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ECOLOGY & ENVIRONMENT

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INTRODUCTION

ECOLOGY

Ecology is a science that studies the interdependent, mutually reactive and interconnected relationship between the organisms and their physical environment on the one hand and among the organisms on the other hand.

The word 'Ecology', derived from the Greek word: oikos meaning habitation, and logos meaning discourse or study, implies a study of the habitations of organisms. Ecology was first described as a separate field knowledge in 1866 by the German zoologist, Ernst Haeckel, who invented the word 'oeckologie' for "the relation of the animal to its organic as well as its inorganic environment, particularly its friendly or hostile relation to those animals or plants with which it comes in contact".

Ecology has been variously defined as "scientific natural history", "the study of biotic communities" or "the science of community population"; probably the most often given: a study of animals and plants in their relationship to each other and to their environment. Krebs (1985) defined ecology in simple modern comprehensive way as "the scientific study of the interactions that determine the distribution and abundance of organisms".

ECOLOGICAL PRINCIPLES

1. The first & second law of thermodynamics:**1st law;** energy can neither be created nor destroyed; it can only be changed from one form into another.

   2nd law; there is no loss of total energy, but there is a loss of useful energy.

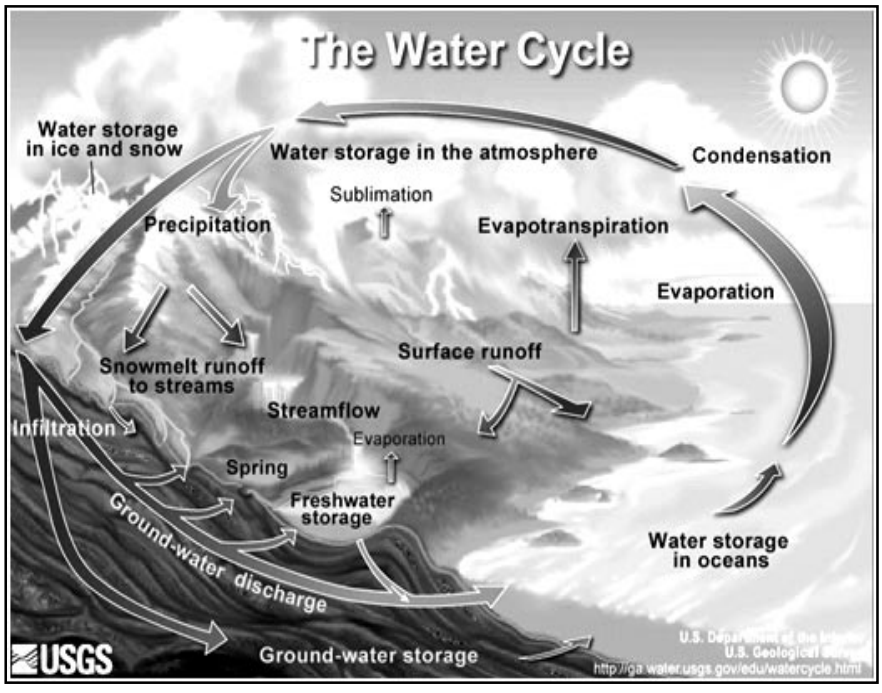
2. Limiting Factor Principle: Too much or too little of any abiotic factor can limit or prevent growth of a population, even if all other factors are at or near the optimum range of tolerance.

3. Homeostatic principle: It is the maintenance of constant internal conditions in the face of a varying external environment. The thickening of fur in winter, the darkening of skin in sunlight, the seeking of shade in heat, and the production of more red blood cells at high altitude are all examples of adaptations animals make in order to maintain homeostasis.

GEOCHEMICAL CYCLES

A biogeochemical cycle or substance turnover or cycling of substances is a pathway by which a chemical element or molecule moves through both biotic (biosphere) and abiotic (lithosphere, atmosphere, and hydrosphere) compartments of Earth.

The Earth is a closed system for matter, except for small amounts of cosmic debris that enter the Earth's atmosphere. This means that all the elements needed for the structure and chemical processes of life come from the elements



that were present in the Earth's crust when it was formed billions of years ago. This matter, the building blocks of life, continually cycle through Earth's systems, the atmosphere, hydrosphere, biosphere, and lithosphere, on time scales that range from a few days to millions of years. These cycles are called biogeochemical cycles, because they include a variety of biological, geological, and chemical processes.

Many elements cycle through ecosystems, organisms, air, water, and soil. Many of these are trace elements. Other elements, including carbon, nitrogen, oxygen, hydrogen, sulphur, and phosphorus are critical components of all biological life. Together, oxygen and carbon account for 80 per cent of the weight of human beings. Because these elements are key components of life, they must be available for biological processes. Carbon, however, is relatively rare in the Earth's crust, and nitrogen, though abundant in the atmosphere, is in a form that is not useable by living organisms. The biogeochemical cycles transport and store these important elements so that they can be used by living organisms. Each cycle takes many different pathways and has various reservoirs, or storage places, where elements may reside for short or long periods of time. Each of the chemical, biological, and geological processes varies in their rates of cycling.

1. Hydrologic Cycle (Water Cycle)

Water is always on the move. Rain falling where you live may have been water in the ocean just days before. And the water you see in a river or stream may have been snow on a high mountaintop.

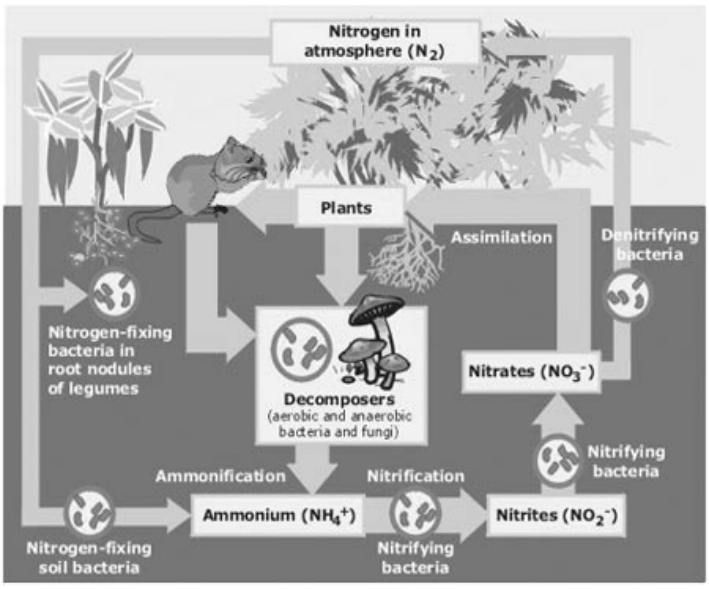
Water can be in the atmosphere, on the land, in the ocean, and even underground. It is recycled over and over through the water cycle. In the cycle, water changes state between liquid, solid (ice), and gas (water vapour).

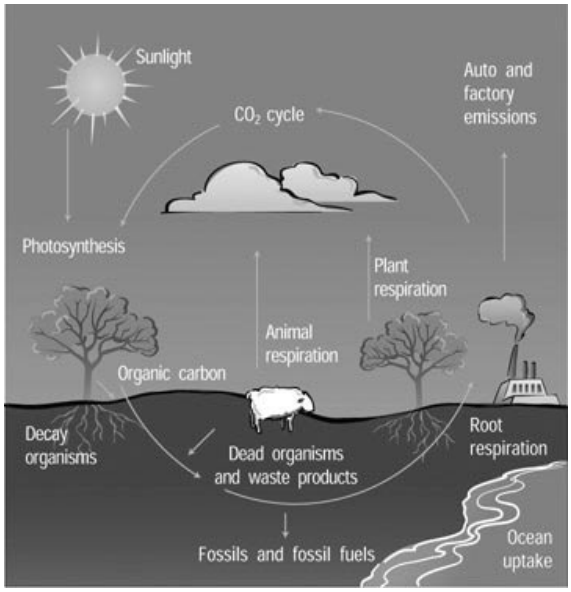
Most water vapour gets into the atmosphere by a process called evaporation. This process turns the water that is at the top of the ocean, rivers, and lakes into water vapour in the atmosphere using energy from the Sun. Water vapour can also form from snow and ice through the process of sublimation and can evaporate from plants by a process called transpiration.

The water vapour rises in the atmosphere and cools, forming tiny water droplets by a process called condensation. Those water droplets make up clouds. If those tiny water droplets combine with each other they grow larger and eventually become too heavy to stay in the air. Then they fall to the ground as rain, snow, and other types of precipitation.

Most of the precipitation that falls becomes a part of the ocean or part of rivers, lakes, and streams that eventually lead to the ocean. Some of the snow and ice that falls as precipitation stays at the Earth surface in glaciers and other types of ice. Some of the precipitation seeps into the ground and becomes a part of the groundwater.

Water stays in certain places longer than others. A drop of water may spend over 3,000 years in the ocean before moving on to another part of the water cycle while a drop of water spends an average of just eight days in the atmosphere before falling back to Earth.





2. Nitrogen Cycle

Nitrogen is required for the manufacturing of all amino acids and nucleic acids; however, the average organism cannot use atmospheric nitrogen for these tasks and as a result is dependent on the nitrogen cycle as a source for its usable nitrogen. The nitrogen cycle begins with nitrogen stored in the atmosphere as N_2 or nitrogen stored in the soil as ammonium (NH_4+), ammonia (NH_3), nitrite (NO_2-), or nitrate (NO_3). Nitrogen is assimilated into living organisms through three stages: nitrogen fixation, nitrification, and plant metabolism. Nitrogen fixation is a process which occurs in prokaryotes in which N_2 is converted to (NH_4+). Atmospheric nitrogen can also undergo nitrogen fixation by lighting and UV radiation and become NO_3-. Following nitrogen fixation, nitrification occurs. During nitrification, ammonia is converted into nitrite, and nitrite is converted into nitrate. Nitrification occurs in various bacteria. In the final stage, plants absorb ammonia and nitrate and incorporate it into their metabolic pathways. Once the nitrogen has entered the plant metabolic pathway, it may be transferred to animals when the plant is eaten. Nitrogen is released back into the cycle when denitrifying bacteria convert NO_3- into N_2 in the process of denitrification, when detritivorousbacteria convert organic compounds back into ammonia in the process of ammonification, or when animals excrete ammonia, urea, or uric acid.

A lot of environmental problems are caused by the disruption of the nitrogen cycle by human activity, some of the problems caused range from the production of troposphere (lower atmospheric) smog to the perturbation of stratospheric ozone and contamination of ground water. An example of one of the problems caused is the formation of greenhouse gas. Like carbon dioxide and water vapor greenhouse gas traps heat near the earth's surface and destroys the stratospheric ozone. Once that occurs nitrous oxide in the earth's atmosphere is broken down by UV light into nitrogen dioxide and nitric oxide. These two products can reduce the ozone. Nitrogen oxides can be changed back into nitrates and nitrite compounds and recycled back into the earth's surface.

3. Carbon Cycle

Carbon is required for the building of all organic compounds. Carbon in the form of carbon dioxide (CO_2) is obtained from the atmosphere and transformed into a usable organic form by organisms. The reservoirs for the carbon cycle are the atmosphere, where carbon dioxide exists as a free gas, fossil organic deposits (such as oil and coal), and durable organic materials like cellulose. Mineral carbonates, such as limestone, are a significant geological sink for carbon. During the process of carbon fixation, carbon dioxide is taken up from the atmospheric reservoir (or from bio-carbonates dissolved in water) by plants, photosynthetic bacteria, and algae and is "fixed" into organic substances. Animals obtain their requirements for carbon (as carbon-based molecules) by eating plants or other animals. For the biological links, the carbon cycle comes full cycle when carbon is released by either plants or animals as they respire or after life as they decompose. Organisms respire carbon dioxide as a waste product from the breakdown of organic molecules as their cells derive energy from oxidizing the molecules containing "fixed" carbon. The burning of organic material such as wood or fuels also results in the release of carbon dioxide from organic carbon.

CO_2 is a trace gas and has huge effects on Earth's heat balance by absorbing infrared radiation. During the growing season or summer, there is a decrease in atmospheric CO_2 because increased sunlight and temperature helps plants increase their carbon dioxide uptake and growth. In the winter time, more CO_2 enters the atmosphere than can be removed by plants. This happens because plant respiration and the death of plants happens faster than photosynthesis.

4. Oxygen Cycle

The oxygen cycle is the cycle that helps move oxygen through the three main regions of the Earth, i.e. the Atmosphere, the Biosphere, and the Lithosphere. The Atmosphere is of course the region of gases that lies above the Earth's surface and it is one of the largest reservoirs of free oxygen on earth. The Biosphere is the sum of all the Earth's ecosystems. This also has some free oxygen produced from photosynthesis and other life processes? The largest reservoir of oxygen is the lithosphere. Most of this oxygen is not on its own or free moving but part of chemical compounds such as silicates and oxides.

In the atmosphere Oxygen is freed by the process called photolysis. This is when high energy sunlight breaks apart oxygen bearing

molecules to produce free oxygen. One of the most well known photolysis it the ozone cycle. O_2 molecule is broken down to atomic oxygen by the ultra violet radiation of sunlight. This free oxygen then recombines with existing O_2 molecules to make O_3 or ozone. This cycle is important because it helps to shield the Earth from the majority of harmful ultra violet radiations turning it to harmless heat before it reaches the Earth's surface.

In the biosphere the main cycles are respiration and photosynthesis. Respiration is when animals and humans breathe consuming oxygen to be used in metabolic process and exhaling carbon dioxide. Photosynthesis is the reverse of this process and is mainly done by plants and plankton.

The lithosphere mostly fixes oxygen in minerals such as silicates and oxides. Most of the time the process is automatic, all it takes is a pure form of an element coming in contact with oxygen such as what happens when iron rusts. A portion of oxygen is freed by chemical weathering. When a oxygen bearing mineral is exposed to the elements a chemical reaction occurs that wears it down and in the process produces free oxygen.

THE MINISTRY OF ENVIRONMENT & FORESTS

The Ministry of Environment & Forests (MoEF) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes.

The primary concerns of the Ministry are implementation of policies and programmes relating to conservation of the country's natural resources, including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing these policies and programmes, the Ministry is guided by the principle of sustainable development and enhancement of human well-being.

