that the protection soil and water is more important than tree felling for development. To him, every standing green tree in the forest is a sentry to protect us from avalanches and land slides to save our soils and conserve an water. Important gift of the tree is not timber but soil, water and oxygen. The chipko plan contained planting of trees which contained five F's like food, fodder, fuel, fiber and fertilizer.

Another movement that attracted attention all over the country and even outside was related to silent valley of Kerala. A dam was to be built there. The dam could generate electricity which could benefit people of that region. But more than that the dam was going to submerge large areas of forests having a great biodiversity. It could lead large scale damage to the unique ecosystem of silent valley. People raised their voice against silent valley in which Kerala Sastra Sahitya Parishad took the lead. The project was later abandoned. Similar movements of at large or small scale are still going on in many parts of India. The March to Western Ghats is one such example which aimed at sensitizing the people to protect the natural biotic potential of the region.

4.7 Bio-diversity and its conservation

The environment is a complex ecosystem comprising of variety of species of plants, animals and microorganisms, each of them represented by a number of strains and each with its genetic identity. This biological diversity is a condition for the long term sustainability

of the environment. The maintenance of its integrity is, therefore, recognized as being indispensable to sustain human life on this planet. The taxonomic knowledge of species is far from complete as we know nearly half of the 30 million or more plants and animals that occur on the surface of this planet. It is also essential to guard against their extinction among which are some which provide us with food, and medicine or can be used in the biological control of pests and pathogens.

Biodiversity (biological diversity) encompasses all species of plants, animals (including man) and microorganisms and the ecosystems and ecological processes of which they are part. This term has been expanded by Norse et al. (1986) to refer to biological diversity at three levels : genetics, species and ecosystem diversity.

4.7.1 Genetic diversity

Genetic diversity is the sum total of genetic information contained in the genes of individual plants, animals and microorganisms that inhabit the planet earth Genetic information varies from one species of Organism to other. This information is in code from in the structural elements called chromosomes. These, in turn are located in the nucleus of every cell of which the living beings are made up. The genetic make up of two organisms are never similar. For example, the total number of genes and the characters they express of a monkey and a man are completely different. This is called the genetic diversity.

4.7.2 Species diversity

Species diversity refers to the variety of living organisms on the surface of the earth. It denotes to the number and varieties of species in an areas. The species richness is shown in absolute numbers and the proportion they represent is a measure of species diversity. The species diversity depends on a number of factors like climate, soil and human intervention etc. A desert land will have less species diversity when compared with a rainforest.

4.7.3 Ecosystem diversity

Ecosystem diversity refers to the variety of habitats, biotic communities and ecological processes in the biosphere as well as the enormous diversity within the ecosystems in terms of habitat difference and the variety of ecological processes. There are three types of ecosystem diversity which may be called as alpha, Beta and Gamma diversity. Alpha diversity refers to the diversity of organisms from the same habitat and these organisms are evenly distributed in the habitat. It is the community diversity within Beta diversity means the association of different communities within a certain range of the habitat along the effect of environmental parameters such as attitude, moisture content, depth of the water bodies etc. It may be called as between the community diversity.

Gamma diversity covers a vast stretch of geographical area such as a grass-land, mountain range etc. It may be called a biome where many small and big ecosystems are discernible.

4.8 Value of Biodiversity: Consumptive use, Productive use, Social, ethical and aesthetic values:

Biodiversity provides the basis for life on earth. It is fundamental to the fulfillment of human needs. In fact, it is the part of our daily lives and livelihood and constitutes resources upon which social structures like families, communities, nations and future generations depend. The fundamental social, ethical, cultural and economic values of these resources have been recognized in religion art and literature from the earliest days of recorded history. Wild species and the genetic variations within there make substantial contribution to the development of agriculture, medium and industry. Perhaps, even more important, many species have been fundamental to the stabilization of climate, protection of watersheds, retention of the fragile soil and development of nurseries and breeding ground. An environment rich in biological diversity offers broadest any of options for sustainable economic activity for supporting human welfare and for adapting to change. On the other hand, the loss of biodiversity has serious economic and social implications for a country. It is difficult to determine the total economic values of the full range of goods and services which biodiversity provides.

For well over 10,000 years, much of the human progress has been associated with major break through in the use of natural resources whether in expansion of number of wild plants and animals that are exploited or domesticated, on which the economy of the world depends. On one side, there are developing countries which are rich in genetic resources but do not have technologies to exploit them for their benefit. On the other side, there are developed countries which lack the abundance of the genetic resources but possess the technological advantage for making the best use of the resources. The international negotiations on biodiversity have assumed importance in this context of potential economic exploitability of the vast plant and animal genetic resources. The need to collect, conserve and evaluate genetic resources before they disappear forever has been the subject of world attention during the last few decades.

Biological resources have made substantial contribution in human welfare especially in the rural areas of developing countries. For example, fire wood and cattle dung provide over 90 percent of the energy needs in many areas of India. Nepal and such types of countries, Human beings have used about 1000 kinds of plants for food, but only 20 species of plants supply 90 percent of our food requirements. Again, just three crop plants such as wheat, rice and maize supply more than 50 per cent of our food requirements. Although the major food

Table 7 : Biodiversity Hotspots by region as designated by Myers et al (2000)

Hotspots by Region	Endemic Plants (% of global)	Endemic Vertebnrates (% of global)
North and Central America		
Caribbean	2.3	2.9
California Floristic Province	0.7	0.3
Mesoamerica	1.7	4.2
South America		
Tropical Andes	6.7	5.7
Choc/Darien/Western Ecuador	0.8	1.5
Brazil's Atlantic Forest	2.7	2.1
Brazil's Cerrado	1.5	0.4
Central Chile	0.5	0.2
Europe and Central Asia		
Caucasus	0.5	0.2
Mediterranean Basis	4.3	0.9
Africa		
Madagascar (includes nearby Indian Ocean islands Mauritius, Reunion, Seychelles and Comores)	3.2	2.8
Eastern Arc and Coastal Forests of Tanzania/Kenya	0.5	0.4
Western Africa Forests	0.8	1.0
Cape Floristic Province	1.9	0.2
Succulent Karoo	0.5	0.2
Mainland Asia	1.2	0.7
South-Central China	2.3	1.9
Indo-Burma	0.7	1.3
Western Ghats/Sri Lanka		
Asia-Pacific	1.9	1.9
Philippines	5.0	2.6
Sundaland	0.5	1.9
Wallacea	1.4	0.4
Southwest Australia	0.6	0.5
New Zealand	0.9	0.3
New Caledonia	1.1	0.8

crops in use today were domesticated thousands of years ago, the potential of other species to play prominent role in world agriculture is great. Numerous locally important, through much less known species of wild and domesticated plants could be cultivated and used more wilds.

Genetic diversity of a crop is the total genetic variation of the species available for further crop improvement with an ever increasing growth of human population more food has to be produced to meet the needs. The key to better yielding varieties is provided by plants breeding so that their ford value, resistance to fungal, bacterial and viral disease and insects, nematodes and other pests. The inbuilt genetic resistance and adaptation may eliminate the need for environmentally undesirable pesticides.

The rich biodiversity is continuing basis of life and life supporting system and contains genetic elements evolved over millions of years that hold the key to future survival. The immense genetic diversity of traditional farming systems is the product of human innovations and experimentations. The rich biodiversity in India has given shape to variety of cultural and ethnic diversity which includes over 550 tribal communities of 227 ethnic groups spread over 5000 forested villages.

Hence, a region rich in biodiversity can serve as the source of food, source of medicinal plants and reservoir of genetic diversity. It can have stabilizing effects on the ecosystem balance and a source of cultural and aesthetic value. In short, forests with rich biodiversity are the hot spots of productive, protective and bio-aesthetic value.

4.9 Biodiversity hot spots

A British conservationist Norman Myers (1988) put forward the concept of biodiversity hot spots. These are the areas featuring exceptional concentrations of species with exceptional levels of endemism and experiencing exceptional loss of habitat. Myers (1988) initially identified 10 hotspots areas largely centered in tropical forests with further studies (Myers, 1990) identified another 8 hotspot areas, 4 of them in tropical forests and 4 of them in Mediterranean type zones increasing the number of hotspots to 18. In these two preliminary efforts analysis was limited to vascular plants. Since then both qualitative and quantitative assessment were made with expanded criteria for hotspot determination. The expanded criteria require that a hotspot contain endemic plant species comprising at least 0.5% of the global total of plant species. Four vertebrate groups were also included in the analysis. Focus was also made on species diversity. Basing on these expanded criteria, some new hotspots were designated. Some hotspots reported earlier were combined looking at their biological commonalities between them. For example, the hotspots areas of 'The Western Ghats of India' and SouthWestern Sri Lanka of the previous report were combined to from Western Ghat/Sri Lanka hotspot even though these areas

present the number of hotspots designated for priority conservation has been increased to 25 which is given in the table below:

4.9.1 Criteria for Biodiversity hotspots

The first criterion for designating biodiversity hotspot status to a region is the number of endemic species present. When a species of plant or animal is unique to a particular region and found no where else in the globe, then they are referred to as the endemic. Endemism is always related to geographic context. For hotspot designation, the endemic species of vascular plants (comprising around 90 per cent of all plants) constitute the primary criterion, as they are essential to virtually all forms of animal life and fairly well known scientifically. To quality as a hotspot, an area must contain at least 0.5% or 1500 of world's 300,000 plant species as endemic. Animal biodiversity in hot spot areas are analyzed only taking 4 vertebrate groups (mammals, birds, reptiles and amphibians) into consideration. The other vertebrate group, fishes and invertebrates are not considered for analysis because of their poorly documented records available. Terrestrial vertebrates do not serve as an alternative determinant of hotspot status, nor do their endemics have to comprise 0.5% of global endemics have to comprise 0.5% of global totals.

The second criterion for designating hotspot status, applied only after an area met the first criterion i.e. it contains at least 1500 species of endemic plants, is the degree of threat through habitat loss. To qualify as a hotspot, an area should have last 70% or more of its primary vegetation. The 70% cut off is justified on the grounds that most lorge scale concentrations of endemic plant species occur here.

4.10 Threats to biodiversity and habitat loss

Throughout the geological history of the Earth, species of plants and animals had been subjected to multidimensional evolutionary processes. Some species became extinct during the different geological periods. The last major extinction of species occurred at the end of the cretaceous period, nearly 65 million years ago when birds and mammals were particularly affected. The total disappearance of the dinosaurs occurred during that great extinction. It is generally agreed that they were triggered by natural environmental phenomena during the geological evolution of Earth. In recent history, biological resources have been lost at the accelerated rate, mainly due to human exploitation. Tropical deforestation between 1990 and 2020 may eliminate between 5 and 15 per cent of the worlds species. The world conservation monitoring centre has recognized that some 22000 species of plants and animals are actually threatened with extinction.

Every day, some 100 species, out of the earth's 30-50 million species are being lost each day under agricultural activities, industrial developments and dams or through pollution

or erosion. The current disappearance rate is about 400 times faster than that recorded recent geological times and the rate of loss is unmatched in the last 65 million years sinc the age of dinosaurs. As the earth's biological diversity erodes, so do the building blocks huge.

Among the causes identified for the loss of biological diversity are (1) habitat loss fragmentation, and modification. As forests are cleared, wetlands drained, valleys flooded and roads built, so habitats are transformed and effectively lost for certain species. As a result the species must adapt to changes, more elsewhere or may succumb to predation starvation or disease and die.

(2) Over exploitation of resources such as commercial harvesting has been a threat to many marine species, extinction of some large terrestrial animals like African elephant (3) Pesticides and oil pollution have affected several species of birds and other organisms. Both air and water pollution have led to the elimination of sensitive species. (4) The impact of introduction of exotic species as they threaten natural flora and fauna by predation, competition and altering the natural habitat.

The introduction of high yielding wheat and rice varieties, since the mid 1980's has caused a loss of the gene pool in many centers of crop diversity as Turkey, Iran, Iraq, Afghanistan, Pakistan and India.

4.11 Endangered and endemic species of India

India wildlife is rich and diverse. There are 45000 species of plants, of which 7000 are endemic to our country. Animal species number at around 75000 of which 850 are mammals. These endemic species are mainly dominating North-East, Western Ghats, North-West Himalayas, and the Andaman and Nicobar islands. Nearly 44 species of the Indian mammals and 55 species of Indian birds are reported to be endemic. But very high percentage of Indian reptiles and amphibians have been determined to be endemic. Nearly 50% of the Indian lizards and 62% of the known amphibians are endemic to India.