The Ministry also serves as the nodal agency in the country for the United Nations Environment Programme (UNEP), South Asia Co-operative Environment Programme (SACEP) and International Centre for Integrated Mountain Development (ICIMOD) and for the follow-up of the United Nations Conference on Environment and Development (UNCED). The Ministry is also entrusted with issues relating to multilateral bodies such as the Commission on Sustainable Development (CSD), Global Environment Facility (GEF) and of regional bodies like Economic and Social Council for Asia and Pacific (ESCAP) and South Asian Association for Regional Co-operation (SAARC) on matters pertaining to the environment.

The broad objectives of the Ministry are:

- Conservation and survey of flora, fauna, forests and wildlife.
- Prevention and control of pollution.
- Afforestation and regeneration of degraded areas.
- Protection of the environment and.
- Ensuring the welfare of animals.

These objectives are well supported by a set of legislative and regulatory measures, aimed at the preservation, conservation and protection of the environment. Besides the legislative measures, the National Conservation Strategy and Policy Statement on Environment and Development, 1992; National Forest Policy, 1988; Policy Statement on Abatement of Pollution, 1992; and the National Environment Policy, 2006 also guide the Ministry's work.

TERMINOLOGY OF ECOLOGY

- **Species:** A species is a natural biological unit tied together by the sharing of a common gene pool. It can be also defined as a uniform interbreeding population spread over time and space.
- **Vegetation:** The collective and continuous growth of plants in space is called vegetation. Thus, vegetation is actually the totality of plant growth, including large or small populations of each species intermixed in a region. In other words we may say that vegetation is the sum total of plant population covering a region.
- **Flora:** Flora is the species content of the region irrespective of the numerical strength of each species.
- **Population:** A population is a group of individual organisms of the same species in a given area.
- **Community:** A community is a group of population of different species in a given

area. It thus includes all the populations in that area- all plants, all animals and microorganisms.

- **Factor:** Any external force, substance or condition that affects organisms in any way, is known as factor.
- **Environment:** The sum of all factors constitute environment. It thus becomes indeed a complex of so many factors, better referred to as environmental complex.
- **Habitat:** The place, where an organism lives, or the place where one would go to find the particular organism is known as the habitat of that organism. The habitat of an organism actually represents a particular set of environmental conditions suitable for its successful growth.
- **Adaptation:** Any species puts its efforts to make full use of the available nutrient pool and other environmental conditions prevailing in the area of its growth. It ensures its own protection against adverse conditions of the habitat. This all is accomplished by the development of some characteristics.
- **ECAD:** Some of the species have more than one kind of populations spread over wide range of habitat conditions. An ecad of a plant species is a population of individuals which although belong to the same genetic stock, but differ markedly in vegetative characters such as size, shape, number of leaves, stems, etc. These variations are simply environmentally induced, and thus are temporary or reversible i.e. one type of ecad may change into another with the change in its habitat.
- **Ecotype:** An ecotype is a population of individuals of a species, which are genetically different. Since different ecotypes are inter-fertile, these are kept under the same taxonomic species. Their variations are permanent and irreversible as these are genetically fixed.
- **Eco-tone:** Although plant species grow in association with each other in groups as communities in nature, there is hardly distinguishable a point or sharp line of distinction between the two different communities. There is generally a zone of transition, presenting a situation of special ecological interest between two different types of communities, which is known as an eco-tone.
- **Life Form:** A life form is the sum of the adaptation of the plant to the climate. This view point is considered in the physiognomic method of study of plant communities.
- **Biological Spectrum:** The percentage distribution of species among the various life forms of a flora is called the biological spectrum of that place.
- **Ecological Succession:** Vegetation is hardly stable, and thus dynamic, changing over time and space. Although comparatively less evident than vegetation, animal populations, particularly lower forms, also show dynamic character to some extent. Succession is a natural process by which different groups or communities colonize the same area over a period of time in a definite sequence. The succession, which starts from a primitive substratum without any previous living matter, is known as the primary succession, whereas that starting from the previously built up substratum where living matter already existed, is known as the secondary succession. If the existing community, as a result of its reaction with the environment, causes its own replacement, then such a succession is known as autogenic succession but if the replacement of the existing community takes place due to the influence of any external force or condition, then it is called allogenic succession.
- **Climax:** In the natural process of succession, one community continues to follow another, until a stage comes when a type of community cannot be displaced under the prevailing environmental conditions. This final, terminal community, that can maintain itself more or less indefinitely in equilibrium with the prevailing environment, is known as the climax community and the stage is said to be the climax.
- **Biome:** A complex of several types of communities, some in climax stage and others in different stages of succession, maintained more or less similar climatic conditions is known as a biome.
- **Ecosystem:** In a given area, the biotic

assemblage of all the organisms, plant as well as animal communities, interacts with its physical environment in such a manner that there is a flow of energy leading to clearly defined trophic structure, biotic diversity and material cycles within a system, is known as an ecological system or ecosystem. An ecosystem is the whole biotic community in a given area plus its abiotic environment.

- **Biosphere:** The earth's living organisms interacting with their physical environment may be considered as a giant ecosystem, which is the largest and most nearly self-sufficient biological system we know, and this is designated as the biosphere or ecosphere. Thus the planet earth along with the atmosphere, hydrosphere and lithosphere which sustain life is known as biosphere.
- **Standing State:** The amount of inorganic substances, such as P, S, C, N, H etc. present at any given time in the environment of an ecosystem, is known as the standing state or standing quality.
- **Standing Crop:** The amount of living material, present in a component population at any time, is known as the standing crop, which may be expressed in terms of numbers or weight per unit area.
- **Biomass:** Biomass is the standing crop expressed in terms of weight (i.e. organism mass) of the living matter present.
- **Food Chain:** In any ecosystem, various living organisms are arranged in a definite sequence according to their food habits. Plants are producers which are eaten by herbivores, which in turn are eaten by carnivores. This transfer of food energy from the source in plants through a series of organisms with repeated eating and being eaten is known as a food chain in an ecosystem.
- **Food Web:** Under natural conditions in the same ecosystem, depending upon the variety of organisms, there generally operate a number of linear food chains at a time. These chains are interlinked with each other at several points. This interlocking pattern of a number of food chains forms a web-like arrangement known as food-web.
- **Productivity:** The rate of production i.e. amount of organic matter accumulated in the living component of an ecosystem in unit time is referred to as the productivity of the ecosystem. Primary Productivity is defined as the rate at which radiant energy of sun is stored by photosynthetic and chemosynthetic activities of producers in the form of organic substances, used as food materials. The rates of energy storage at consumer levels are referred to as Secondary Productivity.
- **Gross Primary Productivity:** It is the total rate of photosynthesis, including the organic matter used up in respiration during the period of measurement. This is also called Total Photosynthesis or Total Assimilation.
- **Net Primary Productivity:** It is the rate of storage of organic matter in plant tissue in excess of that utilized in respiration by plants during the period of measurement. This is also called Apparent Photosynthesis or Net Assimilation.
- **Net productivity:** Net productivity of a community is the rate of storage of organic matter not used by heterotrophs i.e. net primary production minus heterotrophic consumption, during the period under consideration.
- **Biogeochemical Cycles:** More or less circular pathways, through which the chemical elements, including all the essential elements of the protoplasm, circulate in the biosphere from environment to organisms and back to the environment, are known as the biogeochemical cycles.
- **Ecological Niche:** Ecological niche of an organism include the physical space occupied by it, its functional role in the community i.e. trophic position, and its position in environment gradients of temperature, moisture, pH of soil, etc. and the conditions of existence. Organisms that occupy the same or similar ecological niche in different geographical regions are known as Ecological Equivalents.

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ECOSYSTEM

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The two components of nature, viz. organisms and their environment are not only complex and dynamic, but also interdependent, mutually reactive and inter-related. Ecology deals with the various principles which govern such relationships between organisms and their environment.

Professor Eugene P. Odum (1913-2002), is widely recognized as the "Father of Ecosystem Ecology". His monumental book entitled Fundamentals of Ecology (first published in 1953) revolutionized teaching of ecology world over as it presented a new framework of the subject. Haeckel first used the term ecology. He regarded the ecology of an organism as the knowledge of the sum of the relations of organisms to the surrounding outer world and to organic and inorganic conditions of existence. After the introduction of the term ecosystem in literature by A. Tansley in 1935, started the era of ecosystem approach to ecology.

The various communities of living organisms (plants and animals) interact among themselves as well as with their physical environment like soil, air and water. The living organisms interact with one another through their food chains in which one organism consumes another organism. The living organisms like plants interact with soil to get essential nutrients like nitrogen, phosphorus, etc, with air to get carbon dioxide and also with water bodies for carrying out the process of photosynthesis. Thus, the various communities of living organisms like plants and animals along with soil, air and water of that region form a self-subsisting or functional ambit of the living world. This functional unit or system made up of living and non-living components which is capable of independent existence is called an ecosystem.

Definition: Tansley defined ecosystem as "the system resulting from the integration of all the living and non-living factors of the environment." He further stated that " the whole system includes not only the organism complex but also the whole complex of physical factors forming what we call the environment of the biome-the habitat factors in the widest sense. "It is the systems so formed which-are basic units of nature on the face of the earth."

Strahler has defined ecosystem as "the total assemblage of components entering into the interactions of a group of organism". He further elaborated that "to the geographer, ecosystems are the part of the physical composition of the life layer."

Ecosystem has also been defined as-"a unit that includes all the organisms (biological factors) in a given area interacting with the environment (physical factors) so that a flow of energy leads to a clearly defined trophic (nutrient requiring) structure, biotic diversity, and material cycles (i.e. exchange of materials between living and non-living sectors)."

An ecosystem is an overall integration of whole mosaics of interacting organisms and their environment. It is normally an open system with a continuous, but variable, influx and loss of material and energy. It is a basic, functional unit with no limits of boundaries, consisting of both biotic and abiotic components interacting with each other, both necessary for maintenance of life upon earth. Thus an ecosystem represents the highest level of ecological integration which is energy-based and this functional unit is capable of energy transformation, accumulation and circulation. Its main function in ecological sense is to emphasize obligatory relationships, interdependence and causal relations.

KINDS OF ECOSYSTEM

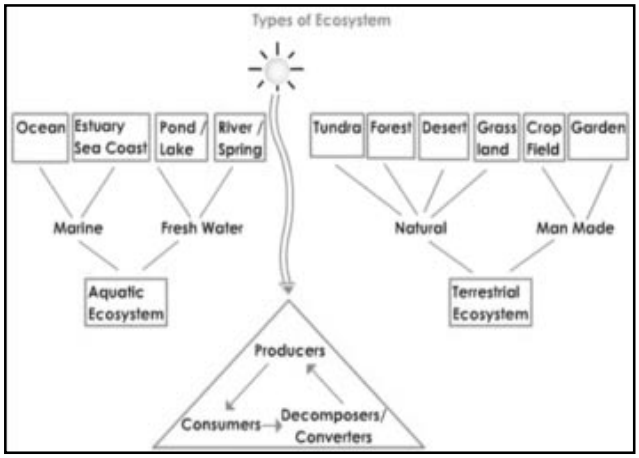
Ecosystems may be categorized as follows:

1. **Natural Ecosystems:** These operate by themselves under natural conditions without any major interference by man. Based upon the particular kind of habitat, these are further divided as:
   a) **Terrestrial,** as forest, grassland, desert, etc.
   b) **Aquatic,** which may be further distinguished as:

i) **Freshwater,** which may be lotic (running water as spring, stream, or rivers) or lentic (standing water as lake, pond, pools, swamp, etc.).

ii) **Marine,** such deep bodies as an ocean or shallow ones as a sea or estuary, etc.

2. **Artificial** (man-engineered) ecosystems: these are maintained artificially by man where, by addition of energy and planned manipulations, natural balance is disturbed regularly. For example croplands like maize, wheat, rice-fields, etc. where man tries to control the biotic community as well as the physio-chemical environment, are artificial ecosystems.



STRUCTURE AND FUNCTION OF AN ECOSYSTEM

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

By structure we mean

1. The composition of biological community, including species, numbers, biomass, life history and distribution in space, etc.
2. The quantity and distribution of the nonliving materials, such as nutrients, water, etc. and
3. The range or gradient of conditions of existence, such as temperature, light, etc.

By function we mean

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

Structure of an Ecosystem

All the ecosystems are made up of two main components i.e. Abiotic components and Biotic components.

1. **Abiotic component** of an ecosystem includes:

   i) The amount of inorganic substances like carbon dioxide, nitrogen, oxygen, water and elements (P, S, C, N, H etc.) involved in material cycles. The amount of these inorganic substances, present at any given time in ecosystem, is designated as the Standing State or Standing Quality.

   ii) The amount and distribution of inorganic chemicals, such as chlorophyll, etc., and of organic materials, such as proteins, carbohydrates, lipids, etc., present either in the biomass or in the environment i.e. Biochemical Structure that links the biotic and abiotic components of the ecosystem.

   iii) The physical factors or climatic factors like light, temperature, pressure and humidity.

2. **Biotic component** of an ecosystem is indeed the trophic structure of any ecosystem, where living organisms are distinguished on the basis of their nutritional relationships. From this trophic standpoint, an ecosystem has two components:

A. ***Autotrophic Component*** in which fixation of light energy, use of simple inorganic substances and build up of complex substances predominate. The component is constituted mainly by green plants, including photosynthetic bacteria. To some lesser extent, chemosynthetic microbes also contribute to the build up of organic matter. Members of the autotrophic component are known as Producers.

B. ***Heterotrophic Component*** in which utilization, rearrangement and decomposition of complex materials predominate. The organisms involved are known as Consumers, as they consume the matter built up by the autotrophs. The Consumers are further categorized as:

a) ***Macroconsumers:*** These are the consumers, which in an order as they occur in a food chain are Herbivores, Carnivores (or Omnivores). Herbivores are also known as Primary Consumers. Secondary and Tertiary Consumers, if present, are Carnivores or Omnivores. They all are Phagotrophs which include chiefly animals that ingest other organic and particulate organic matter.

b) ***Microconsumers:*** These are popularly known as Decomposers. They are Saprotrophs (Osmotrophs) and include chiefly bacteria, actinomycetes and fungi. They breakdown complex compounds of dead or living protoplasm, absorb some of the decomposed products and release inorganic nutrients in environment, making them available again to autotrophs.

The biotic component of any ecosystem may be thought of as the Functional kingdom of nature, since they are based on the type of nutrition and the energy source used. The trophic structure of an ecosystem is one kind of producer-consumer arrangement, where each "food" level is known as trophic level. The amount of living material in different trophic levels or in a component population is known as the Standing Crop, a term applicable to both, plants as well as animals. The standing crops may be expressed in terms of

1. Number of organisms per unit area, or
2. Biomass i.e. organism mass in unit area, which can be measured as living weight, dry weight, ash-free dry weight or carbon weight, or calories or any other convenient unit suitable for comparative purposes.