International Union of conservation of Nature and Natural Resources (IUCN) in 1963 categorized the threatened species facing extinction.

i) **Extinct species** : A plant or animal is said to be extinct when its representative is not seen for the last 50 years. At present, they are only seen in the museums, or tales about them is read from the books with their photographs Ex-Indian cheetah.

ii) **Endangered species** : Once these were abundant but have since dropped drastically in number due to human activities and now their very existence is in danger. Ex-Blue whale, Gharial.

iii) **Vulnerable species :** Vulnerable species may become endangered in near future of sufficient protection measures are taken for the same.

iv) **Rare species :** These are not endangered at present but there is a risk because their occurrence is in a very low number. They are also restricted to small geographical areas. Example – Great Indian Bustard.

v) **Indeterminate :** These organisms may be in danger but true picture about them is not available. Hence, they are not being properly assessed. Ex-short eared rubbit of Sumatra.

Besides, the term threatened is used for certain which are likely to become endangered within a foreseeable future, throughout or in a significant portion of its range. Example – Horned rhino, grizzly bear.

In India, more than 450 plants have been identified as endangered, threatened or rare. Among them major share of plants are from Himalayas and Eastern India, the least is from Gangetic plane. Gangetic plane, being thickly populated and the major agricultural centre of the country many of the plant species have become extinct before human being could make a scientific study of it.

Many of the animal species are in the endangered list. It is observed that 12 of 19 primates are endangered. Like wise many birds, carnivorous mammals, reptiles, invertebrates that occur in India are endangered.

4.12 Biodiversity Conservation at local and global levels

The intense pressure on biological diversity is a direct reflection of the increasing human activities. This pressure is expected to increase until population growth stabilizes, towards 2050-2070 at about 10 billion. Such stabilization will only be achieved if present efforts to curtail growth of restricting the human population are pursued vigorously.

Recognizing the growing several of threats to biological diversity and increasing international nature of the action required to address the threats, a global strategy for dealing with all aspects of biological diversity prepared by the World Resources Institute, IUCN (International Union for Conservation of Nature), FAO (Food and Agricultural Organization) and UNEP (United Nations Environment Program) was put forth at the United Nations Conference on Environment and Development held at Rio de Janeiro, Brazil.

The draft convention on biodiversity recognizes the need for species, and ecosystems to be preserved independently of their worth to the people and obligation on the part of the people to take this need to consideration Such obligations are at adds with human interest, if the species concerned is harmful to man. For Example – Small poxvirus, Cerebral malaria parasites etc.

Actions being taken by the International Community and by the Governments to promote the conservation and sustainable use of biodiversity are (1) measures to protect particular habitat as National Parks, Biosphere Reserves or other protected areas. (2) measures to protect a particular species or group of species from overexploitation. (3) Measures to protect *ex situ* conservation of species in botanical gardens or Zoological parks or in gene banks and (4) measures to curly contamination of biosphere with pollutants. These measures are discussed below.

1) **Habitat Conservation** :- Natural abodes of Wildlife are to protected from developmental works like construction of roads, dams, industries etc. and this should be considered and cleared by authorities from the planning stage.

2) **Development of reserves** :- Reserves for specific plants and animals to be earmarked and the area should be completely made free from human interference.

3) **Regulating introduction of foreign species** :- Foreign species sometime cause ecological disasters. For example, introduction of *Pistia* in India has caused great havoc to the flora and fauna of the static water bodies of India due to their excessive bloom.

4) **Pollution Control** :- Now, the source of Pollution is multifarious. It may be due to industries, agriculture, human habitation, waste disposal or the like. Hence, efforts may be made to keep it at manageable limits.

5) **Research and Development** :- In order to protect our fragile environment, research for the protection of biodiversity and its implementation is an utmost need. Information on all types of plants and animals and their characteristics may be properly studied and efforts may be made for their protection and development.

6) **Public awareness** :- The mass media has a great role to play in protection and preservation of biodiversity since it has a great impact on the masses. All efforts may be made to educate the people from the grass root level about the subject.

Continuous increase in number of endangered species of flora and fauna in India steps have been taken to protect and manage them. Non-Government voluntary organizations and governmental agencies at the central and state level have been set up to protect the biodiversity.

This means aims at (I) Protection of natural habitats through controlled exploitation of the concerned plants and animals (II) maintenance of the viable number of species in protected areas (national parks, sanctuaries, biosphere reserves etc) (III) establishment of biosphere reserves for plants and animals (IV) Protection through legislation.

It can be further protected by (i) improving the existing protected areas as sanctuaries, national parks etc. (II) imposing restrictions on rare plant and animal species and their products (III) educating public for environmental protection at all levels.

There are a number of non-Government, Voluntary, national and international organizations actively dedicated for biodiversity conservation. The principal organizations are (1) Bombay Natural History Society ; (2) Wildlife Preservation Society of India, Dehradun (3) World wildlife fund for Nature, India, Mumbai.

4.12.1 In situ and Ex situ conservation of Biodiversity

There are four types areas in our country for in situ conservation of biodiversity. The conditions in these areas are closely similar to the original habitats of the organisms. They are (I) National Parks (ii) Sanctuaries (III) Biosphere Reserves.

National Parks

It is an area dedicated to conserve the environment, natural and historical objects and to conserve wildlife therein. At the same time, it provides enjoyment from them in such a manner and such means as will leave them unimpaired for enjoyment of future generating. In National Parks all private rights are non-existent and all forestry operations and other usages such as grazing of domestic animals are prohibited. In India, there are nearly 80 National Parks.

Sanctuaries

Here, Killing, hunting, shooting or capturing of any species of birds and mammals is prohibited except by or under the control of the highest authority in the department for the management of the sanctuary. Private ownership rights may be allowed to continue in a sanctuary and forest and other usages permitted to the extent that may not attach the wildlife. There are 412 wildlife sanctuaries in India.

Biosphere reserves

Under the auspices of UNESCO, Biosphere Reserve project was launched throughout the world. Initially, 200 biosphere reserves were created in 40 countries of the world. Table 8 gives the biosphere reserve of India and their date of creation. The highlights of the programme are (a) Conservation of ecosystem (b) Restoration of the habitat (c) Conservation of soil and water (d) Reforstation of adjoining areas (e) Participation of the local in the forestry measures.

A comparative account of the national parks, sanctuaries and biosphere Reserves are given in the table below:

Table 8 : Biosphere Reserves of India

Name of Reserve	Date of Establishment	Area (in Sq.hm)	State
Nilgiri	01-09-1986	5,520	Karnataka, Kerala & Tamil Nadu
Nanda Devi	18-01-1988	5,860	Uttaranchal
Nokrek	01-01-1988	80.00	Meghalaya
Great Nicobar Islands	06-01-1989	885	Andaman & Nicobar Islands
Gulf of Mannar	18.02.1989	10,500	Tamil Nadu
Manas	14-03-1989	2,837	Assam
Sunderbans	29-03-1989	9,630	West Bengal
Simlipal	22-06-1994	4,374	Orissa
Dibru-Saikhowa	28-07-1997	765	Assam
Dehang-Debang	02-09-1998	5,111	Arunachal Pradesh
Pachmarhi	03-03-1999	4,926	Madhya Pradesh
Khangchendzonga	07-02-2000	2,619	Sikkim
Agasthyamalai	12-11-2001	1,701·,	Kerala

Project Tiger

There was a decline in the tiger population from 40,000 at the beginning of twentieth century to 1827 in 1972. The maint reasons for the extinction of tigers were hunting habitat destruction and construction of dams and bridges for agriculture. Hence a centrally sponsored multimillion dollar project was launched in April 1, 1973 called the project tiger. It was funded by World wide Fund for natural (WWF).

The objective of these Tiger Reserves were :

(a) Ensuring the maintenance of a viable population of tigers in India for scientific, economic, aesthetic, cultural and ecological values :

(b) Preserving for all times, areas of such biological importance as a national heritage for benefit, education and enjoyment of people.

Table 9 : Features of the National Parks, Sanctuaries and Biosphere Reserves

National Park	Sanctuary	Biosphere Reserve
1. Meant for the habitation of a particular wild animal species like tiger, lion etc. Ex. Simlipal Tiger Reserver	Generally species oriented as citrus, pitcher plant, Great	Not meant for any one, two or more species but to whole ecosystem.
2. In India, the area is 0.04 to 3162 Sq. Km. Most common is 100 to 500 sq. km (40% cases, 500 to 1000 sq. km.	Some range is 0.61 to 7818 sq. km. Most common is 100 to 500 km^2	Size range over 5670 Km^2
3. Boundaries circumscribed by legislation	Boundaries are not sarcosanct.	Boundaries circumscribed By legislation.
4. Excepting the buffer zone, no biotic interference	Limited biotic interference	Excepting buffer zone No biotic interference
5. Toursm permissible	Tourism permissible	Tourism normally not permissible.
6. Research and scientific management local	Lacking	Managed
7. So far no attention for to gene pools and conservation.	So far no attention	Attention given

The project concentrated on protecting good tiger habitats by creating sanctuaries and extending the existing one.

Under this project, 18 tiger reserves were set up in India in 1973.

The ex-situ conservation of biodiversity includes the conservation of seeds, tissue culture techniques, botanical gardens, Zoological parks, creation of gene pools, gene banks to store germ plasms of wild animals, plants and even of cultivated one. There are now more than 800 Zoological parks called Zoos and 1500 botanical gardens to scientifically manage the biodiversity. All the organisms are nurtured here under captivity. Nandankanan Zoo is one example.

UNIT – V

ENVIRONMENTAL MANAGEMENT

5.1 Resettlement and rehabilitation of displaced people, its problems, concerns and case studies

The forced displacement of civilians has become one of the major humanitarian problems of our time, affecting tens of millions of people around the world. Well over half of this population are internally displaced persons (IDPs), defined as: "persons who have been forced to flee their homes suddenly or unexpectedly in large numbers, as a result of armed conflicts, internal strife, systematic violation of human rights or natural or man-made disasters; and who are within the territory of their own country".

Since the mid-1980s, the number of IDPs in the world has increased dramatically, rising at least five-fold between 1984-1994. Although the quality and availability of data vary, the number of IDPs appears to have peaked in 1994 at above 25 million, declining somewhat since then. Depending on definitions and sources, IDPs are currently estimated as at least 19.7 million, and possibly as high as 25 million. This is in addition to the 14-16 million global refugees. A large number of IDPs are women, often widows or single mothers; children, many of whom are unaccompanied by their families; and elderly people.

The largest numbers of IDPs are found in Africa, with substantial populations in Europe and South Asia as well. In 1996, more than 10 per cent of the total populations of Angola, Bosnia and Herzegovina, Cyprus, Lebanon, Liberia, Sierra Leone and the Sudan were internally displaced.

While the needs of IDPs are much like those of other poor and isolated social groups, they have special vulnerabilities as a result of being dislocated from their homes: low mobility, weak social networks and limited wage-earning opportunities. For these reasons, in those countries where the proportion of internally displaced is high, IDPs place an unusually heavy burden on social and economic systems.

5.1.1 The causes and categories of internal displacement

Over the past decade, it is the rising number of internal conflicts compounded by natural disasters and/or weak state structures that have been the primary cause of increasing internal displacement. Civilians are forced from their home locales and become internally displaced for a number of reasons:

- ***Victims of 'ethnic cleansing'.*** If a place of origin comes to be identified by the parties to a conflict with a particularly political, ethnic, religious or other communal affiliation,

the residents may be targeted for removal. In this situation, they may be obliged to flee to regions controlled by the government, where they will be subject to attacks by opposition forces, or to areas occupied by the opposition, where they will be considered adversaries by their government and denied access to humanitarian assistance. In recent internal conflicts, ethnic cleansing - removing entire communities from their home locations - has become an increasingly common way to deal with land pressures, economic scarcities, religious differences or perceived historical injustices. The former Yugoslavia, the Caucasus, the Great Lakes region of Central Africa and the Rift Valley in Kenya are recent examples.

- ***Victims caught up in armed conflict.*** If their places of origin become strategically important in an internal conflict, non-combatant civilians may simply become caught in the cross-fire and seek safety, often illusory, in a less turbulent part of the country. When, in the course of their flight, such involuntary migrants cross a national frontier, they can become refugees. By not crossing into another state, however, their vulnerability can be seriously exacerbated simply by their prior geographic association with the conflict area. When internal conflicts are accompanied by political breakdown and governing authority ceases to exist, the displaced populations are marginalized even further.