ECOLOGICAL PYRAMIDS

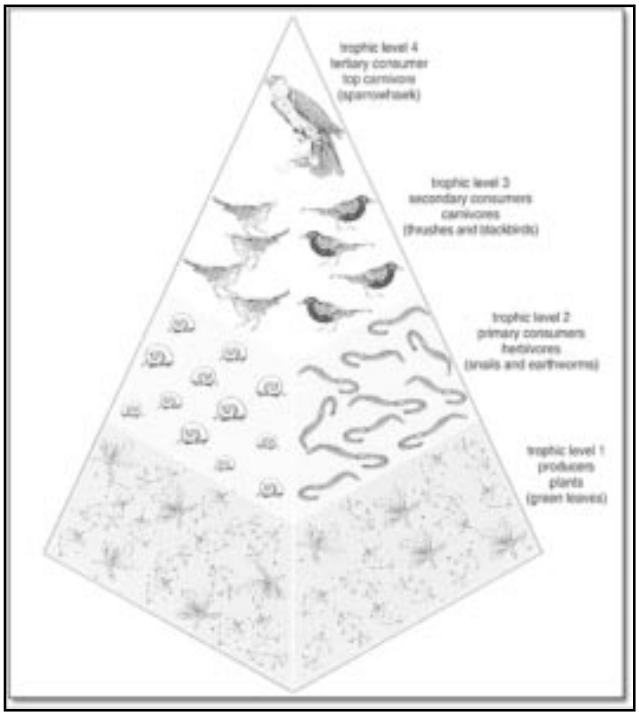
Trophic structure, i.e. the interaction of food chain and the size metabolism relationship between the linearly arranged various biotic components of an ecosystem is characteristic of each type of ecosystem. The trophic structure and function at successive trophic levels, i.e. producers, herbivores, carnivores, may be shown graphically by means of ecological pyramids where the first or producer level constitutes the base of the pyramid and the successive levels, the tiers making the apex.

Ecological pyramids are of three general types-

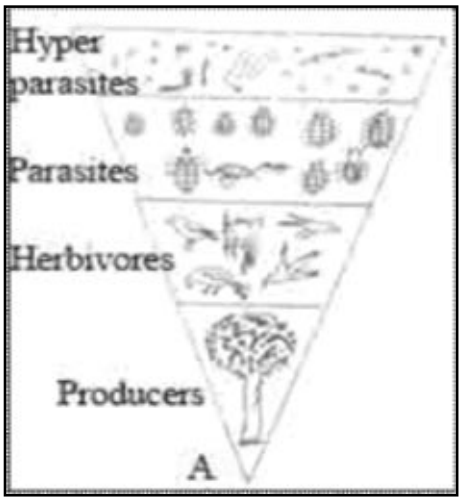
1. Pyramid of numbers, showing the number of individual organisms at each level.
2. Pyramid of biomass, showing the total dry weight and other suitable measures of the total amount of living matter, and
3. Pyramid of energy, showing the rate of energy flow and/or productivity at successive trophic levels.

The pyramids of numbers and biomass may be upright or inverted depending upon the nature of the food chain in the particular ecosystem, whereas pyramids of energy are always upright.

1. Pyramid of Numbers: They show the relationship between producers, herbivores and carnivores at successive trophic levels in terms of their number. In a grassland, the producers, which are mainly grasses, are always maximum in number. This number then shows a decrease towards apex, as the primary consumers (herbivores) like rabbits, mice, etc. are lesser in number than grasses; the secondary consumers, snakes and lizards are lesser in number than the rabbits and mice. Finally, the top (tertiary) consumers, hawks or other birds are least in number. Thus the pyramid becomes upright. Similarly, in a pond ecosystem, the producers, which are mainly phytoplanktons as algae, bacteria, etc. are maximum in number; the herbivores, which

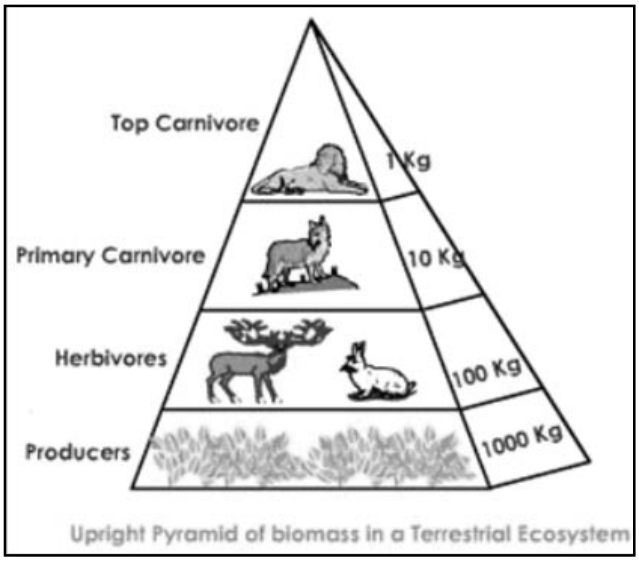


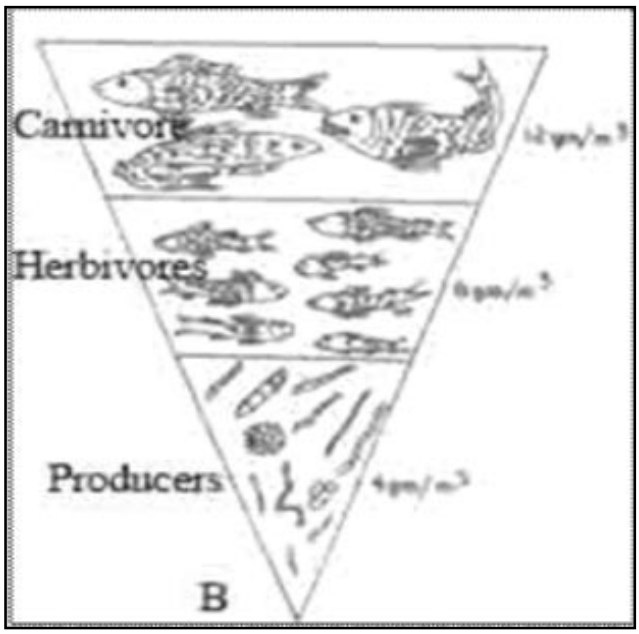
are small fishes, rotifers, etc. are lesser in number than the producers; and the secondary consumers (carnivores), such as fish eating each other, water beetles, etc. are lesser in number than the herbivores. Finally, the tertiary consumers, the bigger fishes are least in number. Similar upright pyramid can be observed in a forest ecosystem also. However, in a parasitic food chain the pyramid of number is always inverted. This is due to the fact that a single plant may support the growth of many herbivores and each herbivore in turn may provide nutrition to several parasites, which again can support numerous hyper-parasites. Thus, from the producer towards consumers, the number of organisms gradually shows an increase, making the pyramid inverted.



Actually the pyramids of numbers do not give a true picture of the food chain as they are not very functional. They generally vary with different communities with different types of food chain in the same environment. It becomes difficult to represent the whole community on the same numerical scale (as in forests).

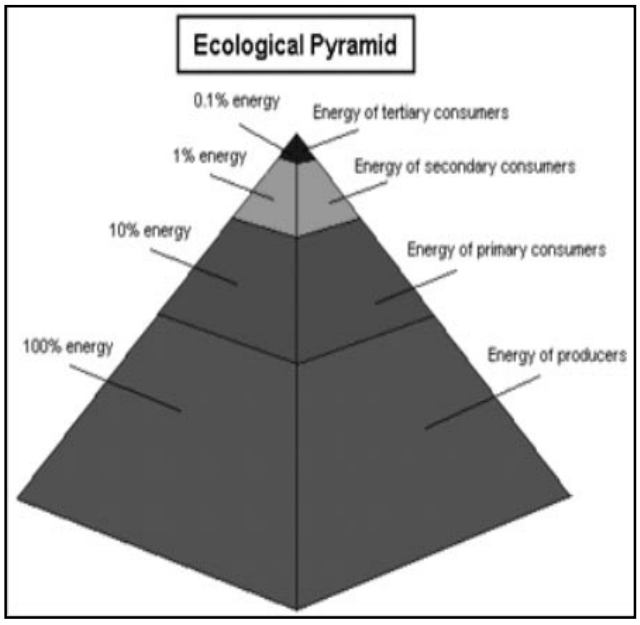
2. Pyramid of Biomass: They are comparatively more fundamental, as they, instead of geometric factor, show the quantitative relationships of the standing crops. The pyramids of biomass





in grasslands and forests are upright as there is generally a gradual decrease in biomass of organisms at successive levels from the producers to the top carnivores. However, in a pond as the producers are small organisms, their biomass is least; this value gradually shows an increase towards the apex of the pyramid, thus making the pyramid inverted in shape.

3. Pyramid of Energy: The pyramid of energy gives the best picture of overall nature of the ecosystem. As against the pyramids of number and biomass the shape of the pyramid of energy is always upright because in this the time factor is always taken into account. The pyramid of energy represents the total quantity of energy unutilized by different trophic level organisms of an ecosystem per unit area over a set period of time (usually per square meter per year). In a terrestrial ecosystem, the quantity of



energy trapped by green plants in an area over a period say a year is highest compared to that of organisms of other trophic levels and therefore the base of the pyramid is broad. In aquatic system also, the population of phytoplanktons quickly complete their life cycle and sets of new generation of crops of phytoplankton are formed every few hours of day. The cumulative energy content that these generations of phytoplanktons trap in course of a year is certainly much more than that of only a few generation of herbivore fishes in the corresponding time and space. The energy content of top carnivores is the least. Therefore, the pyramid of energy can never be of any other shape except upright pyramidal.

One way to calculate the energy transfer, is by measuring the energy at one trophic level and then at the next. Calorie is a unit of measure used for energy. The energy transfer from one trophic level to the next is about 10%. For example, if there are 10,000 calories at one level, only 1,000 are transferred to the next. This 10% energy and material transfer rule can be depicted with an ecological pyramid that looks like this:

This pyramid helps one visualize the fact that in an ecological system there need to be many producing organisms at the bottom of the pyramid to be able to sustain just a couple of organisms at the top.

In the event of destruction of organisms at any level, the organism of next higher trophic level will automatically die for want of food (or source of energy) and ultimately the upright pyramidal shape is maintained.

FUNCTION OF AN ECOSYSTEM

From the operational viewpoint the living and non-living components of ecosystem are so interwoven in the fabric of nature that their separation from each other becomes practically very much difficult. Ecosystems possess a natural tendency to persist. This is made possible by a variety of functions performed by the structural components. For instance, green leaves function as sites of food production, and roots absorbs nutrients from the soil. Herbivores perform the function of utilizing parts of the plant production and in turn, serve as food for carnivores. Decomposers carry out the function of breaking down complex organic materials into simpler inorganic products, which can be used by the producers. These functions are carried out in the ecosystem through deliberately balanced and controlled processes. For example, the process of photosynthesis is involved in food production, and that of decomposition, leads to release of nutrients contained in the organic matter.

Knowledge of the rates at which different processes occur in the ecosystem is necessary to understand the interrelations of the ecosystem's structure and function. The key functional aspects of the ecosystem are:

1. Productivity and energy flow
2. Nutrient cycling; and
3. Development and stabilization.

Productivity of ecosystem

The productivity of an ecosystem refers to the rate of production i.e. the amount of organic matter accumulated in any unit time. Productivity is of following types:

1. **Primary Productivity.** It is associated with the producers which are autotrophic, most of which are photosynthetic, and to a much lesser extent the chemosynthetic microorganisms. These are the green plants, higher macrophytes as well as lower forms, the phytoplanktons and some photosynthetic bacteria. Primary productivity is defined as "the rate at which radiant energy is stored by photosynthetic and chemosynthetic activities of the producers." Primary productivity is further distinguished as:

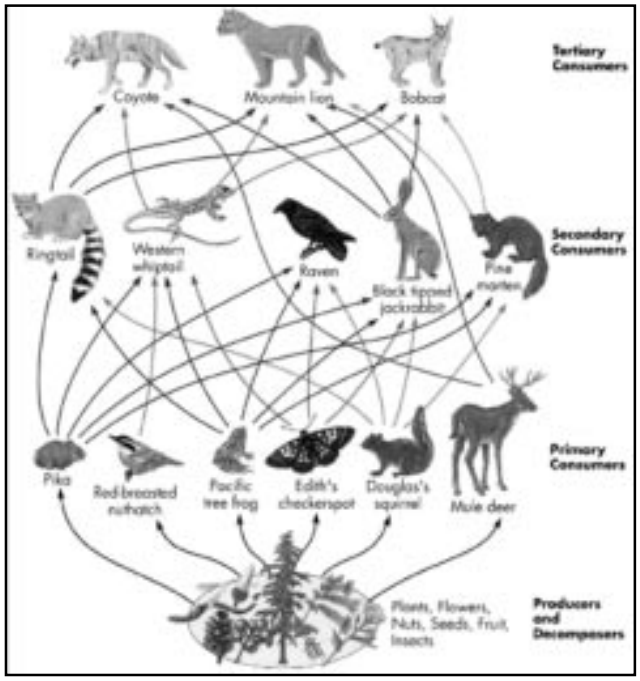
   (a) ***Gross Primary Productivity.*** It is the total rate of photosynthesis including the organic matter used up in respiration during the measurement period. This is also sometimes referred to as Total (Gross) Photosynthesis or Total Assimilation. It depends on the chlorophyll content. It is estimated in terms of either chlorophyll content as, Chl/g dry weight/unit area, or photosynthetic number i.e. amount of CO_2 fixed/g Chl/hour.

   (b) ***Net primary Productivity.*** It is the rate of storage of organic matter in plant tissues in excess of the respiratory utilization by plants during the measurement period. This is thus the rate of increase of biomass and is also known as Apparent Photosynthesis or Net assimilation. Thus net primary productivity refers to balance between gross photosynthesis and respiration and other plant losses as death etc.