- ***Victims of natural disasters and the environmentally displaced.*** Natural disasters and environmental deterioration arising from pressures on resources can cause substantial population displacements if they deny residents their livelihoods and means of subsistence. The line between natural and human-induced destruction is often difficult to draw, particularly in the case of long-term environmental degradation, since human actions can greatly exacerbate the effects of such natural disasters as drought, floods and desertification. Damaged areas must be restored before the residents can return, and when home areas are completely destroyed, alternative receiving areas need to be made ready to meet the long-term needs of the displaced.

- ***Victims of development projects.*** Progress means change. Development brings improved life style and comfort; however, it often carries negative impacts. It displaces people from their habitat making them aliens in their home land. According to the World Bank there are three categories of projects which affect people and need environmental assessment. These are:

Category A Projects

- Dams and reservoirs
- Large-scale industrial projects
- Irrigation and flood control projects
- Mineral development, including oil and gas

- Port and harbor development
- River basin development

Category B projects

- Agro-industries
- Electrical transmission
- Aquaculture and mariculture
- Rural electrification
- Watershed projects
- Tourism

Category C projects

- Education
- Family planning
- Health
- Nutrition
- Institutional development
- Human resource projects

In the context of resettlement and rehabilitation, the World Bank emphasizes the need for:

- Minimizing involuntary settlement
- Providing people displaced by a project with means to improve, or at least restore their former living standards and earning capacity.
- Involving both settlers and hosts in resettlement activities.
- A time-bound resettlement plan.
- Valuation and compensation for land and other assets to the affected people.

5.1.2 The special problems of IDPs

Whatever the cause, the status of IDPs may, in some instances, be only a phase in the process of expatriation. In the first stage before leaving their country, IDPs may be potential refugees unable to cross the border. They may also be reluctant to expatriate due to political, social or personal reasons, and may seek sanctuary inside their country of origin before choosing to flee into exile. Alternatively, repatriating refugees may become internally displaced while attempting to return to their home areas, especially in the case of unorganized return or

when places of origin have been occupied by other groups of uprooted populations. Mixed population movements along interstate borders further blur these various groups.

Compared with refugees, however, IDPs have significantly less access to international protection. Since IDPs have not crossed international boundaries, they are not legally entitled to the internationally recognized civil and social rights ensured by the refugee status as defined by the 1951 Convention Relating to the Status of Refugees and the 1967 Protocol thereto. Since IDPs live under the sovereign authority of their Governments, which have the legal responsibility to provide them with protection, they are particularly vulnerable to pressures from these Governments, whether at the national or local level.

Under this circumstance, international intervention is limited, in principle, to supportive actions undertaken with the consent of the country in question. However, in instances where Governments are unable or unwilling to provide protection to their displaced populations, humanitarian organizations have sought to assist IDPs: grounding their right to provide assistance on existing provisions of international humanitarian law to war victims and on human rights treaties. In these cases, humanitarian assistance is given to IDPs despite their Governments, rather than with their Governments' support.

While the scope for the international community to provide protection to the displaced is often restricted, the protection of IDPs is a critical issue. It is not unusual for governments to deny, or at least downplay, their internal displacement problems. At the same time, the displaced are typically highly vulnerable social groups with limited ability to articulate their needs for assistance and protection. Both factors complicate the international community's ability to help them.

Over the past few years, however, IDPs have become more visible on the humanitarian scene, for several reasons. First, as internal conflicts and consequent population displacements became more widely recognized in the early 1990s, the humanitarian community has moved the problem of IDPs to the top of its agenda. Second, internal displacement has become more visible to the general public: some of the recent humanitarian crises that have captured the mass media's attention pinpointed mass migrations, such as in the Great Lakes region of Central Africa and in former Yugoslavia. Third, the magnitude of the phenomenon implies that internal displacement cannot be seen anymore as a minor side-effect of a refugee problem, although situations of internal and external displacement are often mixed.

5.1.3 Institutional developments

There is no single humanitarian agency with a comprehensive global mandate to assist and protect IDPs. There is also no institutionalized system to coordinate assistance to IDPs, either at the headquarters level or in the field. Given this situation, in the 1990s, United

Nations agencies and other humanitarian partner organizations have aided the growing number of IDPs, both by actively pursuing their traditional mandates and by expanding their capacities to meet these needs.

Among the United Nations agencies:

- **UNDP** responds to the needs of internally displaced persons primarily in the prevention and resettlement phases: earmarking resources for countries beset by disasters or complex emergencies which have substantial displaced populations.
- **UNHCR** becomes involved with IDPs in conflict situations, depending upon a case-by-case extension of its mandate to include the problem of IDPs. It acts by limiting outflows as far as possible and encouraging their return to home communities.
- **UNICEF** assists children wherever they are rendered vulnerable, whether because they are refugees, internally displaced, affected by conflict or natural disasters, inequity or poverty.
- **WFP** assists IDPs with relief food distribution, rehabilitation, recovery and/or development programmes provided through governments or NGOs.
- **WHO**, at the request of governments or the United Nations, furnishes emergency health services and facilities to particular groups, including IDPs. Among non-United Nations organizations:
- **ICRC** plays a key role, since IDPs are at the core of its mandate to protect all victims of armed conflict. In carrying out its mandate to such victims, including IDPs, the ICRC provides the following kinds of assistance: protection of the civilian population; visits to detainees; health and medical services, including the supply of potable water; food aid; the provision of shelter and clothing; and the restoration of family ties, including tracing missing persons and arranging for family reunification.
- **IOM**'s mandate, which explicitly mentions assistance to internally displaced persons, is to ensure the orderly migration of persons in need of migration assistance. Through an internal task force established in 1994, IOM has gathered information from its missions around the world on assistance to IDPs, and is currently reviewing a set of policy and operational guidelines to derive basic principles for all IOM activities relating to IDPs.
- Numerous **international NGOs** also assist IDPs in all sectors of humanitarian assistance: food, health, water and sanitation, shelter, etc.

Although rich and variegated, the overall response of the humanitarian community to IDPs has been fragmented and ad hoc. In recognition of this major challenge, several steps have been taken towards a more systemic approach.

In resolution 92/73 (1992), the Commission on Human Rights asked the United Nations Secretary-General to appoint a representative to look into the legal and institutional requirements for more effective assistance and protection to IDPs. Ambassador Francis Deng was appointed to this post in 1992 and serves as the United Nations' primary advocate for IDPs. His assignment is to raise awareness about their plight; highlight unmet needs; suggest ways to improve responses in particular countries; develop an appropriate normative framework; and strengthen institutional arrangements.

In December 1994, the Inter-Agency Standing Committee requested the ERC to serve as the United Nations reference point for internal displacement. Shortly thereafter, in July 1995, the Economic and Social Council called upon the United Nations humanitarian system to review its capacity to respond to humanitarian crises and disasters including, *inter alia*, a detailed review of a number of issues relating to IDPs. The IASC, in reviewing this matter through a Task Force on IDPs, has recommended that additional work is needed to ensure a comprehensive and coordinated approach to IDP problems.[3] While deciding that no uniform model can be applied and that the precise structures for assisting IDPs should be determined on a case-by-case basis, the IASC has attempted to clarify the focal points at the headquarters and field levels, as well as operational arrangements, for assisting IDPs.

Measures being considered to strengthen humanitarian response to IDPs include the following:

- The ERC, as Chairman of the IASC, remains the focal point at United Nations Headquarters for the inter-agency coordination of humanitarian assistance to IDPs. Subject to IASC agreement, he is responsible for:
    - global advocacy on both assistance and protection requirements;
    - resource mobilization and the identification of gaps in resources;
    - management of global information on IDPs; and
    - support to the field on IDP-related humanitarian issues, including negotiation of access to IDP populations.
- The Resident/Humanitarian Coordinator, in consultation with inter-agency country teams, is responsible for coordinating assistance to IDPs, including:
    - addressing IDP's humanitarian requirements before, during and after an emergency;
    - serving as an advocate for the assistance and protection of IDPs;
    - recommending to the ERC a division of operational responsibilities among the agencies; and

- on a case-by-case basis, also recommending to the ERC that the IASC confirm a lead agency to assume operational responsibilities for IDPs, including camp management where appropriate.

- With regard to operational coordination, there is a continuing need to clarify how agencies divide or mesh their responsibilities for IDPs. In such crucial areas as food aid, rehabilitation programs, transport and logistics, protection, and human rights, coordination is often addressed through bilateral memoranda of understanding signed by two or more agencies. For example:

  - UNHCR, UNICEF and WHO agreed in a recent Memorandum of Understanding (MOU) that UNICEF and WHO will, respectively, assist displaced women and children and provide health care to IDPs. UNHCR will also be involved, when requested by a competent organ of the United Nations.

  - UNHCR and WFP agreed in a MOU revised in 1997 to divide their responsibilities for food assistance to IDPs.

In carrying out their operational responsibilities, agencies must take care to distinguish among the needs of differing groups of displaced people. Some IDPs are mixed among resident communities; others gather in camps; still others simply disperse throughout a territory. Interventions in these various settings will tend to have different costs and impacts.

In countries emerging from protracted conflict, one special category of IDPs of great concern to the humanitarian community is demobilized soldiers. Their displacement is not only from their homes, but also from the basic fabric of society, since they are all too often socially and psychologically alienated from their traditional communities, livelihoods and skills. A large proportion of demobilized soldiers never return to their traditional homelands and, unless they receive targeted reintegration and rehabilitation assistance, they can threaten public security even after the conflict has ended.

While a number of steps have been taken along these lines to strengthen the international institutions aimed at assisting IDPs, much still needs to be done. The challenge which now faces the humanitarian community is not only to ensure that IDPs' basic needs of survival are met, but also to broaden the efforts to prevent human rights abuses, improve governance and promote equitable development practices. Both adequate early warning systems and reintegration measures addressed to all vulnerable groups in the community are needed in order to improve the conditions of life for IDPs.

5.2 Issues of environmental ethics

Environmental ethics is the discipline that studies the moral relationship of human beings

to, and also the value and moral status of, the environment and its nonhuman contents. Suppose that putting out natural fires, culling feral animals or destroying some individual members of overpopulated indigenous species is necessary for the protection of the integrity of a certain ecosystem. Will these actions be morally permissible or even required? Is it morally acceptable for farmers in non-industrial countries to practice slash and burn techniques to clear areas for agriculture? Consider a mining company which has performed open pit mining in some previously unspoiled area. Does the company have a moral obligation to restore the landform and surface ecology? And what is the value of a humanly restored environment compared with the originally natural environment? It is often said to be morally wrong for human beings to pollute and destroy parts of the natural environment and to consume a huge proportion of the planet's natural resources. If that is wrong, is it simply because a sustainable environment is essential to (present and future) human well-being? Or is such behavior also wrong because the natural environment and/or its various contents have certain values in their own right so that these values ought to be respected and protected in any case?

These are among the questions investigated by environmental ethics. Some of them are specific questions faced by individuals in particular circumstances, while others are more global questions faced by groups and communities. Yet others are more abstract questions concerning the value and moral standing of the natural environment and its nonhuman components.

5.3 Climate change

Ever since the earth came into being there has been a climate system. The climate of a place is the average weather that it experiences over a period of time. The factors that determine the climate at a location are the rainfall, sunshine, wind, humidity, and temperature. While changes in the weather may occur suddenly and noticeably, changes in the climate take a long time to settle in and are therefore less obvious. Throughout the earth's history there have been changes in the climate. There have been well-marked cold and hot periods and all life forms adapted naturally to this change. Over the last 150-200 years the change has been taking place too rapidly and certain plant and animal species have found it hard to adapt. Human activities are said to be responsible for the speed at which this change has occurred and it is now a cause of worry to scientists. Climate change is a threat to mankind. Since the end of the 19th century the earth's average surface temperature has increased by 0.3-0.6 °C. Over the last 40 years, the rise has been 0.2-0.3 °C. Recent years have been the warmest since 1860, the year when regular instrumental records became available. In 1995, a group of 2000 leading scientists got together under the IPCC (Intergovernmental Panel on Climate Change) and concluded that global warming is real, serious, and accelerating. They predicted that over the next 100 years, the earth's average temperature could further rise by 1.4-5.8 °C. The magnitude of this predicted warming may seem negligible, but its rate is faster than any seen in the last 10, 000 years.

Some important aspects of our lives can be affected through changes in weather patterns and some of these are discussed here.

Agriculture: The steadily-increasing human population has led to a rise in the demand for food. As more land comes under agricultural cultivation there will be more pressure on natural ecosystems. Climate change will affect agricultural yield directly because of alterations in temperature and rainfall, and indirectly through changes in soil quality, pests, and diseases. In particular, the yield of cereals is expected to decline in India, Africa, and the Middle East. As the temperature rises conditions will become more favorable for pests such as grasshoppers to complete a number of reproduction cycles thereby increasing their population. In the higher latitudes (in the northern countries) agriculture will benefit with the rise in temperature as the winter season will be shorter and the growing seasons longer. This will also mean that pests that will move towards the higher latitudes as the temperatures rise. Extreme weather conditions such as high temperature, heavy rainfall, floods, droughts, etc. will also affect crop production.

Weather: A warmer climate will change rainfall and snowfall patterns, lead to increased droughts and floods, can cause melting of glaciers and polar ice sheets, and result in accelerated sea-level rise. Rising warmth will lead to an increase in the level of evaporation of surface water; the air will also expand and this will increase its capacity to hold moisture. This, in turn, will affect water resources, forests, and other natural ecological systems, agriculture, power generation, infrastructure, tourism, and human health. An increase in the number of cyclones and hurricanes over the last few years has been attributed to changes in temperature.

Sea level rise: Coastal areas and small islands are among the most densely-populated parts of the World. They are also the most threatened because of rises in sea level that global warming may cause. The heating of oceans, and melting of glaciers and polar ice sheets, is predicted to raise the average sea level by about half a meter over the next century. Sea-level rise could have a number of physical impacts on coastal areas, including loss of land due to inundation and erosion, increased flooding, and salt-water intrusion. These could adversely affect coastal agriculture, tourism, freshwater resources, fisheries and aquaculture, human settlements, and health. Rising sea levels threaten the survival of many low-lying island nations, such as the Maldives and Marshall Islands. There could be large decreases in the availability of water in many rivers because of rainfall and snow. The volume in others would increase due to glaciers melting, for example, the rivers originating in the Himalayas. Shifts in water availability could also affect hydropower generation, and industries such as paper, pharmaceutical, and chemical manufacturing, that use large quantities of water. Buildings and other infrastructure would be

vulnerable to any increase in the frequency of storms and other extreme events, which could also disrupt transport routes.

Forests and wildlife: Ecosystems sustain the earth's entire storehouse of species and genetic diversity. Plants and animals in the natural environment are very sensitive to changes in climate. The ecosystems that are most likely to be affected by this change are the ones in the higher latitudes, the tundra forests. Polar regions will feel the impact of warming more than others. Interiors of continents will experience more warming than the coastal regions. National parks are supposed to provide a sanctuary to wildlife from the ravages of humankind on nature. But no park boundary or conservation law can protect an ecosystem from climate change. A recent report by the WWF (The World Wide Fund for Nature) states that this invisible killer has entered the most cherished natural areas. The giant pandas of Wolong in China, the grizzly bears of America's Yellowstone National Park, and the tigers in Kanha National Park in India are some of the animals at risk from climatic temperature rise. Mountain parks have been identified as being especially at risk from the environmental destruction caused by climate change. Species that live in the higher alpine zones, are forced to move higher up to find a suitable habitat thus reducing the area in which they can live. If the rate of climate change continues to accelerate, then the extinction of some mountain plants and animals is certain. Migratory birds fly from the cold northern parts of the world to the warmer south. Factors such as the weather and food sources along the route are very important for the successful completion of their journey. Changes in climate may bring about a shift in their feeding points and disruptions to their flight patterns.

Marine life: Corals are known as the tropical forests of the oceans and sustain diverse life forms. As ocean waters in the tropics become warmer, the damage to coral reefs seems to be increasing. These corals are very sensitive to changes in water temperature, which causes bleaching. Large stretches of the Great Barrier Reef in Australia have been damaged by bleaching. Zooplanktons, small organisms that float on the sea surface are declining in numbers, reducing the number of fish and sea birds that feed on these organisms. There is still a great deal that we do not understand about our climate, and about how our activities will change it. But one thing can be said loud and clear: if we wait to get answers to these questions, it will probably be too late.

Health impacts of climate change

Direct impacts: The weather has a direct impact on our health. If the overall climate becomes warmer, there will be an increase in health problems. It is anticipated that there will be an increase in the number of deaths due to greater frequency and severity of heat waves and other extreme weather events. The elderly, the very young and those suffering from respiratory and cardiovascular disorders will probably be affected by such weather extremes as they have lesser coping

capacity. An extreme rise in the temperature will affect people living in the urban areas more than those in the rural areas. This is due to the 'heat islands' that develop here owing to the presence of concrete constructions, paved and tarred roads. Higher temperatures in the cities would lead to an increase in the ground-level concentration of ozone thereby increasing air pollution problems.

Indirect impacts: Indirectly, changes in weather pattern, can lead to ecological disturbances, changes in food production levels, increase in the distribution of malaria, and other vector-borne diseases. Fluctuation in the climate especially in the temperature, precipitation, and humidity can influence biological organisms and the processes linked to the spread of infectious diseases. Higher temperature will cause the sea levels to rise that could lead to erosion and damage to important ecosystems such as wetlands and coral reefs. Direct impact of this rise would include deaths and injury caused by intense flooding. Temperature rise would indirectly result in geo-hydrological changes along the coastline such as saltwater intrusion into the groundwater and the wetlands, coral reef destruction, and damage to the drainage in the low-lying areas. Climate change could increase air pollution levels by accelerating the atmospheric chemical reactions that produce photochemical oxidants due to a rise in the temperature.

Diseases: The GHGs have been responsible for the depletion of stratospheric ozone, which protects the earth from the harmful direct rays of the sun. Depletion of stratospheric ozone results in higher exposure to ultra violet rays of the sun, leading to an increase in the incidents of skin cancer in light skinned people. It could also lead to an increase in the number of people suffering from eye diseases such as cataract. It is also thought to cause suppression of the immune system.

Due to global warming there will be an increase in the areas of habitat of disease-spreading insects such as the mosquito. causing an increase in the transmission of infection through these carriers.

Potential effects on health due to sea level rise include:

- death and injury due to flooding;
- reduced availability of fresh water due to saltwater intrusion;
- contamination of water supply through pollutants from submerged waste dumps;
- change in the distribution of disease-spreading insects;
- effect on the nutrition due to a loss in agriculture land and changes in fish catch
- health impacts associated with population displacement.

Causes of climate change

The earth's climate is dynamic and always changing through a natural cycle. What the world is more worried about is that the changes that are occurring today have been speeded up because of man's activities. These changes are being studied by scientists all over the world who are finding evidence from tree rings, pollen samples, ice cores, and sea sediments. The causes of climate change can be divided into two categories - those that are due to natural causes and those that are created by man.

Natural causes: There are a number of natural factors responsible for climate change. Some of the more prominent ones are continental drift, volcanoes, ocean currents, the earth's tilt, and comets and meteorites.

Continental drift: The continents that we are familiar with today were formed when the landmass began gradually drifting apart, millions of years back. This drift also had an impact on the climate because it changed the physical features of the landmass, their position and the position of water bodies. The separation of the landmasses changed the flow of ocean currents and winds, which affected the climate. This drift of the continents continues even today; the Himalayan range is rising by about 1 mm (millimeter) every year because the Indian land mass is moving towards the Asian land mass, slowly but steadily.

Volcanoes: When a volcano erupts it throws out large volumes of sulfur dioxide (SO_2), water vapor, dust, and ash into the atmosphere. Although the volcanic activity may last only a few days, yet the large volumes of gases and ash can influence climatic patterns for years. Millions of tons of sulfur dioxide gas can reach the upper levels of the atmosphere (called the stratosphere) from a major eruption. The gases and dust particles partially block the incoming rays of the sun, leading to cooling. Sulfur dioxide combines with water to form tiny droplets of sulfuric acid. These droplets are so small that many of them can stay aloft for several years. They are efficient reflectors of sunlight, and screen the ground from some of the energy that it would ordinarily receive from the sun. Winds in the upper levels of the atmosphere, called the stratosphere, carry the aerosols rapidly around the globe in either an easterly or westerly direction. Movement of aerosols north and south is always much slower. This should give you some idea of the ways by which cooling can be brought about for a few years after a major volcanic eruption. Mount Pinatoba, in the Philippine islands erupted in April 1991 emitting thousands of tons of gases into the atmosphere. Volcanic eruptions of this magnitude can reduce the amount of solar radiation reaching the Earth's surface, lowering temperatures in the lower levels of the atmosphere (called the troposphere), and changing atmospheric circulation patterns. The extent to which this occurs is an ongoing debate. Another striking example was in the year 1816, often referred to as "the year without a summer." Significant

summer frosts in the United States and Canada. These strange phenomena were attributed to a major eruption of the Tambora volcano in Indonesia, in 1815.

The earth's tilt: The earth makes one full orbit around the sun each year. It is tilted at an angle of 23.5° to the perpendicular plane of its orbital path. For one half of the year when it is summer, the northern hemisphere tilts towards the sun. In the other half when it is winter, the earth is tilted away from the sun. If there was no tilt we would not have experienced seasons. Changes in the tilt of the earth can affect the severity of the seasons - more tilt means warmer summers and colder winters; less tilt means cooler summers and milder winters. The Earth's orbit is somewhat elliptical, which means that the distance between the earth and the Sun varies over the course of a year. We usually think of the earth's axis as being fixed, after all, it always seems to point toward Polaris (also known as the Pole Star and the North Star). Actually, it is not quite constant: the axis does move, at the rate of a little more than a half-degree each century. So Polaris has not always been, and will not always be, the star pointing to the North. When the pyramids were built, around 2500 BC, the pole was near the star Thuban (Alpha Draconis). This gradual change in the direction of the earth's axis, called precession is responsible for changes in the climate.

Ocean currents: The oceans are a major component of the climate system. They cover about 71% of the Earth and absorb about twice as much of the sun's radiation as the atmosphere or the land surface. Ocean currents move vast amounts of heat across the planet - roughly the same amount as the atmosphere does. But the oceans are surrounded by land masses, so heat transport through the water is through channels. Winds push horizontally against the sea surface and drive ocean current patterns.

Certain parts of the world are influenced by ocean currents more than others. The coast of Peru and other adjoining regions are directly influenced by the Humboldt current that flows along the coastline of Peru. The El Niño event in the Pacific Ocean can affect climatic conditions all over the world. Another region that is strongly influenced by ocean currents is the North Atlantic. If we compare places at the same latitude in Europe and North America the effect is immediately obvious. Take a closer look at this example - some parts of coastal Norway have an average temperature of -2°C in January and 14°C in July; while places at the same latitude on the Pacific coast of Alaska are far colder: -15°C in January and only 10°C in July. The warm current along the Norwegian coast keeps much of the Greenland-Norwegian Sea free of ice even in winter. The rest of the Arctic Ocean, even though it is much further south, remains frozen. Ocean currents have been known to change direction or slow down. Much of the heat that escapes from the oceans is in the form of water vapor, the most abundant greenhouse gas on Earth. Yet, water vapor also contributes to the formation of clouds, which shade the surface and have a net cooling effect. Any or all of these phenomena can have an impact on the climate, as is believed to have happened at the end of the last Ice Age, about 14,000 years ago.

Human causes: The Industrial Revolution in the 19th century saw the large-scale use of fossil fuels for industrial activities. These industries created jobs and over the years, people moved from rural areas to the cities. This trend is continuing even today. More and more land that was covered with vegetation has been cleared to make way for houses. Natural resources are being used extensively for construction, industries, transport, and consumption. Consumerism (our increasing want for material things) has increased by leaps and bounds, creating mountains of waste. Also, our population has increased to an incredible extent. All this has contributed to a rise in greenhouse gases in the atmosphere. Fossil fuels such as oil, coal and natural gas supply most of the energy needed to run vehicles, generate electricity for industries, households, etc. The energy sector is responsible for about ¾ of the carbon dioxide emissions, 1/5 of the methane emissions and a large quantity of nitrous oxide. It also produces nitrogen oxides and carbon monoxide (CO) which are not greenhouse gases but do have an influence on the chemical cycles in the atmosphere that produce or destroy greenhouse gases.

Carbon dioxide is undoubtedly, the most important greenhouse gas in the atmosphere. Changes in land use pattern, deforestation, land clearing, agriculture, and other activities have all led to a rise in the emission of carbon dioxide. Methane is another important greenhouse gas in the atmosphere. About ¼ of all methane emissions are said to come from domesticated animals such as dairy cows, goats, pigs, buffaloes, camels, horses, and sheep. These animals produce methane during the cud-chewing process. Methane is also released from rice or paddy fields that are flooded during the sowing and maturing periods. When soil is covered with water it becomes anaerobic or lacking in oxygen. Under such conditions, methane-producing bacteria and other organisms decompose organic matter in the soil to form methane. Nearly 90% of the paddy-growing area in the world is found in Asia, as rice is the staple food there. China and India, between them, have 80-90% of the world's rice-growing areas. Methane is also emitted from landfills and other waste dumps. If the waste is put into an incinerator or burnt in the open, carbon dioxide is emitted. Methane is also emitted during the process of oil drilling, coal mining and also from leaking gas pipelines (due to accidents and poor maintenance of sites).