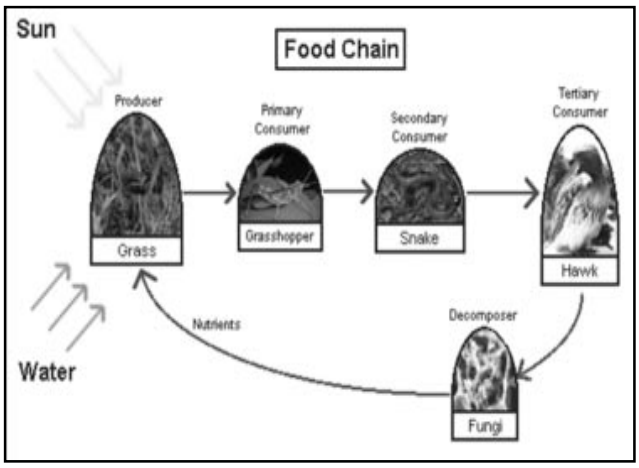
2. **Secondary Productivity.** It refers to the consumers or heterotrophs. These are the rates of energy storage at consumer level. Since consumers only utilize food material (already produced) in their respiration, simply converting the food matter to different tissues by an overall process, secondary productivity is not divided into 'gross' and 'net' amounts. Thus, some ecologists prefer to use the term assimilation rather than production at this level. Secondary productivity actually remains mobile (i.e. keeps moving from one organism to another) and does not live in situ like the primary productivity.

3. **Net Productivity.** It refers to the rate of storage of organic matter not used by the heterotrophs (consumers) i.e. equivalent to net primary production minus consumption by the heterotrophs during the unit period, as a season or year, etc. It is thus the rate of increase of biomass of the primary producers which has been left over by the consumers. Net productivity is generally expressed as production of C g/m2/day which may then be consolidated on month, season or year basis.

FOOD CHAINS IN ECOSYSTEM



The unidirectional transfer of food energy from the producers, through a series of organisms (herbivores to carnivores to decomposers) with repeated eating and being eaten, is known as food chain. Producers utilize the radiant energy of sun which is transformed to chemical



form, ATP during photosynthesis. Thus green plants occupy, in any food chain, the first trophic (nutritional) level- the producers level, and are called the primary producers. The energy, as stored in food matter manufactured by green plants, is then utilized by the plant eaters- the herbivores, which constitute the second trophic level- the primary consumers level, and are called the primary consumers (herbivores). Herbivores in turn are eaten by the carnivores, which constitute the third trophic level- the secondary consumers level, and are called the secondary consumers (carnivores). These in turn may be eaten still by other carnivores at tertiary consumers level i.e. by the tertiary consumers (carnivores). Some organisms are omnivores eating the producers as well as the carnivores at their lower levels in the food chain.

A number of food chains are interconnected by organisms which occur in more than one food chain. All organisms, including man need food which provides energy for growth, maintenance and reproduction. A part of the energy provided by food is used for biological processes and the rest is dissipated to the environment as heat energy by the process of respiration. Undigested food is excreted and enters the detritus path. Now, plants can be eaten by a rat. The rat, in turn, can be eaten by a cat and finally, the cat can be eaten by a dog. So, we find that there is a sequence in which one organism eats up the other organisms to fill its belly. The sequence of living organisms in a community, in which one organism consumes another organism to transfer food energy, is called a Food Chain.

FOOD WEB

A food web is a graphical description of feeding relationships among species in an ecological community, that is, of who eats whom. It is also

a means of showing how energy and materials flow through a community of species as a result of these feeding relationships. Typically, species are connected by lines or arrows called "links", and the species are sometimes referred to as "nodes" in food web diagrams.

The pioneering animal ecologist Charles Elton (1927) introduced the concept of the food web (which he called food cycle) to general ecological science. As he described it: "The herbivores are usually preyed upon by carnivores, which get the energy of the sunlight at third-hand, and these again may be preyed upon by other carnivores, and so on, until we reach an animal which has no enemies, and which forms, as it were, a terminus on this food cycle. There are, in fact, chains of animals linked together by food, and all dependent in the long run upon plants. We refer to these as 'food-chains' and to all the food chains in a community as the 'food-cycle.

A food web differs from a food chain in that the latter shows only a portion of the food web involving a simple, linear series of species (e.g., predator, herbivore, plant) connected by feeding links. A food web aims to depict a more complete picture of the feeding relationships, and can be considered a bundle of many interconnected food chains occurring within the community. All species occupying the same position within a food chain comprise a trophic level within the food web. For instance, all of the plants in the food web comprise the first or "primary producer" tropic level, all herbivores comprise the second or "primary consumer" trophic level, and carnivores that eat herbivores comprise the third or "secondary consumer" trophic level. Additional levels, in which carnivores eat other carnivores, comprise a tertiary trophic level.

ENERGY FLOW IN ECOSYSTEM

At the base of an ecosystem, primary producers are actively converting solar energy into stored chemical energy. Photosynthesis is the process of converting solar energy, water and carbon dioxide into carbohydrates and oxygen. The process occurs in two steps: first light energy is absorbed by chlorophyll to split a molecule of water releasing hydrogen and oxygen. The second step uses the energy to convert carbon dioxide to carbohydrates.

The carbohydrate ($C_6H_{12}O_6$) can be converted into starch and stored by the plant. Carbohydrate can be combined with other sugar molecules to make cellulose, the basic structural material of a plant.

Oddly enough, of all the solar radiation striking a plant, only about 1 per cent is used in photosynthesis. The rate of photosynthesis is dependent on several things, including the amount of light received. As solar radiation increases, the rate of photosynthesis increases. For many plants there is an upper limit to the rate of photosynthesis. In some plants, as incident solar radiation increases, the rate of photosynthesis levels off, or may decrease. The increasing solar energy causes the plant to be too hot and the need to cool the plant increases. As a result, transpiration takes over as the dominate plant process. Transpiration, the loss of water from plants, acts to cool the plant by releasing latent energy. Adequate supplies of water, carbon dioxide and the availability of nutrients in the soil affect photosynthesis.

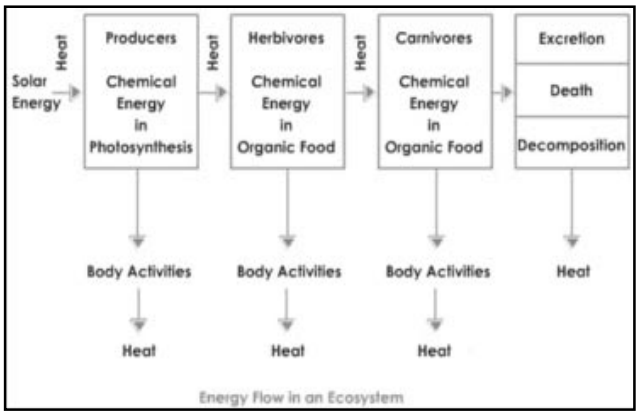
Respiration

While photosynthesis builds stored chemical energy in a plant, respiration is the process of "burning" stored chemical energy, basically through oxidation, for maintaining plant metabolism. During respiration, carbohydrates combine with oxygen and are reduced to carbon dioxide, water and heat.

While photosynthesis operates only during day when sunshine is available, respiration goes on both night and day. Plant growth occurs so long as photosynthesis exceeds respiration.

Two laws of physics are important in the study of energy flow through ecosystems.

The first law of thermodynamics states that energy cannot be created or destroyed; it can only be changed from one form to another. Energy for the functioning of an ecosystem comes from the Sun. Solar energy is absorbed by plants wherein it is converted to stored chemical energy.



Energy Flow in an Ecosystem

The second law of thermodynamics states that whenever energy is transformed, there is a loss of energy through the release of heat. This occurs when energy is transferred between trophic levels as illustrated in a food web. When one animal feeds off another, there is a loss of energy in the process. Additional loss of energy occurs during respiration and movement. Hence, more and more energy is lost as one moves up through trophic levels. This fact lends more credence to the advantages of a vegetarian diet. For example, 1350 kilograms of corn and soybeans is capable of supporting one person if converted to beef. However, 1350 kilograms of soybeans and corn utilized directly without converting to beef will support 22 people.

To summarize: In the flow of energy and inorganic nutrients through the ecosystem, a few generalizations can be made:

1. The ultimate source of energy (for most ecosystems) is the sun.
2. The ultimate fate of energy in ecosystems is for it to be lost as heat.
3. Energy and nutrients are passed from organism to organism through the food chain as one organism eats another.
4. Decomposers remove the last energy from the remains of organisms.
5. Inorganic nutrients are cycled, energy is not.

Ecological Efficiencies

Various ratios are used to express the efficiency with which organisms exploit their food resources and convert the food into biomass. Commonly, such ratios are calculated by relating output to input of energy (both expressed in same units) at various points along pathways of energy flow. These ratios are multiplied with 100 to express the efficiency as percentage. At the level of producer, the photosynthetic efficiency and net production efficiency deserve consideration.

The percentage of energy transferred from one trophic level to another is called ecological efficiency. The efficiency of energy transfer from one trophic level to another varies from 5% to 20% depending on the types of organisms and environmental conditions. In the terrestrial ecosystem, only 10% of the plant energy is transformed to herbivores, rest 90% escape in the form of heat. That means on an average, only 10% of energy is transferred from one trophic level to another.

The ability of herbivores and carnivores to use the food energy ingested varies from one species to another. Important efficiency measures for consumers include assimilation efficiency (at one trophic level) and ecological efficiency or trophic level efficiency (between two trophic levels).

BIOLOGICAL MAGNIFICATION

Modern agricultural activities use a large number of toxic chemicals like pesticides, weedicides and rodenticides, to protect the crop plants from pests and diseases. Some of these poisonous chemicals mix up with soil and water and are absorbed by the plants from the soil along with water and other minerals. In this way, the poisonous chemical substances enter the food chain right from the producer level. When man and other animals eat these plants or their products, the poisonous chemical substances are transferred to their bodies. During the process of food transfer through trophic levels, these harmful chemicals get concentrated at each successive level. The increase in concentration of harmful chemical substances like pesticides in the body of living organisms at each trophic level of a food chain is called biological magnification.

In 1992, at lot of DDT was put in the Lake Michigan in North America to kill the mosquitoes and eliminate malaria. After about 20 years, it was found that the number of pelican birds which lived around this lake was decreasing very rapidly. The scientists explained the abnormal disease in the pelican population on the basis of bio-magnification of the DDT pesticide in the bodies of pelicans. Due to the presence of DDT, the eggs laid down by them had a very thin outer shell. Due to this, even before the young ones of pelicans could hatch, the thin shell of the egg broke off, which resulted in the decrease of pelican population.

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BIODIVERSITY

CHRONICLE
IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

Biological diversity or biodiversity refers to numbers, variety, and variability of living organisms and ecosystems. The term 'biodiversity' includes all terrestrial marine, and other aquatic organisms. It also covers diversity within species, between species, as well as the variation among ecosystems. It is concerned also with their complex ecological interrelationships.

Biodiversity boosts ecosystem productivity where each species, no matter how small, have an important role to play. For example,

- A larger number of plant species means a greater variety of crops.
- Greater species diversity ensures natural sustainability for all life forms.
- Healthy ecosystems can better withstand and recover from a variety of disasters.

Types of Biodiversity

Biological diversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels; the genetic variability within a species, the variety of species within a community, and the organization of species in an area where distinctive plant and animal communities constitute ecosystem diversity.

I. Genetic Diversity: It refers to variation of genes within species. Each member of any animal or plant species differs widely from other individuals in its genetic makeup because of the large number of combinations possible in the genes that give every individual specific characteristic. Thus, for example, each human being is very different from all others. This genetic variability is essential for a healthy breeding population of a species. If the number of breeding individuals is reduced, the dissimilarity of genetic makeup is reduced and in-breeding occurs. Eventually this can lead to the extinction of the species. The diversity in wild species forms the 'gene pool' from which our crops and domestic animals have been developed over thousands of years. Today the variety of nature's bounty is being further harnessed by using wild relatives of crop plants to create new varieties of more productive crops and to breed better domestic animals. Modern biotechnology manipulates genes for developing better types of medicines and a variety of industrial products.

II. Species diversity: The number of species of plants and animals that are present in a region constitutes its species diversity. This diversity is seen both in natural ecosystems and in agricultural ecosystems. Some areas are richer in species than others. Natural undisturbed tropical forests have much greater species richness than plantations developed by the Forest Department for timber production. A natural forest ecosystem provides a large number of non-wood products that local people depend on such as fruit, fuel wood, fodder, fibre, gum, resin and medicines. Timber plantations do not provide the large variety of goods that are essential for local consumption.

In the long-term the economic sustainable returns from non-wood forest products is said to be greater than the returns from felling a forest for its timber. Thus the value of a natural forest, with all its species richness is much greater than a plantation. Modern intensive agricultural ecosystems have a relatively lower diversity of crops than traditional agro-pastoral farming systems where multiple crops were planted. Areas that are rich in species diversity are called 'hotspots' of diversity.

The following factors determine the degree of species diversity in an ecosystem or community:

a) Habitat stress: species diversity is low in habitats under any stress such as harsh climate or pollution.

b) Geographical isolation: species diversity is less in isolated regions like an island. If a species in an island disappears due to random events, it cannot be easily replaced. Organisms from the mainland have difficulties in reaching and colonizing the island.

c) **Dominance by one species:** the dominant species consumes a disproportionate share of the resources. This does not allow many species to evolve and flourish.

d) **Edge effect:** there is always greater species diversity in transition area, where two or more ecosystems overlap.

e) **Geological history:** old and stable ecosystems such as rain forests that have not experienced many changes have high species diversity. An ecosystem like the arctic has undergone many changes and this does not allow any species to establish themselves.

III. Ecosystem Diversity: There are a large variety of different ecosystems on earth, which have their own complement of distinctive inter linked species based on the differences in the habitat. Ecosystem diversity can be described for a specific geographical region or a political entity such as a country, a State or a taluka. Distinctive ecosystems include landscapes such as forests, grasslands, deserts, mountains, etc., as well as aquatic ecosystems such as rivers, lakes, and the sea. Each region also has man-modified areas such as farmland or grazing pastures. An ecosystem is referred to as 'natural' when it is relatively undisturbed by human activities or 'modified' when it is changed to other types of uses, such as farmland or urban areas. Ecosystems are most natural in wilderness areas. If natural ecosystems are overused or misused their productivity eventually decreases and they are then said to be degraded. India is exceptionally rich in ecosystem diversity.

MEASURING OF BIODIVERSITY

Purvis & Hector (2000) describe three facets of biodiversity that can be measured:

- **Numbers:** e.g. the number of genes, populations, species or taxa in an area.
- **Evenness:** a site containing 1000 species may not seem very diverse if 99.9% of the species are the same.
- **Difference:** some pairs populations, species or taxa may be very similar whilst others are very different. For example, if populations within a species are very different they may be considered as different sub-species, management units or evolutionary significant units. Some differences may be considered to be more important than others, for example, ecological differences between species may be important for ecosystem function. All of these kinds of differences are likely to be at least partly reflected by phylogenetic diversity among organisms, which is the sum total of the branch lengths in the evolutionary tree (phylogeny) that links the organisms together. If you sample the phylogeny in different places you will find different things.