A large amount of nitrous oxide emission has been attributed to fertilizer application. This in turn depends on the type of fertilizer that is used, how and when it is used and the methods of tilling that are followed. Contributions are also made by leguminous plants, such as beans and pulses that add nitrogen to the soil.

How we all contribute every day: All of us in our daily lives contribute our bit to this change in the climate. Give these points a good, serious thought:

- Electricity is the main source of power in urban areas. All our gadgets run on electricity generated mainly from thermal power plants. These thermal power plants are run on

fossil fuels (mostly coal) and are responsible for the emission of huge amounts of greenhouse gases and other pollutants.

- Cars, buses, and trucks are the principal ways by which goods and people are transported in most of our cities. These are run mainly on petrol or diesel, both fossil fuels.
- We generate large quantities of waste in the form of plastics that remain in the environment for many years and cause damage.
- We use a huge quantity of paper in our work at schools and in offices. Have we ever thought about the number of trees that we use in a day?
- Timber is used in large quantities for construction of houses, which means that large areas of forest have to be cut down.
- A growing population has meant more and more mouths to feed. Because the land area available for agriculture is limited (and in fact, is actually shrinking as a result of ecological degradation!), high-yielding varieties of crop are being grown to increase the agricultural output from a given area of land. However, such high-yielding varieties of crops require large quantities of fertilizers; and more fertilizer means more emissions of nitrous oxide, both from the field into which it is put and the fertilizer industry that makes it. Pollution also results from the run-off of fertilizer into water bodies.

Solutions to climate change

Since human activities have a large impact on the climate, a large part of the solution lies in our hands. We can bring down the use of fossil fuels, cut down on consumerism, halt deforestation and use more environment- friendly agricultural methods.

In the energy sector, emissions can be lowered if the demand for energy is reduced and if we shift to cleaner sources of energy which do not release any carbon dioxide. These include solar, wind, geothermal, and nuclear energy.

A number of countries have cut down on the use of coal and have moved to cleaner sources of energy. Japan is a world leader in energy efficiency and the development of alternative energy sources.

Vehicles running on cleaner technologies and fuel are being tested and strict emission laws are being adopted in the transport sector. Some countries have begun taxing industries, that is, the polluting industry has to pay society for the damage it has caused and is causing.

Governments all over the world should see that forest cover is maintained because plants use carbon dioxide to grow and help remove it from the atmosphere. Forests are therefore, called 'sinks' of carbon dioxide. If trees are felled, reforestation should be

immediately carried out. Wetlands are another ecosystem that play a very important role in maintaining ecological balance and thereby the stability of the climate. Preserving these areas has to be given top priority.

Biotechnology can be used to reduce the water requirement of crops, increase crop yield, and reduce the use of fertilizers and pesticides. Special strains of rice are being developed in laboratories that can grow with less water and lead to lower emissions of methane.

5.4 Nuclear accidents

One of the scariest things about nuclear power is when something goes wrong and an accident occurs. Radiation is released into the environment and people get hurt. Two of the most famous nuclear accidents occurred at the Three Mile Island reactor 2 in the United States and the Chernobyl reactor 4 in the former Soviet Union. In this text we will discuss these two disasters, along with correcting a few common misconceptions about nuclear accidents. It is impossible for any nuclear reactor to explode like an atomic bomb. This is because in order for an uncontrolled chain reaction to occur that is similar to an atom bomb, the uranium fuel must be extremely enriched, much more than the 4% ^{235}U that is present in regular, commercial nuclear reactor fuel. So, if it can't explode, what does happen in a nuclear reactor? The answer is what is called a meltdown. When a meltdown occurs in a reactor, the reactor "melts". That is, the temperature rises in the core so much that the fuel rods actually turn to liquid, like ice turns into water when heated. If the core continued to heat, the reactor would get so hot that the steel walls of the core would also melt. In a complete reactor meltdown, the extremely hot (about 2700° Celsius) molten uranium fuel rods would melt through the bottom of the reactor and actually sink about 50 feet into the earth beneath the power plant. The molten uranium would react with groundwater, producing large explosions of radioactive steam and debris that would affect nearby towns and population centers. In general a nuclear meltdown would occur if the reactor loses its coolant. Without coolant, the core's temperature would rise, resulting in the meltdown scenario explained above. Then simply dropping the control rods in the reactor when it starts to get out of control would solve the disaster. But the problem is that, even if the control rods are completely dropped in and the nuclear chain reaction stops, the reactor is still extremely hot and will not cool down unless coolant is put back in. The residual heat and the heat produced from the decay of the fission products are enough to drive the core's temperature up even if the nuclear chain reaction stops. The two most important nuclear disasters are discussed below.

Three Mile Island disaster: On an island 10 miles from Harrisburg, Pennsylvania resides the Three Mile Island Nuclear Power Station. There are two reactors at the plant, dubbed Unit 1 and Unit 2. One of them is inoperable. Unit 2 experienced a partial reactor meltdown on March 28, 1979. A partial nuclear meltdown is when the uranium fuel rods start to liquefy,

but they do not fall through the reactor floor and breach the containment systems. The accident which occurred at Unit 2 is considered to be the worst nuclear disaster in US history. Why did it happen? There are many reasons for the accident, but the two main ones are simple human error and the failure of a rather minor valve in the reactor. In the following paragraphs, we will explain how it was possible for the accident to happen and both its psychological and physical effects on the American people. The accident at Three Mile Island began at about four in the morning with the failure of one of the valves that controlled coolant flow into the reactor. Because of this, the amount of cool water entering the reactor decreased, and the core temperature rose. When this happened, automatic computerized systems engaged, and the reactor was automatically scrammed. The nuclear chain reaction then stopped. This only slowed the rate at which the core temperature was increasing, however. The temperature was still rising because of residual heat in the reactor and energy released from the decaying fission products in the fuel rods. Because the pumps removing water from the core were still active, and a valve that controlled the cool water entering the core failed, water was leaving the core, but not coming in. This reduced the amount of coolant in the core. There wasn't enough coolant in the core, so the Emergency Core Cooling System automatically turned on. This should have provided enough extra coolant to make up for the stuck valve, except that the reactor operator, thinking that enough coolant was already in the core, shut it off too early. There still wasn't enough coolant, so the core's temperature kept increasing. A valve at the top of the core automatically opened to vent some of the steam in the core. This should have helped matters by removing the hot steam, but the valve didn't close properly. Because it didn't close, steam continued to vent from the reactor, further reducing the coolant level. The reactor operators should have known the valve didn't close, but the indicator in the control room was covered by a maintenance tag attached to a nearby switch. Because the operators didn't know that the valve had failed to close, they assumed that the situation was under control, as the core temperature had stopped rising with the first venting of steam from the core. They also thought that the coolant had been replaced in the core, because they didn't know that the pump outlets were closed. A few minutes later the core temperature began to rise again, and the Emergency Core Cooling System automatically switched on. Once again, an operator de-activated it, thinking the situation was under control. In reality, it was not. Soon, because of the coolant lost through the open valve at the top of the reactor, the core temperature began to rise again. At this point the fuel rods started to collapse from the intense heat inside the core. The operators knew something was wrong, but didn't understand what it was. This was about 5 minutes after the initial valve failure. It took almost 2 hours for someone to figure out that the valve releasing steam at the top of reactor hadn't closed properly. During those 2 hours, precious coolant continued to be released from the reactor a meltdown was underway. At approximately 6AM, an operator discovered the valve at the top of the core was open and closed it. During the day hydrogen gas began to accumulate inside the reactor and caused an explosion later in the afternoon. This explosion did not damage the

containment systems, however. Two days later, the core was still not under operator control. A group of nuclear experts were asked to help evaluate the situation. They figured out that a lot of hydrogen gas had accumulated at the top of the core. This gas could have exploded, like the explosion on the first day of the accident, or it could have displaced the remaining coolant in the reactor, causing a complete nuclear reactor meltdown. No one really knew what to do about the hydrogen build-up. A hydrogen recombiner was used to remove some of the hydrogen, but it was not very effective. However, hydrogen also dissolves in water, which is what the coolant was composed of. Thus, over time the hydrogen that had collected at the top of the core completely dissolved in the coolant. Two weeks later the reactor was brought to a cold shutdown and the accident was over. No one was directly injured as a result of the accident. However, some radioactive gas and water were vented to the environment around the reactor. At one point, radioactive water was released into the Susquehanna river, which is a source of drinking water for nearby communities. No one is really sure what effects these radioactive releases might have had on people living near the power plant.

Chernobyl: About 80 miles (130 km) north of Kiev (USSR), now in Ukraine, is located the Chernobyl nuclear power plant. At this plant the worst reactor disaster to ever occur took place on April 26, 1986. It happened largely because normal reactor operations were suspended; an experiment was to take place in the reactor. As a result, normal safety guidelines were disregarded, and the accident occurred. However, as with most accidents of this type, it was a result of many small mistakes adding up to create a catastrophe. Early in the day, before the test, the power output of the reactor was dropped in preparation for the upcoming test. Unexpectedly, the reactor's power output dropped way too much, almost to zero. Because of this drop, some control rods were removed to bring the power back up. (As you recall from the fission power text, the more control rods there are in a reactor, the more free neutrons are absorbed and the less fissioning that goes on. So, more control rods means less energy and power output.) The reactor's power output raised up, and all appeared to be normal. More preparation for the test began later when two pumps were switched on in the cooling system. They increased water flow out of the reactor, and thus removed heat more quickly. They also caused the water level to lower in a component of the reactor called the steam separator. Because of the low level of water in the steam separator, the operator increased the amount of feed water coming into it, in the hopes that the water level would rise. Also, more control rods were taken out of the reactor to raise internal reactor temperature and pressure, also in the hopes that it would cause the water level in the steam separator to rise. The water level in the steam separator began to rise, so the operator adjusted again the flow of feed water by lowering it. This decreased the amount of heat being removed from the reactor core. Because many control rods had been removed and the amount of heat being taken from the core by the coolant had been reduced, it began to get very hot. Also, there was relatively low pressure in the core because the amount of incoming water had been decreased..

Because of the heat and the low pressure, coolant inside the core began to boil to form steam. The actual test began with the closing of the turbine feed valves. This should have caused an increase in pressure in the cooling system, which in turn would have caused a decrease in steam in the core. This should have lowered the reactivity in the core. Thus, the normal next step when closing the turbine feed valves was to retract more control rods, increasing reactivity in the core. This is what the operator at Chernobyl did. The only problem was that in this case there was no increase in pressure in the cooling system because of the earlier feed water reduction. This meant that there was already a normal amount of steam in the core, even with the turbine feed valves closed. Thus, by retracting more control rods to make up for a reduction in steam that didn't happen, the operator caused too much steam to be produced in the core. With the surplus of steam, the reactor's power output increased. Soon, even more steam was being produced. The operator realized there was a problem and scrammed the reactor, completely disabling all fission reactions. However, it was too late. The temperature and pressure inside the reactor had already risen dramatically, and the fuel rods had begun to shatter. After the fuel rods shattered, two explosions occurred as a result of liquid uranium reacting with steam and from fuel vapor expansion (caused by the intense heat). The reactor containment was broken, and the top of the reactor lifted off. With the containment broken, outside air began to enter the reactor. In this particular Soviet reactor, graphite was used as a moderator instead of water. (water was the coolant) As air entered the core, it reacted with the graphite. Graphite is essentially just carbon, so oxygen from the air chemically combined with the carbon to form CO (carbon monoxide). Carbon monoxide is flammable and soon caught fire. The fire emitted extremely radioactive smoke into the area surrounding the reactor. Additionally, the explosion ejected a portion of the reactor fuel into the surrounding atmosphere and countryside. This fuel contained both fission products and trans-uranic wastes. During the days following the accident, hundreds of people worked to quell the reactor fire and the escape of radioactive materials. Liquid nitrogen was pumped into the reactor core to cool it down. Helicopters dumped neutron-absorbing materials into the exposed core to prevent it from going critical. Sand and other fire-fighting materials were also dropped into the core to help stop the graphite fire. All in all, over 5000 (metric) tons of material were dropped into the core. After the fires were brought under control, construction of what is called "the sarcophagus" (meaning Egyptian elaborate coffins) began. In this case, the sarcophagus is a structure erected from about 300,000 metric tons of concrete that surrounds the reactor. It was designed to contain the radioactive waste inside. It has served its purpose well, but, now, twenty years after the accident, several flaws have been found in it. Holes have begun to appear in the roof, allowing rainwater to accumulate inside. This water can corrode the structure, further weakening it. Also, birds and other animals have been seen making homes in the sarcophagus. If they should ingest radioactive material, they could spread it around the countryside. Additionally, with time the sarcophagus has become worn down. It is conceivable that an intense event like an earthquake, tornado, or plane crash directly on the sarcophagus

could lead to its collapse. This would be catastrophic, as radioactive dust would once again rain down on the surrounding areas. Scientists and engineers are working on ways to repair or replace the structure. One of the great tragedies of the accident was that the Soviet government tried to cover it up. Clouds of fallout were traveling towards major population centers such as Minsk, and no one was warned. No one outside the Soviet Union knew about the accident until two days later, when scientists in Sweden detected massive amount of radiation being blown from the east. The effects of the disaster at Chernobyl were very widespread. The World Health Organization (WHO) found that the radiation release from the Chernobyl accident was 200 times that of the Hiroshima and Nagasaki nuclear bombs combined. The fallout was also far-reaching. For a time, radiation levels in a Scotland were 10,000 times the norm. 30 lives were directly lost during the accident or within a few months after it. Many of these lives were those of the workers trying to put out the graphite fire and were lost from radiation poisoning. The radiation released has also had long-term effects on the cancer incidence rate of the surrounding population. According to the Ukrainian Radiological Institute over 2500 deaths resulted from the Chernobyl incident. The WHO has found a significant increase in cancer in the surrounding area. For example, in 1986 (the year of the accident), 2 cases of childhood thyroid cancer occurred in the Gomel administrative district of the Ukraine (this is the region around the plant). In 1993 there were 42 cases, which is 21 times the rate in 1986. The rate of thyroid cancer is particularly high after the Chernobyl accident because much of the radiation was emitted in the form iodine-131, which collects in the thyroid gland, especially in young children. Other cancer incidence rates didn't seem to be affected. For example, leukemia was no more prevalent after the accident than before.

What caused the accident? This is a very hard question to answer. The obvious one is operator error. The operator was not very familiar with the reactor and hadn't been trained enough. Additionally, when the accident occurred, normal safety rules were not being followed because they were running a test. For example, regulations required that at least 15 control rods always remain in the reactor. When the explosion occurred, less than 10 were present. This happened because many of the rods were removed to raise power output. This was one of the direct causes of the accident. Also, the reactor itself was not designed well and was prone to abrupt and massive power surges.

5.5 Global warming

The atmosphere surrounding the earth is made up of nitrogen (78%), oxygen (21%) and the remainder, 1%, is made up of trace gases (called so because they are present in very small quantities) that include the greenhouse gases carbon dioxide, methane, ozone, water vapor, and nitrous oxide. These greenhouse gases act as a blanket and protect it from the harmful ultra violet rays of the sun. They can also be regarded as natural controllers of the earth's temperature system.

Over the years, human activities have greatly increased greenhouse gas emissions, so that they are now far above their natural levels in the atmosphere. Some important human activities that produce greenhouse gases are: industrial processes, emissions from power plants and transport/vehicles. The increase in the quantity of greenhouse gases has raised the temperature of the earth, a phenomenon commonly known as global warming. This effect has been made worse by cutting down trees and forests that help us by absorbing carbon dioxide.

If countries around the world do not reduce emission of greenhouse gases, the following would be the probable scenario by the end of the 21st century.

- Temperature will have increased by 1–3.5° C depending on population and economic growth.
- Sea level will be 15–90 cm higher, threatening about 92 million people with floods.
- Rainfall would have decreased and there would be a reduction of food crops.

So is it not high time the world woke up to the seriousness of the problem?

5.6 Ozone hole

The presence of ozone in the stratosphere is more concentrated and dense near the equator and decreases gradually as one moves towards the poles. This is determined by the movement of the prevailing winds, the shape of the earth and the rotation of the earth. Towards the poles it varies depending on the season. The depletion of the ozone layer is clearly seen in the South Pole, i.e. at Antarctica, where there is a large ozone hole. In the North Pole the ozone destruction is not so strong. The World Meteorological Organization, the WMO, has played a major role in identifying and communicating the problem of ozone depletion. Since the atmosphere has no international boundaries it was realized that remedies should be discussed and decided at an international level.

The UNEP, United Nation Environment Program, initiated the Vienna Convention, attended by more than 30 countries. This led to the landmark Protocol on Substances that Deplete the Ozone Layer, which was adopted in 1987 at Montreal. It listed the substances which cause depletion of the ozone and called for about 50% reduction of CFCs by the year 2000. Chlorofluorocarbon (CFC) is said to be one of the main gases responsible for the greenhouse effect. It is emitted mainly from air conditioners, refrigerators and aerosols or spray can propellants. Another widely used chemical that is a threat to the ozone layer is methyl bromide.

This can release bromide, which is 30 to 50 times as destructive to ozone as chlorine. It is used as a fumigant (fumes used as disinfectants) for soil and commodities and as a transport fuel additive. No single alternative chemical is at present available to replace all methyl bromide applications. It has to be clearly stated that the expected recovery of the ozone layer would have been impossible without the Montreal Protocol on Substances that Deplete the Ozone Layer (1987) which called for a phased reduction of all ozone depleting substances. The dead line for developed countries was 1996, whereas India has up to 2010 to completely phase out these highly destructive chemicals.

5.7 Acid rain

The phenomenon occurs when sulfur dioxide and nitrogen oxides from the burning of fossil fuels such as, petrol, diesel, and coal combine with water vapor in the atmosphere and fall as rain, snow or fog. These gases can also be emitted from natural sources like volcanoes. Acid rain causes extensive damage to water, forest, soil resources and even human health. Many lakes and streams have been contaminated and this has led to the disappearance of some species of fish in Europe, USA and Canada as also extensive damage to forests and other forms of life. It is said that it can corrode buildings and be hazardous to human health. Because the contaminants are carried long distances, the sources of acid rain are difficult to pinpoint and hence difficult to control. For example, the acid rain that may have damaged some forest in Canada could have originated in the industrial areas of USA. In fact, this has created disagreements between Canada and the United States and among European countries over the causes of and solutions to the problem of acid rain. The international scope of the problem has led to the signing of international agreements on the limitation of sulfur and nitrogen oxide emissions.

5.8 Consumerism and waste products

Consumerism epitomizes the capitalist practice of producing both environmental problems and false solutions, in order to profit at both ends. ***Consumerism*** *is economically manifested in the chronic 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 sums 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.* By the 1930s the world economy reached a point where it needed to manufacture ***needs*** and ***desires*** and raise the level of consumption so that the capitalist class could continue accumulating capital; the system had reached a point where the appetites of capitalists exceeded the demand of consumers for basic goods and services. So began the impetus for, and the creation of **mass consumerism.** By the 1950s a whole industry— led by public relations and marketing— had developed that

functioned to help the capitalist class grab the surplus value from high production levels under "consumerism."

How Consumerism Is Fostered

Several important **tactics that capitalists use to generate consumerism** are:

- Creating new ***psychological "needs"*** in people
- Stimulating ***impulse buying***
- Creating and marketing ***fads and styles*** to spur temporary "usefulness" of material goods (or social obsolescence)
- Making *short-lived or hard-to-fix goods*; many products are designed to have uneconomically short lives, with the intention of forcing consumers to repurchase too frequently. This is technical obsolescence, often called ***planned obsolescence***.

Massive consumerism is in force, and some troubling consequences are starting to be felt. The most alarming one is solid waste and its management. William Rees, an urban planner at the University of British Columbia, estimated that it requires four to six hectares of land to maintain the consumption level of the average person from a high-consumption country. The problem is that in 1990, worldwide there were only 1.7 hectares of ecologically productive land for each person. He concluded that the deficit is made up in core countries by drawing down the natural resources of their own countries and expropriating the resources, through trade, of peripheral countries. **In other words, someone has to pay for our consumption levels.**

India is a unique country with a great cultural diversity, associated with all kinds of climates and rich flora and fauna. The human societies in our country have evolved within magnificent environments, and reverence to nature is inherent in our cultural ethos. The roots of ecological and environmental values are deep in our ancient Vedic literature and Upanishads. The *Atharva-Veda* solemnly recognizes an enduring allegiance of human kind to Mother Earth. A stanza in *Isha-Upanishad* states : "The whole universe

together with its creatures belongs to the Lord (Nature).... Let no one species encroach over the rights and privileges of other species. One can enjoy nature by giving up greed."

Living in harmony with nature has always been emphasized with the philosophy to take from nature only what we actually need and not more. '*Khsiti*' (Soil), 'Aapah' (water), '*Tej*'(energy/Sun), '*Maruta*' (air) and '*Byoma*' (space) are recognized as the basic resources of the earth.

All organisms including man are integral part of nature, returning all the nourishment

borrowed from Mother Earth. Our classical literature is abound with the message that resources should not be used wasted, but conserved. For example, Kautilya's famous treatise *Arthashashtra* describes what may be considered as the World's first forest conservation and wildlife management program. Contemporary Mauryan kings maintained forests for different purposes, like elephant domestication, hunting, and forests as reserve. Through history, the Indian people have not been exploiters but utilizes of nature. Our country has been under the influence of humans and agriculture for about 10,000 years.

Fortunately for us, the resource depletion has not been proportional to our very long history. This has been mainly due to the compassion for the living and the non-living and the principle of *Ahimsa puromo dharma* that are ingrained in our culture. There is a need to incorporate these principles in regulating resource use. Based on our cultural heritage and tradition, our resource utilization should be optimized. We must recognize our responsibility to conserve earth's resources for future generations. We must conserve resources for our future generations.

5.9 Environment protection act

Environmental issues do not concern one state or nation, but the entire world. Depletion of Ozone layer, loss of biodiversity, disposal of toxic and nuclear wastes, extinction of forests and encroachment of arable soil are a few of the many global issues that will affect survival of the present and future generations. Any carelessness on the part one individual, may result a serious accident which may threaten the existence of many individuals.

In order to avoid the chance of any major accident, which may wipe out the plant, animal or human life completely from the globe, a need for concerted action was felt by many nations. In 1972, representatives of 113 World Government assembled in Stockholm to participate in United Nations Conference on Human Environment. With it began the era of increasing global consciousness regarding urgent need to protect the environment.

Many countries, therefore, have introduced laws and control mechanisms to abate environmental pollution. Laws are just the vehicle for implementation of the policies of the nation. The policies are made keeping in view the interests and needs of the people, as a whole. These interests and needs may sometimes, differ but an urbane society has to strive to implement it for the sake of the interest of the majority.

India was the first country to impose constitutional obligation on the state and citizens to protect and improve the environment as one of the primary duties. Article 48 A of the constitution of India provides: ***The state shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country.*** Article 51A provides : ***It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and have compassion for all***

living creatures. Protection of environment has, thus, attained the status of joint venture of the Government and the people.

In the Constitution of India it is clearly stated that it is the duty of the state to 'protect and improve the environment and to safeguard the forests and wildlife of the country'. It imposes a duty on every citizen 'to protect and improve the natural environment including forests, lakes, rivers, and wildlife'. Reference to the environment has also been made in the Directive Principles of State Policy as well as the Fundamental Rights. The Department of Environment was established in India in 1980 to ensure a healthy environment for the country. This later became the Ministry of Environment and Forests in 1985. The constitutional provisions are backed by a number of laws – acts, rules, and notifications. The EPA (Environment Protection Act), 1986 came into force soon after the Bhopal Gas Tragedy and is considered an umbrella legislation as it fills many gaps in the existing laws. Thereafter, a large number of laws came into existence as the problems began arising, for example, Handling and Management of Hazardous Waste Rules in 1989.