Although biodiversity can be measured in lots of different ways the most commonly used measure is that of species richness because:

a. Species often keep their genes to themselves and thus can have independent evolutionary trajectories and unique histories; it thus makes biological sense to measure species richness rather than a higher taxonomic grouping.

b. It is often easier to count the number of species compared to other measures of biodiversity. Humans tend to be able to recognize species and these are the units typically used in folk knowledge, practical management and political discourse. Humans can visualize variation in biodiversity as variation in species richness.

c. There is a substantial body of information already available on species, for example, in museums and herbaria.

d. Species richness can act as a 'surrogate' for other measures of biodiversity. In general as long as the number of species involved is moderate, greater numbers of species will tend to have more genetic diversity and have greater ecological diversity as more niches, habitats or biomes will be represented.

IMPORTANCE OF BIODIVERSITY

Environmental services from species and ecosystems are essential at global, regional and local levels. Some environmental services are discussed below:

a) Ecosystem Services

- **Protection of water resources:** The natural vegetation cover in catchments

areas helps in maintaining hydrological cycles, regulating and stabilizing runoff and acts as buffer against extreme events like flood and drought. It also helps to regulate underground water table and prevents its drying up. Thus a pointer to degradation of habitats is the depletion of ground water levels. In India, the last 25 years have seen a decline of water level by 30 feet in the entire eastern coast and can be reasoned for the occurrence of frequent floods and drought.

- **Soil formation and protection:** Bio-diversity also helps maintenance of soil structure and increases the moisture retention capacity as well as nutrient level of soil. No sustained effort to preserve the ecology has resulted in denudation and soil erosion. Thus, salinization of soils, leaching of nutrients, top soil erosion, etc. lead to overall decline in soil productivity. Trees also help in soil formation, their root system enables deep penetration of water and transport mineral nutrients to surface.

- **Nutrient storage and cycling:** Nutrient recycling is an essential event concerned with maintenance of the ecosystem. Biological diversity is inevitable for this. Microorganisms in the soil, by decomposing dead and decayed wastes, replenish the soil nutrients. The function of nitrate bacteria and that of a nitrifying bacteria being different, diversity of the microorganisms is also essential.

- **Pollution, breakdown and absorption:** The many pollutants, including sewage, garbage, oil spills etc. are all deleterious to the balance of the ecosystem. The diverse components of ecosystem, with special mention of the decomposers, break down and assimilate these wastes.

- **Climatic Stability:** Vegetation influences climate both at the micro and macro levels. Forests maintain rainfall by recycling water vapour steadily into atmosphere turbulence. There happens an increase in temperature due to increase in levels of CO_2 in atmosphere. Only trees can absorb CO_2 and maintain a stable CO_2-O_2 balance.

- **Maintenance of ecosystems:** The animal-plant interrelationship is essential to allow survival, and to maintain balance between living things and the needful resources. Thus vegetation is integral to maintenance of water and moisture levels as well. The web of life is so intricate that removal or disturbance of one part of the ecosystem could affect the smooth functioning of many of its other components.

b) Biological Resources

- **Food Resources:** Heterotrophs depend on autotrophs, the primary producers of food. Only through conservation of floral biodiversity can global food capacity be met with since nutritional value is different for different groups. Further, diversity of food crops increases opportunities for enhancing agricultural productivity.

- **Medicine:** The Ayurvedic system of medication is entirely dependent on the biodiversity of the flora. Diverse plants have diverse medicinal values. Plant products are immense ranging from Quinine, Cinchona, Tylorebrine, to the Vine Tylophra (for the treatment of serious lymphoid leukemia). Thus, to provide resource of searching new medically active compounds, at least some part of the nature has to be left undisturbed. The Silent Valley Forests of Kerala are preserved since it was known to hoard diverse endemic varieties with immense medicinal value.

- **Wood requirements:** Wood is a basic commodity and is harvested from the wild. The timber industry forms a significant part of our modern economy. Hard woods, soft woods etc. are put to entirely different uses; others are used as fuels, for paper manufacturing, etc. So to meet different needs, bio-diversity has to be maintained.

c) Social Benefits

Nature serves as the best laboratory for studies. It's hard to duplicate strictly a natural environment. So, research, education and such extension works can progress only with the help

of nature and its inherent biodiversity. Unaltered habitants help us to evolve indexes to formulate different management levels.

- **Recreation and tourism**: The aesthetic qualities of natural habitats are a result of its biological diversity. No two spots in a forest can exactly be alike in all aspects. Since time immemorial nature has satisfied recreational pursuits of the humans. The gifted nature and the rich bio-diversity have made India one of the important tourist attractions of the modern world.
- **Cultural Value**: There are ample evidences to prove that human culture has co-evolved with the environment. For this reason itself, conservation of bio-diversity is important for man's cultural identity. For, it has been found that nature has always provided inspirational, aesthetic and educational needs of the people. Nature also contributes to our emotional and spiritual well being.

LOSS OF BIO-DIVERSITY

Extinction is a natural event. But humans have increased the species extinction rate by as much as 1,000 times over background rates typical over the planet's history. 10-30% of mammal, bird, and amphibian species are currently threatened with extinction.

In modern era, failure to consider the importance of nature has resulted in the threat to bio-diversity as a whole. There exists an overall lack of any sustained effort to preserve the ecosystem. As genetic diversity erodes our capacity to maintain and enhance agricultural forest and livestock productivity decreases. Due to human actions, biodiversity is threatened with destruction to an extent rarely seen in earth history. We can attribute the loss of species to the accelerating transformation of the earth by a growing human population. We appropriate roughly half of the world's net primary production and most available fresh water, and we harvest virtually all of the available productivity of the oceans. No wonder that species are disappearing and ecosystems are being destroyed. Apart from population growth the Millennium Ecosystem Assessment identifies habitat change, climate change, invasive species, over-exploitation and pollution as the primary drivers leading to loss of biodiversity.

a) Habitat change

Humans have had an effect on every habitat on Earth, particularly due to the conversion of land for agriculture. Cultivated systems (areas where at least 30% of the landscape is in croplands, shifting cultivation, confined livestock production, or freshwater aquaculture) now cover one quarter of Earth's terrestrial surface. Habitat loss also occurs in coastal and marine systems, though these changes are less well documented. Trawling of the seabed, for instance, can significantly reduce the diversity of benthic habitats.

b) Climate change

Observed recent changes in climate, especially warmer regional temperatures, have already had significant impacts on biodiversity and ecosystems, including causing changes in species distributions, population sizes, the timing of reproduction or migration events, and an increase in the frequency of pest and disease outbreaks. By the end of the twenty-first century, climate change and its impacts are likely to be the dominant direct driver of biodiversity loss and changes in ecosystem services globally.

c) Invasive Species

The spread of invasive alien species has increased because of increased trade and travel. While increasingly there are measures to control some of the pathways of invasive species, for example, through quarantine measures and new rules on the disposal of ballast water in shipping, several pathways are not adequately regulated, particularly with regard to introduction into freshwater systems.

d) Overexploitation

*For marine systems, the dominant direct driver of change globally has been overfishing. Demand for fish as food for people and as feed for aquaculture production is increasing, resulting in increased risk of maj*or, long-lasting collapses of regional marine fisheries. 50% of the world's commercial marine fisheries are fully exploited whilst 25% are being overexploited. For example, the Atlantic cod

stocks off the east coast of Newfoundland collapsed in 1992, forcing the closure of the fishery, the depleted stocks may not recover even if harvesting is significantly reduced or eliminated

e) Pollution (especially nutrient loading)

Since 1950, human mediated increases in nitrogen, phosphorus, sulphur, and other nutrients (nutrient loading) has emerged as one of the most important drivers of ecosystem change in terrestrial, freshwater, and coastal ecosystems, and this driver is projected to increase substantially in the future. For example, humans now produce more biologically available nitrogen than is produced by all natural pathways combined. Aerial deposition of reactive nitrogen into natural terrestrial ecosystems, especially temperate grasslands, shrub-lands, and forests, leads directly to lower plant diversity; excessive levels of reactive nitrogen in water bodies, including rivers and other wetlands, frequently leads to algal blooms and eutrophication in inland waters and coastal areas. Similar problems have resulted from phosphorus, the use of which has tripled between 1960 and 1990. Nutrient loading will become an increasingly severe problem, particularly in developing countries and particularly in East and South Asia.

Some case Studies:

- **Kailadevi Wildlife Sanctuary - Sawai Madhopur, Rajashtan**

While conservation efforts are associated with conflicts between villagers and Forest Officials in most Protected Areas across the country, the Kailadevi Wildlife Sanctuary in Rajasthan has involved local community initiatives for conservation and regeneration. The Sanctuary was initiated in 1983, over 674 sq km forming a part of the 1334 sq km Ranthambore Tiger Reserve. It is located within the Karauli and Sapotra blocks of Sawai Madhopur district. The primary occupation of the predominant Meena and Gujjar communities is pastoralism and subsistence agriculture. Pressures on the sanctuary included migrant grazers known as the Rabaris, who came from the Mewar region of Rajasthan with herds of over 150,000 sheep. Other pressures were from exploitation of timber and fuelwood and mining. The threat posed by the migrant grazers spurred the formation of the "Baragaon ki Panchayat" in 1990, which in turn initiated a 'Bhed Bhagao Andolan'.

The Forest Department supported the villagers in the formation of Forest Protection Committees and Van Suraksha Samitis. The benefits of involving local people in protection of their resources were obvious. Illegal felling was checked. The use of forest resources for local use was monitored. The Forest Protection Committees (FPCs) were also successful in stopping the mining in the Sanctuary. Mining is now banned in the Sanctuary. The people not only protect their forests but also use their resources judiciously.

- **Kokkare Bellur - Karnataka: Co-existence (Man and Wildlife)**

The pelican, which is an endangered species breeds in large numbers at Kokkare Bellur which is one of the ten known breeding sites in India. Kokkare Bellur is a village in Karnataka in Southern India. In December every year, hundreds of spot billed pelicans, painted storks, ibis and other birds migrate to this area to establish breeding colonies on the tall tamarind trees in the centre of the village. The local people have protected the birds, believing that they bring good luck with regard to rain and crops. The villagers collect a rich supply of the natural fertilizer that collects below the nests - the guano. The droppings of fish-eating birds are rich in nitrates.

The owners of the trees inhabited by the birds dig deep pits under the trees, into which the guano falls. Silt from nearby lakes and ponds are mixed with the guano which is used in their fields and sold as fertilizer. They have now planted trees around their homes to encourage nesting.

EFFECTS OF LOSS OF BIO-DIVERSITY

Extinction has become frequent and many species are disappearing without even being documented. Species are generally not being described as extinct till they have not been spotted for many years. According to a recent study by the zoological survey of India, the cheetah, the pink headed duck and the mountain quail have already become extinct in

the last decade and the brown antlered deer, hispid hare etc., are feared to be in a critical species status. The fate of its floral diversity follows the same suit.

A. Loss of genetic diversity: it imperils agriculture. The popularity of the hybrids among growers results in total neglect of its wild relatives, which finally die out. Some varieties of rice were susceptible to grassy stunt virus. When this disease assumed epidemic proportions, search began for its wild relative, seeking resistant genes. Only a wild variety, oryzanivara from U.P., had the necessary genes. This proves the significance of conservation of genetic resources. Some 492 genetically distinct populations of tree species are endangered worldwide.

B. Loss of cultural diversity: the loss of both genetic and ecosystem diversities result in a loss of cultural diversity. As new strains and systems are introduced, they result in an overall change, the extinction of many species embedded in religion, mythology and folklore etc. Large animals in higher tropic levels with slow rates of population growth, with longer gestation period are more susceptible to extinction due to habitat loss. The alteration of the habitat results in mass extinction of particularly the endemic species. Great auck and stellars sea cow are examples. Species with less population, whether at higher or low tropic levels, are more prone to extinction due to habitat loss. Large species with high metabolic demand, occupying large habitat, with highly specific food and living requirements, species with narrow dispersal ability and low rates of reproduction, lesser level of adaptability etc., are more prone to extinction.

C. Ecosystem breakdown: the loss of a species can have deleterious effects on the remaining species in an ecosystem. The loss of even one species can ruin an entire forest ecosystem of plants and animals. The animals that depended on this vanished species as prey have now lost their food source. In turn, the animals that it fed on have lost a predator, and these species often undergo population explosions which are devastating for the plants or animals that they feed on. This cascade effect occurs when local extinction of one species significantly alters the population size of other species. The entire ecosystem can collapse in this manner, and is therefore prevented from performing its usual "ecosystem services", a utilitarian term for the natural processes which provide rich soil, clean water, and the air we breathe.

The species, whose presence or absence has a profound effect on the rest of a natural community, is called a key-stone species. While a keystone predator limits its prey population, key-stone mutually beneficial interactions and are affected by the diversity of its partners. Key-stone species do not enjoy equal status in all ecosystems. One serving this role may not be a key-stone in other ecosystems. It is important to determine the ideal key-stone before any conservation attempts are employed.

D. Food insecurity: biodiversity underpins the health of the planet and has a direct impact on all our lives. Put simply, reduced biodiversity means millions of people face a future where food supplies are more vulnerable to pests and disease and where water is in irregular or short supply.

E. Economic impact : the loss of plant species also means the loss of unknown economic potential, as extinct plants can hardly be harvested for food crops, fibres, medicines, and other products that forests, especially rainforests, provide. Thousands of small plants, insects and other less conspicuous creatures are vanishing before they are even discovered, but it is often these small, less spectacular species which have the greatest potential "usefulness" to humans. Also, loss of biodiversity would imply monetary loss in terms of decline in natural and wildlife tourism.

F. Impact on marine ecosystems: human-dominated marine ecosystems are experiencing accelerating loss of populations and species, with largely unknown consequences. Overall, rates of resource collapse have increased and recovery potential, stability and water quality have decreased exponentially with declining diversity. Restoration of

biodiversity, in contrast, would increase productivity fourfold and decrease variability by 21%, on an average. We can conclude that marine biodiversity loss is increasingly impairing the ocean's capacity to provide food, maintain water quality and recover from perturbations.