5.9.1 Environment (Protection) Act:

The Environment (Protection) Act 1986 authorizes the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and /or operation of any industrial facility on environmental grounds. **The Environment (Protection) Rules 1986** lay down procedures for setting standards of emission or discharge of environmental pollutants. **The objective of Hazardous Waste (Management and Handling) Rules 1989** is to control the generation, collection, treatment, import, storage, and handling of hazardous waste. **The Manufacture, Storage, and Import of Hazardous Rules 1989** define the terms used in this context, and sets up an authority to inspect, once a year, the industrial activity connected with hazardous chemicals and isolated storage facilities. **The Manufacture, Use, Import, Export, and Storage of hazardous Micro-organisms/ Genetically Engineered Organisms or Cells Rules 1989** were introduced with a view to protect the environment, nature, and health, in connection with the application of gene technology and microorganisms. **The Public Liability Insurance Act and Rules 1991 and Amendment, 1992** was drawn up to provide for public liability insurance for the purpose of providing immediate relief to the persons affected by accident while handling any hazardous substance. **The National Environmental Tribunal Act 1995** has been created to award compensation for damages to persons, property, and the environment arising from any activity involving hazardous substances. **The National Environment Appellate Authority Act 1997** has been created to hear appeals with respect to restrictions of areas in which classes of industries etc. are carried out or prescribed subject to certain safeguards under the EPA. **The Biomedical waste (Management and Handling) Rules 1998** is a legal binding on the health care institutions to streamline the process of proper handling of hospital waste

such as segregation, disposal, collection, and treatment. **The Environment (Siting for Industrial Projects) Rules, 1999** lay down detailed provisions relating to areas to be avoided for siting of industries, precautionary measures to be taken for site selecting as also the aspects of environmental protection which should have been incorporated during the implementation of the industrial development projects. **The Municipal Solid Wastes (Management and Handling) Rules, 2000** apply to every municipal authority responsible for the collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes. **The Ozone Depleting Substances (Regulation and Control) 2000** Rules have been laid down for the regulation of production and consumption of ozone depleting substances. **The Batteries (Management and Handling) Rules, 2001** rules shall apply to every manufacturer, importer, re-conditioner, assembler, dealer, auctioneer, consumer, and bulk consumer involved in the manufacture, processing, sale, purchase, and use of batteries or components so as to regulate and ensure the environmentally safe disposal of used batteries. **The Noise Pollution (Regulation and Control) (Amendment) 2002 Rules** lay down such terms and conditions as are necessary to reduce noise pollution, permit use of loud speakers or public address systems during night hours (between 10:00 p.m. to 12:00 midnight) on or during any cultural or religious festive occasion. **The Biological Diversity Act 2002** is an act to provide for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources and knowledge associated with it.

5.9.2 Water Act 1974

The Water (Prevention and Control of Pollution) Act establishes an institutional structure for preventing and abating water pollution. It establishes standards for water quality and effluent. Polluting industries must seek permission to discharge waste into effluent bodies. The Central Pollution Control Board was constituted under this act. The following modifications to this act were undertaken in subsequent years. **The Water (Prevention and Control of Pollution) Cess Act 1977** provides for the levy and collection of cess or fees on water consuming industries and local authorities. **The Water (Prevention and Control of Pollution) Cess Rules 1978** contains the standard definitions and indicate the kind of and location of meters that every consumer of water is required to affix. **The Coastal Regulation Zone Notification 1991** puts regulations on various activities, including construction, are regulated. It gives some protection to the backwaters and estuaries.

5.9.3 Air Act 1981

The Air (Prevention and Control of Pollution) Act provides for the control and abatement of air pollution. It entrusts the power of enforcing this act to the Central Pollution Control Board. **The Air (Prevention and Control of Pollution) Rules 1982** defines the procedures of the meetings of the Boards and the powers entrusted to them. **The Atomic Energy**

Act 1982 deals with the radioactive waste. **The Air (Prevention and Control of Pollution) Amendment Act 1987** empowers the central and state pollution control boards to meet with grave emergencies of air pollution. **The Motor Vehicles Act 1988** states that all hazardous waste is to be properly packaged, labeled, and transported.

5.10 Issues Involved in enforcement of acts

India's ongoing population explosion has placed great strain on the country's environment. This rapidly growing population, along with a move toward urbanization and industrialization, has placed significant pressure on India's infrastructure and its natural resources. Deforestation, soil erosion, water pollution and land degradation continue to worsen and are hindering economic development in rural India, while the rapid industrialization and urbanization in India's booming metropolises are straining the limits of municipal services and causing serious air pollution problems.

Nevertheless, despite a greater commitment by the Indian government to protect public health, forests, and wildlife, policies geared to develop the country's economy have taken precedence in the last 20 years. While industrial development has contributed significantly to economic growth in India, it has done so at a price to the environment. Not only is industrial pollution increasing public health risks, but abatement efforts also are consuming a significant portion of India's gross domestic product (GDP).

As such, one of the main responsibilities of Ministry of Environment and Forest continues to be the reduction of industrial pollution. The Central Pollution Control Board serves as the national board, with oversight powers over the various state boards. It is also the ruling body for the Union Territories. The Board was legislated into existence in 1977, following the implementation of the Water Act. However, by 1987, only 20 of 25 states had ratified the original measure and constituted their own state boards. Funding from the central government has increased steadily since the Board's inception in 1977. By 1987, its budget had increased more than ten-fold from its original allocation of Rs. 2 million to Rs. 21.2 million. At that time, most of the Board's expenditures were targeted toward inter-state monitoring, basin and sub-basin studies, comprehensive industry documentation and air pollution control. Administrative expenses accounted for Rs. 5.63 million in 1987-88. Litigation costs rose from Rs. 30,000 in 1984-85 to Rs. 89,000 in 1987-88. The cost of India's water pollution problems has been staggering. In 1982, the National Engineering and Research Institute estimated 70% of the nation's water was polluted, and 73 million workdays at a cost of Rs. 60 million were lost to health-related illnesses. The Board may prosecute polluting industries under Section 33 (apprehension of pollution) and Section 44 (violation of conditions of consent order) in the Water Act. Through its first ten years in operation, the Board's efforts at litigation were lethargic as it filed only 181 cases, and eventually dropped charges in 16 of those. For most of those years, only a few cases were filed annually. 104 cases were filed in 1986-87,

marking a change in the Board's enforcement strategy. Regulatory reforms aimed at improving the air pollution problem in cities such as New Delhi have been quite difficult to implement, however. For example, India's Supreme Court lifted a ruling which required all public transport vehicles in New Dehli to switch to compressed natural gas (CNG) engines by April 1, 2001. This ruling, however, led to the disappearance of some 15,000 taxis and 10,000 buses from the city, creating public protests, riots, and widespread "commuter chaos". To ease the transition, the local government changed course and allowed for a gradual phase out of the existing diesel bus fleet. The court was similarly unsuccessful when it attempted to ban all public vehicles that were more than 15 years old and ordered the introduction of unleaded gasoline and CNG. India's high concentration of pollution is not due to a lack of effort in building a sound environmental legal regime, but rather to a lack of enforcement at the local level. Efforts are currently underway to change this as new specifications are being adopted for auto emissions, which currently account for approximately 70% of air pollution. In the absence of coordinated government efforts, including stricter enforcement, this figure is likely to rise in the coming years due to the sheer increase in vehicle ownership.

In addition, India's reliance on coal-fired power plants for its electricity generation has undermined some of the vehicular-oriented air quality improvement initiatives. Despite the fact that India is a large coal consumer, its Central Pollution Control Board has been slow to set sulfur dioxide emissions limits for coal-fired power plants, mainly because most of the coal mined in India is low in sulfur content. Coal-fired power plants do not face any nitrogen oxide emissions limits either, although thermal plants fueled by other fossil fuels are subject to particulate matter emission standards. Again, however, the government's support for air quality standards has been undermined by the lack of enforcement of these standards. Furthermore, Indian economic policies such as high import tariffs on high-quality coal and subsidies on low-quality domestic coal also have contributed to increased use of low-quality coal.

5.10 Public awareness

Effective implementation of environmental management and conservation programs depends on education, awareness raising and training in the relevant areas. Without an understanding of how to conserve their natural resources, or indeed, why they must do so, few communities would be motivated to participate actively in programs on environmental conservation. The target groups for environmental education are diverse, ranging from children through youth and women's groups to community leaders and politicians. In addition, the India has a diverse range of languages and cultures which also require special attention. In order that environmental information is effectively imparted to each of these target groups, it is essential that innovative and practicable communication and educational programs are

implemented. The implementation of such programs requires skilled personnel with a dedicated approach to environmental education and training. Often, in-country training of educators is required to ensure that good teaching practices are employed in formal, non-formal and public education areas. These activities require the dedication of time, funds and personnel. Ensuring widespread awareness and knowledge will strengthen the capacity to manage the use of their natural resources over the long term.

UNIT – V

ENVIRONMENTAL LAWS

Environmental issues do not concern one state or nation, but the entire world. Depletion of Ozone layer, loss of biodiversity, disposal of toxic and nuclear wastes, extinction of forests and encroachment of arable soil are a few of the many global issues that will affect survival of the present and future generations. Any carelessness on the part one individual, may result a serious accident which may threaten the existence of many individuals.

In order to avoid the chance of any major accident, which may wipe out the plant, animal or human life completely from the globe; a need for concerted action was felt by many nations. In 1972, representatives of 113 World Government assembled in Stockholm to participate in United Nations Conference on Human Environment. With it began the era of increasing global consciousness regarding urgent need to protect the environment.

Many countries, therefore, have introduced laws and control mechanisms to abate environmental pollution. Laws are just the vehicle for implementation of the policies of the nation. The policies are made keeping in view the interests and needs of the people, as a whole. These interests and needs may sometimes, differ but an urbane society has to strive to implement it for the sake of the interest of the majority.

Many countries have enacted special protection laws or amended their penal codes by creating new criminal laws in order to prosecute the offenders of the environmental hazards. The Japanese law for punishment of crimes relating to environment pollution was first such step. Later, many countries like Germany, Hungary, Portugal, Spain, and Brazil followed the suit.

Constitutional provisions

India was the first country to impose constitutional obligation on the state and citizens to protect and improve the environment as one of the primary duties. Article 48 A of the constitution of India provides: ***The state shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country.*** Article 51A provides : ***It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and have compassion for all living creatures.*** Protection of environment has, thus, attained the status of joint venture of the Government and the people.

Major provisions of environmental laws

The central, state and concurrent lists of subjects on which parliament and state legislatures are empowered to legislate control include noise control, land improvement,

irrigation, town planning, slum clearance, housing schemes, pest control, smoke control, water pollution, forests, wildlife, recreation etc. In addition to constitutional provisions for environment, Indian penal code has also taken care of water pollution by prescribing punishment under section 277 wherein person voluntarily corrupting or fouling the water of any public spring or reservoir has been made liable for punishment. Further under section 278, act of making atmosphere noxious to health has been made punishable.

The matter relating to environment were initially dealt by the Department of Science and Technology until a Department of Environment was formed in 1980 and the integrated Department of Environment, Forests and Wildlife came into being in 1985. Later the Department of Environment had constituted a working group of experts to examine the various aspects of the problem in detail and suggest procedures, research areas, and systems for effectively tackling the environmental issues. The working group formulated the guidelines for integrating environmental concerns with exploitation of natural resources. The guidelines included the approach to the problems related to (i) Water pollution (ii) Solid waste management (iii) Land degradation (iv) Air pollution (v) Noise pollution (vi) Human settlements (vii) Impact of mining etc. Specific laws with intention to preserve environment were also legislated all over the world. Our country has also enacted certain acts dealing with environment. They are:

(1) The water (prevention and control of Pollution) Act, 1974

(2) The water (Prevention and Control of Pollution) Cess Act, 1977

(3) The Air (Prevention and Control of Pollution) act, 1981

(4) The Environment (Protection) Act, 1986

(5) The wildlife (Protection) Act, 1972

(6) The Public liability Insurance Act, 1991.

These acts have been modified and specific new acts have been formulated over the years depending on the need of the country or a particular state. Certain important environmental acts are detailed below:

I. **Water Act: 1974 - The Water (Prevention and Control of Pollution) Act** establishes an institutional structure for preventing and abating water pollution. It establishes standards for water quality and effluent. Polluting industries must seek permission to discharge waste into effluent bodies. The Central Pollution Control Board (CPCB) was constituted under this act. The following modifications to this act were undertaken in subsequent years. **The Water (Prevention and Control of Pollution) Cess Act 1977** provides for the levy and collection of cess or fees on water consuming industries and local authorities. **The Water (Prevention and Control of Pollution) Cess Rules 1978** contains the standard definitions and indicate

the kind of and location of meters that every consumer of water is required to affix. The **Coastal Regulation Zone Notification 1991** puts regulations on various activities, including construction, are regulated. It gives some protection to the backwaters and estuaries.

II. **Air Act: 1981 - The Air (Prevention and Control of Pollution) Act** provides for the control and abatement of air pollution. It entrusts the power of enforcing this act to the CPCB. **The Air (Prevention and Control of Pollution) Rules 1982** defines the procedures of the meetings of the Boards and the powers entrusted to them. **The Atomic Energy Act 1982** deals with the radioactive waste. **The Air (Prevention and Control of Pollution) Amendment Act 1987** empowers the central and state pollution control boards to meet with grave emergencies of air pollution. **The Motor Vehicles Act 1988** states that all hazardous waste is to be properly packaged, labeled, and transported.