Biodiversity interacts with our life majorly. We would not survive without it. If our earth's biodiversity gets too damaged we could lose our fresh water causing larger water restrictions. There would be more bushfires affecting our lives, home and property. It would spread tropical diseases and parasites. There will be a large spread of weeds, pests and bugs. It will damage or destroy our coastal areas and beaches. There will be a loss of rainforests and jungles causing more deserts.

BIODIVERSITY CONSERVATION

The ever increasing loss of bio-wealth has posed serious threat to the very existence of mankind. If this trend of bio depletion continues, one quarter of the world's species may be gone by the year 2050. Desertification, collapse in fisheries production, tropical deforestation, etc. are some of the ghastly acts threatening biodiversity.

Biodiversity sounds like it has something to do with the pandas and the tigers and the tropical rain forests. It does, but it is something even bigger and more than that, bigger than a single species or a single ecosystem. It is the whole of life-from the microscopic creepy-crawlies to the elephants and condors. It is all the habitats that support life - the Tundra, the Prairies, the Swamps and the tropical forests.

Biodiversity cannot be maintained by protecting few charismatic mega fauna in a zoo, or by preserving a few greenbelts or even large national parks. Biodiversity can maintain itself, however, without human attention or express, without zoo keepers, park rangers, foresters or refrigerated gene banks. All it needs is to be left alone. But, as evolutionary process is a slow phenomenon and with the ever increasing population and pressing economic problem, biological impoverishment has become a problem of global dimensions. There is hardly a place left on earth where people do not log, pave, spray, drain, flood, graze, burn, drill, spill or dump.

One of the most pressing environmental issues today is the conservation of bio-diversity. The challenge is for nations, government agencies, organizations and individuals to protect and enhance biological diversity, while continuing to meet people's needs for natural resources. This challenge exists from local to global scales. If not met, future generations will live in a biologically impoverished world and perhaps one that is less capable of producing desired resources as well.

Conserving biological diversity involves restoring, protecting, conserving or enhancing the variety of life in an area so that the abundance and distribution of species and communities provide for continued existence and normal ecological functioning, including adaptation and extinction. This demands an urgent attention for the conservation of biosphere.

A productive and stable agriculture requires genetic diversity, on-farm. Genetically diverse crop varieties enable farmers to fit their cropping system to heterogeneous conditions, to enhance the food security of their households and to exploit a range of crop products.

The Global Biodiversity Strategy sets out certain principles to guide planning and action for conserving biodiversity:

1. Every form of life is unique, and warrants respect from humanity.
2. Biodiversity conservation is an investment that yields substantial local, national, and global benefits.
3. The cost and benefits of biodiversity conservation should be shared more equitably among nations and among people within nations.
4. As part of the larger effort to achieve sustainable development, conserving biodiversity requires fundamental changes in patterns and practices of economic development worldwide.
5. Increased funding for biodiversity conservation will not, by itself, slow biodiversity loss. Policy and institutional reforms are needed to create the conditions in which increased funding can be effective.
6. Priorities for biodiversity conservation differ when viewed from local, national, and

global perspectives: all are legitimate, and should be taken into account.

7. Biodiversity conservation can be sustained only if public awareness and concern are substantially heightened, and if policy-makers have access to reliable information upon which to base policy choices.

Conservation can broadly be divided into two types:

- **In-situ:** It is on-site conservation or the conservation of genetic resources in natural populations of plant or animal species, such as forest genetic resources in natural populations of tree species. It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or cleaning up the habitat itself, or by defending the species from predators.
- **Ex-situ:** The conservation of elements of biodiversity out of the context of their natural habitats is referred to as ex-situ conservation. Zoos, botanical gardens and seed banks are all example of ex-situ conservation.

In-situ conservation of BIO-DIVERSITY includes:

a) **Biosphere reserves:** Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located. Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity.

Each biosphere reserve is intended to fulfil 3 basic functions, which are complementary and mutually reinforcing:

- a conservation function - to contribute to the conservation of landscapes, ecosystems, species and genetic variation;
- a development function - to foster economic and human development which is socio culturally and ecologically sustainable;
- A logistic function - to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.

Biosphere reserves are organized into 3 interrelated zones:

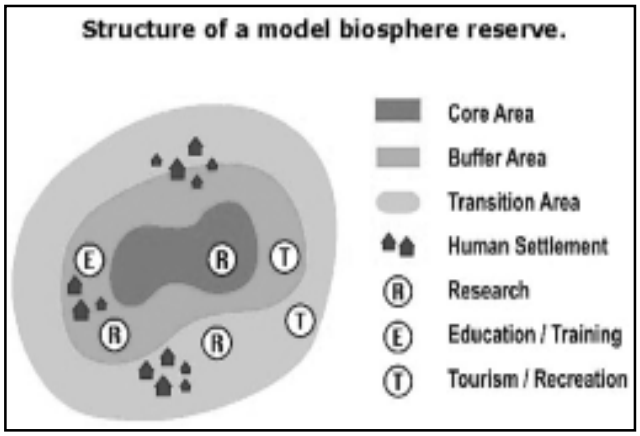
i. Core Areas: These areas are securely protected sites for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research and other low-impact uses (such as education).

ii. Buffer Zones: These areas must be clearly identified, and usually surround or adjoin the Core Areas. Buffer Zones may be used for cooperative activities compatible with sound ecological practices, including environmental education, recreation, ecotourism and applied and basic research.

iii. Transition, or Cooperation, Zones: These areas may contain towns, farms, fisheries, and other human activities and are the areas where local communities, management agencies, scientists, non-governmental organizations, cultural groups, economic interests, and other stakeholders work together to manage and sustainably develop the area's resources.

b) National parks: A national park is a reserve of natural or semi-natural land, declared or owned by a government, which is restricted from most development and is set aside for human recreation and environmental protection.

A national park was deemed to be a place



- With one or several ecosystems not materially altered by human exploitation and occupation, where plant and animal species, geomorphologic sites and habitats are of special scientific, educative and recreative interest or which contain a natural landscape of great beauty.
- The highest competent authority of the country has taken steps to prevent or eliminate exploitation or occupation as soon as possible in the whole area and to effectively enforce the respect of ecological, geomorphological, or aesthetic features which have led to its establishment.
- Visitors are allowed to enter, under special conditions, for inspirational, educative, cultural, and recreative purposes.

c) Wildlife sanctuaries: An area, usually in natural condition, which is reserved (set aside) by a governmental or private agency for the protection of particular species of animals during part or all of the year. An area designated for the protection of wild animals, within which hunting and fishing is either prohibited or strictly controlled. It is maintained by the state government. The first wildlife sanctuary was the Vedanthangal Bird Sanctuary near Madras, set up in 1878, which merely formalised the traditional protection afforded by villagers for pelicans, herons and other birds breeding at Vedanthangal. Another such sanctuary was set up at Ranganathittu near Mysore, in 1942, under British rule.

d) Wetlands conservation: Wetlands are submerged or water saturated lands, natural and man-made, permanent or temporary, with water that is static or flowing, fresh, brackish, salty, including areas of marine water, the depth of which at low tide does not exceed six metres.

The wetlands maintain conditions vital for ecological processes at landscape level, integrating both aquatic and terrestrial habitat (ecotone). In addition to providing critical habitat for threatened and endangered species for breeding, feeding and migration, they support perpetuation of species of medicinal, agricultural and genetic value. Besides, their role in regulating hydrological cycles in the area and recharging underground aquifers has also been well established. They are thus areas of outstanding natural value for hydrological, geological, scenic and biological resources that should be carefully managed to maintain these values. Wetland habitats provide protection to or act as shelters from cyclonic storms, protection to slopes, especially along riverine habitats. They regulate and purify water flow and support natural vegetation on hydric-soils that has significant value for migrant and resident wild fauna.

A programme on conservation of Wetlands was initiated in 1987 with the basic objective of assessment of wetland resources, identification of wetlands of national importance, promotion of R&D activities and formulation and implementation of management action plans of the identified wetlands.

e) Mangroves conservation: Mangrove is a general term applied to plants that thrive in muddy, loose, wet soils in tropical tide waters. They are shrubs and trees that grow between the high water mark of spring tides and a limit close to but above mean sea level. They are capable of reclaiming land with the help of their special widespread underground root system, which instead of growing downward tend to come upwards like shoots and loops to breathe air when flooded by water and also for support. Very often these sprouting shoots take firm hold in loose muddy soil prior to seed detachment from the parent plant. This mechanism helps the seed to anchor the loose soil without being washed away. This adaptation in root/seed and evolution morphology is typical of mangroves, which has assisted them to reclaim land. Mangroves are almost as quick to take root and grow over silt deposited by rivers, as the rivers are efficient in providing them silt to grow on.

In India, a legislative framework for the conservation and management of mangroves is already in place. The Indian Forest Act, 1927 and the Wildlife (Protection) Act, 1972 provide protection to flora and fauna. Although they do not specifically mention mangroves, these Acts can also apply to the conservation of the flora and fauna of mangrove ecosystems. Since 1927, the Indian Forest Act has been applied to the mangrove forests of the Sunderbans, which have

been declared as a reserved area. The Government of India set up the National Mangrove Committee in the Ministry of Environment and Forests in 1976 to advise the government about mangrove conservation and development.

Ex-situ conservation of biodiversity includes:

Ex-situ conservation, using sample populations, is done through establishment of 'gene banks', which include genetic resource centers, zoos, botanical gardens, culture collections, etc.

a) Botanic Gardens

Botanic gardens can be defined as "public gardens which maintain collections of live plants mainly for study, scientific research, conservation and education.

Botanic gardens are able

- to rehabilitate indigenous and threatened species and restore them to protected portions of their former habitats;
- to exploit commercially those species which are plentiful;
- to promote wildlife education to a broad range of target groups such as politicians, school and college students, and communities living in and around wildlife areas.

b) Translocations

Sometimes conservation of faunal species involves or necessitates translocation of animals. This means the movement of individuals from its natural habitat, or from captivity, to another habitat. Translocations are carried out in connection with introductions or reintroductions, and should be handled with extreme caution.

They are generally justified when:

- Land development will definitely destroy wildlife habitat and translocation is the only way of preserving the animals in the area.
- Boosting the numbers of a threatened wild population to ensure its survival by adding other individuals of the same species.
- Splitting an existing population that is at risk, to prevent loosing the entire population.

These operations are carried out often with support from international captive breeding programs and receive the cooperation of zoos, aquaria, etc. Such programmes have to be carefully planned and carried out to ensure success. The success rates of the establishment of translocated species vary. Overall, the translocation of game species (species used for hunting) appears to have been more successful than efforts connected with threatened or rare species. The success rates of establishment for translocated amphibians and reptiles are particularly low at 19% and 25% respectively.

Shifting of Asiatic lions from Gu-jarat to MP

Asiatic lions will now have a second home in Madhya Pradesh's Kuno wildlife sanctuary as the apex court permitted their relocation in limited numbers from Gujarat's Gir forest.A bench of Justices KS Radhakrishnan and CK Prasad has given six months time to the wildlife authorities concerned for translocating the lions from Gir sanctuary to Kuno Palpur reserve.

The two State governments have been in a tug of war for several years. Gujarat Chief Minister Narendra Modi claimed Gujarati asmita (pride) is in its lions, which could not be shared with any other State. Even an offer to translocate tigers to Gujarat in return could not move him. Gujarat claimed that Madhya Pradesh had been unable to protect its own tigers in the Panna reserve, and could not be trusted to host the lion as well.

Whereas according to the wildlife experts Gujarat's lions come from a very narrow genetic base of about 25 animals at the turn of the last century, and that makes them a very vulnerable population. In case there is an epidemic, they could even be wiped out, and hence it's important that they have a second home.

The court has also constituted an expert body to decide the number of lions to be relocated and closely monitor their translocation in Madhya Pradesh.

The court, however, has ruled against the introduction of African cheetahs in India, saying preservation of critically endangered native species, like the wild buffalo and the Great Indian Bustard, should be given primacy. Under its Rs 300 crore Cheetah Reintroduction Programme, the Ministry of Environment and Forests (MoEF) had proposed the introduction of the African Cheetahs in the country.

c) Reintroduction:

The introduction of a species into a habitat in order to increase biodiversity, or to fill an ecologicalniche is a fairly widespread practice, which encompasses both in-situ and ex-situ conservation philosophies. Reintroductions are generally undertaken to increase local biodiversity, by returning a species to a part of its former range. Reintroductions are costly and there are multiple shareholders involved with every such scheme.

Comprehensive surveys of the area mooted for reintroductions are vital to determining wheth er a viable population could be established.

Dudwa rhino reintroduction

The Dudwa forests were home to the one horned rhino a century and half ago. However, due to rampant poaching for its valuable horn and for game hunting, it was wiped out from the area by the late 19th century. Rhinos were successfully reintroduced to Dudwa on 1 April, 1984 following a systematic reintroduction effort of captive bred stock. Suitable habitats were first earmarked prior to their reintroduction. About 27 kmof grasslandsand open forests with perennial source of water was earmarked as the rhino-reintroduction area and two monitoring stations established. Currently there are seven rhinos breeding successfully -4 adult females, 1 adult male, and 2 sub-adult males.

d) Artificial Insemination:

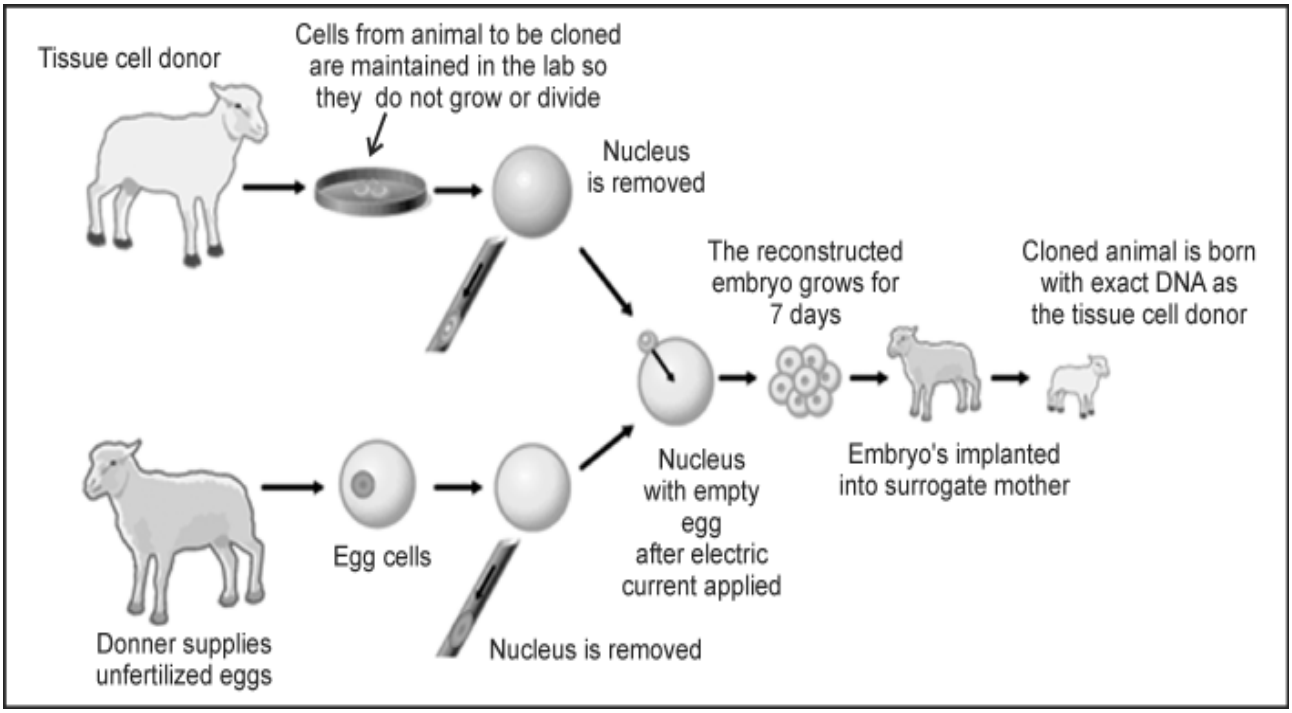
Artificial insemination, or AI, is the process by which sperm is placed into the reproductive tract of a female for the purpose of impregnating the female by using means other than sexual intercourse or natural insemination.

Artificial insemination is widely used for livestock breeding, especially for dairy cattle and pigs. Techniques developed for livestock have been adapted for use in humans.

Artificial insemination of farm animals is very common in today's agriculture industry in the developed world, especially for breeding dairy cattle. (75% of all inseminations).Swine is also bred using this method (up to 85% of all inseminations). It provides an economical means for a livestock breeder to improve their herds utilizing males having very desirable traits.

e) Somatic Cell Cloning

Somatic Cell Cloning holds some promise for propagating from one or a few survivors of an almost extinct species. The nucleus of a somatic cell is removed and kept, and the host's egg cell is kept and nucleus removed and discarded. The lone nucleus is then fused with the 'deprogrammed' egg cell. After being inserted into the egg, the lone (somatic-cell) nucleus is reprogrammed by the host egg cell. The egg, now containing the somatic cell's nucleus, is stimulated with a shock and will begin to divide. After many mitotic divisions, this single cell forms



a blastocyst (an early stage embryo with about 100 cells) with almost identical DNA to the original organism. The technique of transferring a nucleus from a somatic cell into an egg that produced Dolly was an extension of experiments that had been ongoing for over 40 years. In the simplest terms, the technique used to produce Dolly the sheep - somatic-cell nuclear transplantation cloning - involves removing the nucleus of an egg and replacing it with the diploid nucleus of a somatic cell.

f) Seed bank

The preservation of plant germplasm in seedbanks, (or genebanks), is one of the techniques of ex-suit conservation of plant species. Seeds have a natural dormancy feature, which allows for their suspended preservation for long periods of time with little damage, provided the conditions are favourable. Banking dormant seeds enables to keep genetically representative samples of rare and endangered plant species as a kind of "genetic insurance".

Storing germplasm in seedbanks is both inexpensive and space efficient. It allows preservation of large populations with little genetic erosion. Seedbanks also offer good sources of plant material for biological research, and avoid disturbance or damage of natural populations. Two types of seeds may be considered.

- The orthodox seed those that can be dried at low humidity and stored at low temperatures. These orthodox seeds can remain viable for many years and are rather easily stored in seedbanks.
- The recalcitrant seeds do not tolerate low humidity and temperature, and thus are not good material for seedbanking conservation.

Preparation for storage is different for each species and has to be assessed before any conservation planning. Roughly, the different processes imply first collection of the seeds, then drying to a moisture content of less than 6%. The seeds are then stored at low temperature (below -18 degree C). As seeds tend to lose germinative power over time monitoring of viability and regeneration processes must be done frequently.

BIODIVERSITY IN INDIA: BRIEF INTRODUCTION

India is one of the mega-diverse countries with 2.4% of the land area, accounting for 7-8% of the species of the world, including about 91,000 species of animals and 45,500 species of plants that have been documented in its ten bio-geographic regions. Of these 12.6% of mammals, 4.5% of birds, 45.8% of reptiles, 55.8% of amphibians and 33% of Indian plants are endemic, being found nowhere else in the world.

Features of India's Biodiversity

a) Major realms of biodiversity in India are Indo-Malayan, tropical humid forests, tropical delicious forests and the warm deserts.

b) India has ten biogeography regions that include trans- Himalayan, the Himalayan, the Indian desert, the semi-arid Zone (S), the western Ghats, the Deccan peninsula, the Gangetic Plain, North - east India, the islands and the coasts.

c) India is one of the twelve centres of cultivated plants.

d) India has five world heritage sites, twelve biosphere reserves and six Ramsar Wetlands. Amongst the protected areas, India has 88 national parks and 490 sanctuaries covering an area of 1.53 lakh Sq. Km

e) It is further estimated that about 4,00,000 more species may exist in India which need to be recorded and described.

This biodiversity has arisen over the last 3.5 billion years of evolutionary history and its sustainable use has always been a part of the Indian culture. The value of this biodiversity for sustaining and nourishing human communities is immense. The ecosystem services from the forested watersheds of two great mountain chains, the Himalayas and the Western Ghats, indirectly support several million people in India.

India is rapidly seeing a change in its economy from a predominantly agrarian society into a diversified one resulting in mounting pressures on land use. A consequence of this has been the loss and fragmentation of natural habitats, which has been identified as the primary threat to biodiversity.

BIODIVERSITY HOTSPOTS IN INDIA

A biodiversity hotspot is a biogeographic region with a significant reservoir of biodiversity that is

under threat from humans. To qualify as a biodiversity hotspot on Myers 2000 edition of the hotspot-map, a region must meet two strict criteria:

1. It must contain at least 0.5% or 1,500 species of vascular plants as endemics, and
2. It has to have lost at least 70% of its primary vegetation.

Three regions that satisfy these criteria in India are described below:

a) The Western Ghats and Sri Lanka

The Western Ghats are a chain of hills that run along the western edge of peninsular India. Their proximity to the ocean and through orographic effect, they receive high rainfall. These regions have moist deciduous forest and rain forest. The region shows high species diversity as well as high levels of endemism. Nearly 77% of the amphibians and 62% of the reptile species found here are found nowhere else.

There are over 6000 vascular plants belonging to over 2500 genera in this hotspot, of which over 3000 are endemic. Much of the world's spices such as black pepper and cardamom have their origins in the Western Ghats. The highest concentration of species in the Western Ghats is believed to be the Agasthyamalai Hills in the extreme south. The region also harbours over 450 bird species, about 140 mammalian species, 260 reptiles and 175 amphibians. Over 60% of the reptiles and amphibians are completely endemic to the hotspot. Remarkable as this diversity is, it is severely threatened today. The vegetation in this hotspot originally extended over 190,000 square kms. Today, it has been reduced to just 43,000 sq. km.

b) The Eastern Himalayas

The Northeast India, (22-30 degree N and 89-97 degree E) spread over 2,62,379 sq.km., represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese biogeographic regions and a meeting place of the Himalayan Mountains and Peninsular India.

The region is made up of eight states: Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura and is endowed with a wide range of physiography and eco-climatic conditions. The State of Assam has extensive flood plains, while Khangchendzonga in Sikkim stands 8586 m. tall. Cherrapunjee in the State of Meghalaya holds the record for the highest rainfall in a single month (9,300 mm) as well as the most in a year (26,461 mm) in India, while the nearby Mawsynram has the world's highest average rainfall (11,873 mm). The forests in the region are extremely diverse in structure and composition and combine tropical and temperate forest types, alpine meadows and cold deserts. There are regions, for example, in the State of Sikkim, where the faunal assemblages also change rapidly from tropical to subtropical, temperate, alpine and finally to cold desert forms.

The Eastern Himalayan hotspot has nearly 163 globally threatened species including the One-horned Rhinoceros (Rhinoceros unicornis), the Wild Asian Water buffalo (Bubalus bubalis (Arnee)) and in all 45 mammals, 50 birds, 17 reptiles, 12 amphibians, 3 invertebrates and 36 plant species. The Relict Dragonfly (Epiophlebia laidlawi) is an endangered species found here with the only other species in the genus being found in Japan. The region is also home to the Himalayan Newt (Tylototriton verrucosus), the only salamander species found within Indian limits.

c) Indo-Burma

The Indo-Burma region encompasses several countries. It is spread out from Eastern Bangladesh to Malaysia and includes North-Eastern India south of Brahmaputra river, Myanmar, the southern part of China's Yunnan province, Lao People's Democratic Republic, Cambodia, Vietnam and Thailand. The Indo-Burma region is spread over 2 million sq. km of tropical Asia.

Much of Indo-Burma is characterized by distinct seasonal weather patterns. During the northern winter months, dry, cool winds blow from the stable continental Asian high-pressure system, resulting in a dry period under clear skies across much of the south, centre, and west of the hotspot (the dry, northeast monsoon). As the continental system weakens in spring, the wind direction reverses and air masses forming the southwest monsoon pick up moisture from the seas to the southwest and bring abundant rains as they rise over the hills and mountains. A wide diversity of ecosystems is represented in this hotspot, including mixed wet evergreen, dry evergreen, deciduous, and montane forests. There are also patches of shrublands and woodlands on karst limestone outcrops and, in some coastal areas, scattered heath forests. In addition, a wide

variety of distinctive, localized vegetation formations occur in Indo-Burma, including lowland floodplain swamps, mangroves, and seasonally inundated grasslands.

RULES AND REGULATIONS TO CONSERVE BIODIVERSITY IN INDIA

a) Biological Diversity Act, 2002

The Act covers conservation, use of biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey and bio-utilisation. It provides a framework for access to biological resources and sharing the benefits arising out of such access and use. The Act also includes in its ambit the transfer of research results and application for intellectual property rights (IPRs) relating to Indian biological resources.

The Act covers foreigners, non-resident Indians, body corporate, association or organization that is either not incorporated in India or incorporated in India with non-Indian participation in its share capital or management. These individuals or entities require the approval of the National Biodiversity Authority when they use biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey or bio-utilisation.

b) Forest Protection Act, 1980

It was enacted to help conserve the country's forests.

Himalaya hotspot

Western Ghat & Sri Lanka hotspot

Indo-Burma hotspot

The 1927 Act deals with the four categories of the forests, namely reserved forests, village forests, protected forests and private forests. A state may declare forest lands or waste lands as reserved forest and may sell the produce from these forests. Any unauthorized felling of trees quarrying, grazing and hunting in reserved forests is punishable with a fine or imprisonment, or both. Reserved forests assigned to a village Community is called village forests. The state governments are empowered to designate protected forests and may prohibit the felling of trees, quarrying and the removal of forest produce from these forests. The preservation of protected forests is enforced through rules, licenses and criminal prosecutions. Forest officers and their staff administer the Forest Act.

Alarmed at India's rapid deforestation and resulting environmental degradation, Centre Government enacted the Forest (Conservation) Act in 1980. Under the provisions of this Act, prior

approval of the Centre Government is required for diversion of forestlands for non-forest purposes. An Advisory Committee constituted under the Act advises the Centre on these approvals. The Act also lays down the pre-requisites for the diversion of forest land for non-forest purposes.

c) Wildlife Protection Act, 1972

According to the Wildlife Protection Act, 1972, "Wildlife" includes any animal, bees, butterflies, crustacea, fish and moths; and aquatic or land vegetation which forms part of any habitat.

The Act was enacted with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Ministry has proposed further amendments in the law by introducing more rigid measures to strengthen the Act.

The major task of protecting the wildlife cannot be handled by the Government machinery alone through its limited officials but should be the duty of every individual. This was one of the reasons why a new provision, Article 51 A (g), was inserted in our Constitution, making it the fundamental duty of every citizen to protect and improve the natural environment, including forests, lakes, rivers and wildlife, and to have compassion for living creatures.

d) Prevention of Cruelty to Animals Act,1960

The Act was enacted to prevent the infliction of unnecessary pain or suffering on animals and to amend the laws relating to the prevention of cruelty to animals. As per the provisions of the law the government of India formed the Animal Welfare Board of India. From ensuring that animal welfare laws in the country are diligently followed, to provide grants to Animal Welfare Organizations and advising the Government of India on animal welfare issues, the Board has been the face of the animal welfare movement in the country for the last 50 years. The Board consists of 28 Members. The term of office of Members is for a period of 3 years.

NATIONAL LEVEL ORGANIZATIONS TO CONSERVE BIODIVERSITY

a) Compensatory Afforestation Fund Management and Planning Authority

Compensatory Afforestation Fund Management and Planning Authority (CAMPA) are meant to promote afforestation and regeneration activities as a way of compensating for forest land diverted to non-forest uses.

National CAMPA Advisory Council has been established as per orders of The Hon'ble Supreme Court with the following mandate:

- Lay down broad guidelines for State CAMPA.
- Facilitate scientific, technological and other assistance that may be required by State CAMPA.
- Make recommendations to State CAMPA based on a review of their plans and programmes.
- Provide a mechanism to State CAMPA to resolve issues of an inter-state or Centre-State character.

The Hon'ble Supreme Court also approved the guidelines prepared by the MoEF for utilizing CAMPA funds by an agency to be constituted in the states and to be known as The State CAMPA.

b) National Biodiversity Authority

The National Biodiversity Authority (NBA) was established in 2003 to implement India's Biological Diversity Act (2002). The NBA is Autonomous body and that performs facilitative, regulatory and advisory function for Government of India on issue of Conservation, sustainable use of biological resource and fair equitable sharing of benefits of use.

The Biological diversity Act (2002) mandates implementation of the Act through decentralized system with the NBA focusing on advising the Central Government on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of benefits arising out of the utilization of biological resources; advise the State Government in the selection of areas of biodiversity importance to be notified as heritage sites and measures for the management of such heritage sites;

The State Biodiversity Board (SBBs) focuses on advice to the State Government, subject to any guidelines issued by the Central Government, on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources.