III. **Environment (Protection) Act: The Environment (Protection) Act 1986** authorizes the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and /or operation of any industrial facility on environmental grounds. **The Environment (Protection) Rules 1986** lay down procedures for setting standards of emission or discharge of environmental pollutants. The **objective of Hazardous Waste (Management and Handling) Rules 1989** is to control the generation, collection, treatment, import, storage, and handling of hazardous waste. The **Manufacture, Storage, and Import of Hazardous Rules 1989** define the terms used in this context, and sets up an authority to inspect, once a year, the industrial activity connected with hazardous chemicals and isolated storage facilities. **The Manufacture, Use, Import, Export, and Storage of hazardous Micro-organisms/ Genetically Engineered Organisms or Cells Rules 1989** were introduced with a view to protect the environment, nature, and health, in connection with the application of gene technology and microorganisms. **The Public Liability Insurance Act and Rules 1991 and Amendment, 1992** was drawn up to provide for public liability insurance for the purpose of providing immediate relief to the persons affected by accident while handling any hazardous substance. **The National Environmental Tribunal Act 1995** has been created to award compensation for damages to persons, property, and the environment arising from any activity involving hazardous substances. **The National Environment Appellate Authority Act 1997** has been created to hear appeals with respect to restrictions of areas in which classes of industries etc. are carried out or prescribed subject to certain safeguards under the EPA. **The Biomedical waste (Management and Handling) Rules 1998** is a legal binding on the health care institutions to streamline the process of proper handling of hospital waste such as segregation, disposal, collection, and treatment. **The Environment (Siting for Industrial Projects) Rules, 1999** lay down detailed provisions relating to areas to be avoided for siting of industries, precautionary measures to be taken for site selecting as also the aspects of environmental protection which should have been incorporated during the implementation of the industrial development projects. **The Municipal Solid Wastes (Management and Handling) Rules, 2000** apply to every municipal authority

responsible for the collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes. **The Ozone Depleting Substances (Regulation and Control) 2000** Rules have been laid down for the regulation of production and consumption of ozone depleting substances. **The Batteries (Management and Handling) Rules, 2001** rules shall apply to every manufacturer, importer, re-conditioner, assembler, dealer, auctioneer, consumer, and bulk consumer involved in the manufacture, processing, sale, purchase, and use of batteries or components so as to regulate and ensure the environmentally safe disposal of used batteries. **The Noise Pollution (Regulation and Control) (Amendment) 2002 Rules** lay down such terms and conditions as are necessary to reduce noise pollution, permit use of loud speakers or public address systems during night hours (between 10:00 p.m. to 12:00 midnight) on or during any cultural or religious festive occasion. **The Biological Diversity Act 2002** is an act to provide for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources and knowledge associated with it.

IV. **Forest and wildlife (Protection) 1972: The Wildlife Protection Act 1972, Rules 1973 and Amendment 1991** provides for the protection of birds and animals and for all matters that are connected to it whether it be their habitat or the waterhole or the forests that sustain them. **The Forest (Conservation) Act 1980 and Rules, 1981,** provides for the protection of and the conservation of the forests.

Function and Responsibility of Central and State Pollution Control Boards

Once the environment protection laws are formulated, there should be organizations and agencies to implement it and also, to prescribe corrective measures. The ministry of Environment implements various pollution control laws directly and through the Central and State Pollution Control Boards. These agencies are responsible for controlling the discharge of wastes and pollutants to the environment. Standards have been set for such discharges and the ministry has notified standards for discharges into air, water and soil by different industries.

Immediately after 1974, the Pollution Control Boards were constituted at the centre and in most of the states. Though initially constituted to secure proper functioning of the pollution control laws, the Pollution Control Boards have to ensure the gradual elimination of water, air and noise pollution. Pollution control is a multidimensional effort. Science, Engineering, Law and Management have very important roles to perform in controlling pollution. Hence, the functions of Pollution Control Boards consist of preventing or as abating pollution. In case of failure of above, the boards can take regulatory measures.

Laws, today, require that site clearance certificates are to be obtained from the Department of Environment and Forests when new industries are to be set up. Also, no objection certificates from the concerned Pollution Control Boards are mandatory. All the

dustrial units have to obtain consent from the Pollution Control Boards separately under
e water and air acts to run their units. Before issuing this consent, the Pollution Control
oard examines critically the extent of Pollution may be caused by the Unit and the steps to
e taken to contain that pollution. The samples are obtained from these units at any period
f time to verify the pollution levels. The functions of the Pollution Control Boards are as
ollows:

a. To advise the Government in the prevention, control and spread of air, water and soil pollution etc.

b. To function as a regulatory body for environmental safety

c. To carry on research, training, information dissemination related to abatement of Pollution.

Of these, regulatory functions are most important. Some of the important regulatory functions are:

(i) To allow or reject proposals for construction of new industrial units.

(ii) To inspect and analyze industrial effluents

(iii) To initiate legal action against industries violating Pollution norms

(iv) To authorize closure of Pollution by industries and stoppage of water and electricity

(v) To recommend the concerned Government in taking penal action against such units.

Role of Judiciary in Environmental Protection:

All the acts of omission in the protection and maintenance of the balance of the environment can be scrutinized by the judiciary. As the beholder of the constitution of India, the judiciary has played a great role in the aspect of environment management.

In India, perhaps the first judgment in the matter of environment was delivered by the Honorable Supreme Court on 17th February, 1986 in Shri Ram Fruits and Fertilizers Industries. The case related to the leakage of oleum gas from one of the units of the industry and as a result of such leakage several persons were affected. The Count, apart from awarding cost to the petitioner, directed the industry to pay compensation to the victims and imposed conditions for operation of the industry. The Court also directed Government of India for setting up environmental courts on the regional basis comprising one professional judge and two experts from the ecological Sciences Research group.

The second important case in which Honorabel Supreme Court delivered a landmark judgment was Kanpur Tanneries case. Honorable Court in their judgment on 22nd September, 1987 observed that an industry which can not pay minimum wages to its workers can not be

allowed to exist. A tannery which can not set up a primary treatment plant can not be permitted to continue to be in existence. Immediately, 30 tanneries were forced to stop operation. In another famous case, known as M. C. Mehta's case on Ganga, Honorable Supreme Court directed all industries, municipal bodies on the bank of the river Ganga and authorities regulating them to stop polluting discharges causing pollution to Ganga. In pursuance of that judgment, High Courts were directed to look into all cases relating to Ganga pollution within two months. In recent past, many environmental issues like Bhopal gas tragedy, the Silent Valley, Vedanta alumina complex etc. have come before the Honorable Supreme Court and were disposed of giving due significance to environmental balance. In short, the Supreme Court have made the environmental issue a vital one in the country and has helped to draw the attention of people from all walks of life.

Under the code of criminal procedure a District Magistrate or any other Executive magistrate specially empowered in this behalf on receiving information and being satisfied, require the person causing obstruction or nuisance to remove such obstruction or stop such nuisance which is elating to a river or channel or a tank or an animal or well adjacent to a public place posing danger to public at large. Certain well known celebrities of India were punished by the judiciary for wanton violation of the norms of protecting wildlife.

Recently, Honorable Supreme Court by landmark judgment directed Central and all state Governments to implement Police act, 1961, Section 30 of the penal code to implement in letter and spirit to regulate music in streets up to a prescribed hour and at a prescribed decibel. It is appreciated by all sections of people throughout the country.

Preliminary idea on Environmental impact Assessment

Many developmental projects particularly during this era of globalization have been taken up. It is desirable to have an idea of their possible impacts on the environment.

The objective of the environmental impact assessment is to ensure that the development is sustained with minimal environmental degradation. The ministry of Environment and Forests, Govt. of India has been assigned the responsibility for carrying out environmental impact assessment of the developmental projects in various sectors such as multipurpose river valley and irrigation projects, thermal and atomic power, industries, mining, ports and harbors, transport etc. It requires preparing an environmental impact statement on the following:

1. Effect of land including land degradation and subsistence.
2. Deforestation and compensatory reforestation
3. Air and water pollution including ground water pollution
4. Noise pollution and interaction
5. Flora and fauna, and loss of biodiversity
6. Socio-economic impact including human displacement cultural loss and health aspects

7. Risk analysis and disaster management
8. Recycling and reduction of waste
9. Efficient use inputs

Then assessment comprises of the following;

a. Project conception
b. Project planning and design
c. Survey
d. Impact assessment and analysis
e. Public opinion
f. Final remark on the project.

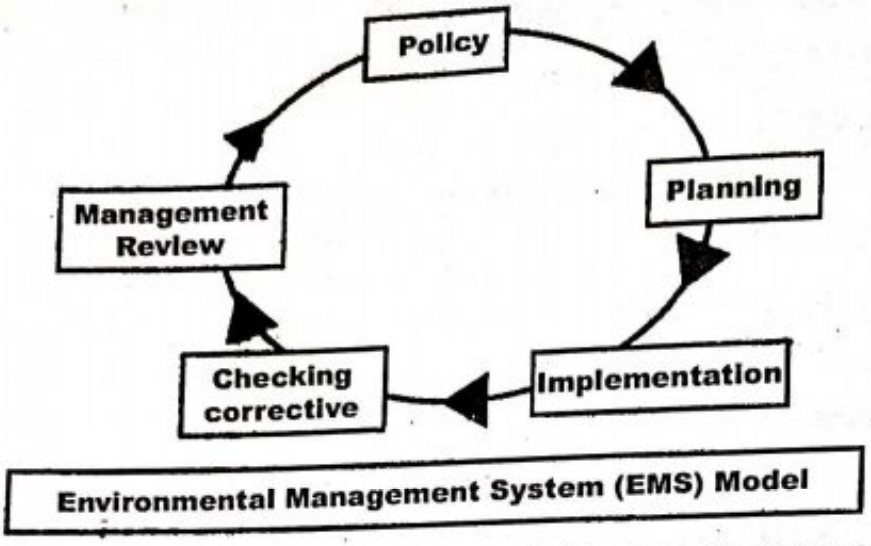
Once a project is submitted to the ministry of Environment, a scrutiny is done by the technical committee as per the guidelines. After ensuring the prima-facie assessment, it is placed before the advisory committee. The advisory committee discusses the impact of the project with project authorities and if necessary, site visits are made for on-the-spot assessment of environmental aspects. Based on their examination, the appraisal committee makes their recommendations for approval or rejection of the project.

Environmental Management systems

Environmental management systems serve as the tool to improve environmental performance, to provide a systematic way of managing an organizations environmental affairs. It is the aspect of the organizations overall management structure that addresses immediate and long term impacts of its products, services and processes on the environment. This system gives order and consistency for organizations to address environmental concerns through the allocation of resources, assignment of responsibility and ongoing evaluation of practices, procedures and processes and focuses on continual improvement system.

Some key elements of environment management systems are – (1) Policy statement – a statement of the organizations commitment to the environment (2) Identification of significant environmental impacts environmental attributes of products, activities and services and their effects on the environment. (3) Development of objectives and targets – environmental goals for the organization (4) Implementation – plans to meet objectives and targets. (5) Training – ensure that employees are aware and capable of their environmental responsibilities (6) Management Review.

The central theme of the environmental management is the reduction or minimization of the impact of human activities on the environment, thus, an Endeavour to avoid overuse, misuse and abuse of environmental resources. The corner stone of the environmental



Environmental Management System (EMS) Model

with the nature. The environment management model involves the following points – Policy, planning, implementation, then checking or corrective action and then management review.

Environmental Audit and Life cycle assessment

Once a system has been introduced for improving its environmental performance, it is important to ensure that the system is alive, effective and in daily use. This can be done by carrying out an environmental audit. By auditing the management, shows its interest in system, making employees aware that it is serious about the system and expects every one to use it.

An environmental audit is a systematic examination of environmental management system that check whether the system is being used as planned or whether the system works in practice.

An internal environmental audit should be carried out at regular intervals by selected employees (environmental auditors). If any deviation is observed as regards to the environmental management systems, the findings may be reported to the management.

Hence, environmental audit evaluates the performance of the unit, its management system and processes with a view to environmental protection and includes an assessment of factual data to evaluate the performance.

Environmental life cycle assessment is a tool for systematic evaluation of environmental aspects of products or service through its entire life cycle. Life cycle assessment starts with life cycle thinking – an understanding that the environmental impact of the entire life cycle of products and services need to be addressed. A products life cycle starts when raw materials are extracted, followed by manufacturing, transport, and use. It ends with waste management including recycling and final disposal Key elements of corporate strategies that implement this approach are benchmarks which include comparing alternative, both within the company and among competitions, identifying suppliers which act consistently with company strategies, research and development and training.

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