It regulates by granting approvals for commercial utilization or bio-survey and bio-utilization of any biological resource by Indians; and Local Level Biodiversity Management committees (BMCs) responsible for promoting conservation, sustainable use and documentation of biological diversity, including preservation of habitats, conservation of land races, folk varieties and cultivators, domesticated stocks and breeds of animals and microorganisms and chronicling of knowledge relating to biological diversity.

c) National Afforestation & Eco-Development Board

The National Afforestation and Eco-Development Board (NAEB) was set up in August 1992. It is responsible for promoting afforestation, tree planting, ecological restoration and eco-development activities in the country, with special attention to the degraded forest areas and lands adjoining the forest areas, national parks, sanctuaries and other protected areas as well as the ecologically fragile areas like the Western Himalayas, Aravallis, Western Ghats, etc. The role and functions of the NAEB are given below:

(i) Evolve mechanisms for ecological restoration of degraded forest areas and adjoining lands through systematic planning and implementation, in a cost effective manner;

(ii) Restore through natural regeneration or appropriate intervention the forest cover in the country for ecological security and to meet the fuelwood, fodder and other needs of the rural communities;

(iii) Restore fuelwood, fodder, timber and other forest produce on the degraded forest and adjoining lands in order to meet the demands for these items;

(iv) Sponsor research and extension of research findings to disseminate new and proper technologies for the regeneration and development of degraded forest areas and adjoining lands;

(v) Create general awareness and help foster people's movement for promoting afforestation and eco-development with the assistance of voluntary agencies, non-government organizations, Panchayati Raj institutions and others and promote participatory and sustainable management of degraded forest areas and adjoining lands;

(vi) Coordinate and monitor the Action Plans for afforestation, tree planting, ecological restoration and eco-development; and

(vii) Undertake all other measures necessary for promoting afforestation, tree planting, ecological restoration and eco-development activities in the country.

d) National Green Tribunal

National Green Tribunal Act (NGT) was established in 2010, under India's constitutional provision of Article 21, which assures the citizens of India, the right to a healthy environment.

The enactment of the law takes into account the (i) United Nations Conference on the Human Environment which took place at Stockholm in June, 1972 and also the (ii) United Nations Conference on Environment and Development which took place at Rio de Janeiro in June 1992, in both of which India was a participant.

It has been established for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources, including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto. NGT is a specialized body equipped with the necessary expertise to handle environmental disputes involving multi-disciplinary issues. The Tribunal shall not be bound by the procedure laid down under the Code of Civil Procedure, 1908, but shall be guided by principles of natural justice.

The Tribunal would have four circuit Benches. It would deal with all environmental laws on air and water pollution, the Environment Protection Act, the Forest Conservation Act and the Biodiversity Act. With this effort, India would join Australia and New Zealand, which have such specialized environment tribunals.

The tribunal shall consist of:

(a) a full time chairperson;

(b) not less than ten but subject to maximum of twenty full time Judicial Members as the

central Government may, from time to time notify;

(c) not less than ten but subject to maximum of twenty full time Expert Members, as the Central Government may from time to time notify.

The Chairperson, Judicial Member and Expert members of the Tribunal shall hold office as such for a term of five years from the date on which they enter upon their office, but shall not be eligible for re-appointment.

The Tribunal is mandated to make and endeavour for disposal of applications or appeals finally within 6 months of filing of the same. Initially, the NGT will be set up at five places of sittings and will follow circuit procedure for making itself more accessible. New Delhi is the Principal Place of Sitting of the Tribunal and Bhopal, Pune, Kolkata and Chennai shall be the other 4 places of sitting of the Tribunal.

With the launch of National Green Tribunal Act, 2010, the National Environment Tribunal Act, 1995 and the National Environment Appellate Authority Act, 1997 have been repealed. The cases pending before the National Environment Appellate Authority at the time of establishment of the National Green Tribunal have been transferred to the National Green Tribunal.

SPECIAL PROJECTS FOR ENDANGERED SPECIES IN INDIA

a) Project Tiger

Project Tiger Scheme was launched in 1973 as a Centrally Sponsored Scheme of Government of India.

The project aims at tiger conservation in specially constituted 'tiger reserves', which are representative of various bio-geographical regions falling within the country. An estimate of the tiger population in India, at the turn of the century, placed the figure at 40,000. Subsequently, the first ever all India tiger census was conducted in 1972 which revealed the existence of only 1827 tigers.

Various pressures in the later part of the last century led to the progressive decline of wilderness, resulting in the disturbance of viable tiger habitats. At the IUCN General Assembly meeting in Delhi, in 1969, serious concern was voiced about the threat to several species of wildlife and the shrinkage of wilderness in the country. In 1970, a national ban on tiger hunting was imposed and in 1972 the Wildlife Protection Act came into force.

The project was launched in 1973, and various tiger reserves were created in the country on a 'core-buffer' strategy. The core areas were freed from all sorts of human activities and the buffer areas were subjected to 'conservation oriented land use'. Management plans were drawn up for each tiger reserve, based on the principles outlined below:

- Elimination of all forms of human exploitation and biotic disturbance from the core area and rationalization of activities in the buffer zone.
- Restricting the habitat management only to repair the damages done to the eco-system by human and other interferences, so as to facilitate recovery of the eco-system to its natural state.
- Monitoring the faunal and floral changes over time and carrying out research about wildlife.

The main objective of Project Tiger is to ensure a viable population of tigers in India for scientific, economic, aesthetic, cultural and ecological values and to preserve for all time, areas of biological importance as a natural heritage for the benefit, education and enjoyment of the people.

Initially, the Project started with 9 tiger reserves, covering an area of 16,339 sq.km., with a population of 268 tigers. At present there are 39 tiger reserves (as in April 2011) covering an area of 49112 sq.km.

The W.W.F. has given an assistance of US $ 1 million in the form of equipments, expertise and literature.

Wireless communication system and outstation patrol camps have been developed within the tiger reserves, due to which poaching has declined considerably. Fire protection is effectively done by suitable preventive and control measures, voluntary Village relocation has been done in many reserves, especially from the core area. In Kanha, Bandipur and Ranthambhore, all the villages have been shifted

from the core, and after relocation, the villagers have been provided with alternate agricultural lands and other community benefits. This has resulted in the improvement of the carrying capacity of the habitat. Live stock grazing has been controlled to a great extent in the tiger reserves. Various compensatory developmental works have improved the water regime and the ground and field level vegetations, thereby increasing the animal density. Research data pertaining to vegetational changes are also available from many reserves. In general, the 'restorative management' and 'intense protection' under 'Project Tiger' have saved many of our eco-typical areas from destruction. The area around the buffer is now contemplated as a zone of multiple use, to bring compatibility between the reserves and the neighbouring communities.

The effective protection and concerted conservation measures inside the reserves have brought about considerable intangible achievements also, viz. arresting erosion, enrichment of water regime thereby improving the water table and overall habitat resurrection. Labour intensive activities in tiger reserves have helped in poverty alleviation amongst the most backward sections, and their dependence on forests has also reduced. The project has been instrumental in mustering local support for conservation programme in general.

Vision For the Future

The dynamics of forest management and wildlife conservation have been distorted due to the need for income, lack of awareness, lack of land use policy and population pressure. Since the traditional use systems of people are neither static nor benign, these should not be overlooked.

A regional development approach in landscapes having Tiger Reserves is of utmost importance in our country. It should be viewed as a mosaic of different landuse patterns, viz. tiger conservation / preservation, forestry, sustainable use and development, besides socio-economic growth.

Tiger habitats exist in environments of thousands of indigenous communities which depend on them. Therefore we cannot view these protected areas in isolation from the surrounding socio-economic realities and developmental priorities of the Govt. This calls for a cross-sectoral and cross-disciplinary approach.

Tigers now need a "preservationist" approach. Regional planning is important around Tiger Reserves to foster ecological connectivity between protected areas through restorative inputs with integrated land use planning. The management plan of a Tiger Reserve, therefore, needs to be integrated in larger regional management plans.

b) Project Elephant

Old literatures indicate that even during the Mughal period, elephants were found all over India, including many parts of Central India like Marwar, Chanderi, Satwas, Bijagarh and Panna. However current distribution of wild elephants in India is confined to South India; North East, including North West Bengal; Central Indian states of Orissa, South WB and Jharkhand; and North West India in Uttarakhand and UP.

Project Elephant (PE) was launched by the Government of India in the year 1992 as a Centrally Sponsored Scheme with following objectives:

- To protect elephants & their habitats

- To address issues of man-animal conflict
- Welfare of domesticated elephants

Financial and technical support is being provided to major elephant-bearing States in the country. The project is being mainly implemented in 13 States / UTs , viz. Andhra Pradesh , Arunachal Pradesh , Assam , Jharkhand , Karnataka , Kerala , Meghalaya , Nagaland , Orissa , Tamil Nadu , Uttaranchal , Uttar Pradesh and West Bengal. Small support is also being given to Maharashtra and Chhattisgarh. Main activities under the Project are as follows:

- Ecological restoration of existing natural habitats and migratory routes of elephants;
- Development of scientific and planned management for conservation of elephant habitats and viable population of Wild Asiatic elephants in India;
- Promotion of measures for mitigation of man-elephant conflict in crucial habitats and moderating pressures of human and domestic stock activities in crucial elephant habitats;
- Strengthening of measures taken for protection of Wild elephants from poachers and unnatural causes of death;
- Research on Elephant management related issues;
- Public education and awareness programmes;
- Eco-development;
- Veterinary care.

c) Gir Lion Project

Sasan- Gir or Gir National Park is only home of pure Asiatic Lion Panthera leon persica. It was established in Saurashtra peninsula of Gujarat in 1965 with a total area of 1412 km sq.

Gir forest was declared as protected area in 1900 by the Nawab of Junagarh Princely State. In addition to it, leopards, spotted deers, blue bull, wild boar, chinkara, blackbucks, striped hyena, jackal are also found in forest area. Gir is a dry scrubland and open deciduous forest.

These lions were once found across northern Africa, south west Asia and northern Greece.

The census of lions takes place every five years. Of the 411 Asiatic lions counted in 2010, 297 were inside the designated Gir National Park and adjoining areas while others were found in the neighbouring places of Girnar, Mitiyala and Paniya as well as in the coastal areas of Una, Kodinar, Sutrapada and Chhara. As many as 53 Asiatic lions have made their new habitat in far-off places like Savarkundla and Liliya in Amreli district and also in Bhavnagar.

Conservation issues

The lions face the usual threats of poaching and habitat degradation. Three major roads and a railway track pass through the Gir Protected Area. Also, there are three big temples inside the Protected Area that attract large number of pilgrims. This is leading to the devastation of biodiversity in the region.

On the other hand, the increased population of lions has resulted in their spill over the area. Therefore, at present, the most pressing threat to the lion population of the Gir forest comes from the increasing hostility toward them from the resident human population. Due to the increase in population, about 100 lions stay outside the area and face conflicts with humans.

An emerging threat is the number of lions falling in the open wells in the fields around Gir National Park. The main reason is that wells in arable fields are unguarded. These wells have been made at ground level without any protection like parapet walls around them.

Conservation measures by GOI

In 1973, the Gir Lion Project relocated almost 600 resident Maldhari families and their livestock and banished hundreds of thousands of cattle that seasonally grazed in Gir. Easing the pressure from domestic animals allowed the vegetation to recover, and as a consequence, wild herbivores bounced back ten-fold. From living off cattle in the early days of the Project, the felines changed their diets to spotted deer, sambhar and nilgai.

A Project has been initiated to construct barricades around open wells around the Gir NP to decrease the incidences of lions falling into such wells.

The Asiatic Lion Reintroduction Project has been introduced by Government of India. It is an effort to save the Asiatic lion from extinction in the wild. The lions are threatened by epidemics, natural disasters and anthropogenic factors. The

project aims to establish a second independent population of Asiatic Lions at the Kuno Wildlife Sanctuary in the Indian state of Madhya Pradesh.

Kuno Wildlife Sanctuary was selected as the reintroduction site for critically endangered Asiatic lion because it is in the former range of the lions before it was hunted into extinction in about 1873. It was selected following stringent international criteria and internationally accepted requirements & guidelines developed by IUCN/SSC Reintroduction Specialist Group and IUCN/SSC Conservation Breeding Specialist Group which are followed before any reintroduction attempt anywhere in the world.

Twenty four villages of the Sahariya tribe, which had lived in the remote core area set aside for the reintroduction of the Asiatic lions in Kuno Wildlife Sanctuary in the Indian state of Madhya Pradesh, were moved out of the Sanctuary to prepare it for receiving a lion population. They were rehabilitated to a new location on the edge of the Kuno sanctuary by incurring an expense equal to millions of dollars under a Central Government of India sponsored scheme. The plan included expenses on infrastructure development, so that they can have access to basic amenities like roads, schools and a hospital.

But the Gujarat government is reluctant to let go of them as it considers Asiatic Lions a state property and wants to keep its monopoly over the tourism revenue generated by the species which is extinct everywhere else in the world (i.e. over its entire original range in South West Asia (The Middle East and Near East) including adjoining parts of Europe (The Balkans and Greece) where it once was found in good numbers.

d) Crocodile Breeding Project

Crocodile hunting was banned in India in 1972, by that time all three species found in the country (the Ghariyal, Gavialis gangeticus; the saltwater crocodile, Crocodylus porosus; and the Mugger or marsh crocodile, C. palustris) were on the verge of extinction. Ironically, it was the Ghariyal, which is completely harmless to man and of relatively low value in terms of its hide, which was most endangered. Stabilization of river banks and dam construction had greatly reduced the gharial's natural environment of free-flowing rivers. In 1973, it was estimated that fewer than 100 Gharials continued to survive. Though relatively larger numbers of saltwater crocodile and mugger were known to exist, they were not enough to avoid the total extinction of the species in the short-term future.

First priority was therefore given to ensuring continuity of the species. With the assistance of the United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO), the Government of India launched a crocodile breeding and conservation project, initially in Orissa in 1975. The project was initiated under the guidance of Dr. H R Bustard. The scheme was subsequently extended to Uttaranchal, Rajasthan, West Bengal, Tamil Nadu, Andhra Pradesh, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Andamans, Assam, Bihar and Nagaland. A total of 16 crocodile rearing centres have been developed in the country in eight States. Eleven sanctuaries have been declared under the project.

FAO assisted government wildlife workers to design and construct special rearing stations. FAO also helped to train local villagers in the collection of gharial eggs from the wild. This was especially important since improper collection could have resulted in the destruction of the last remaining gharial nesting sites.

By the time the project ended in 1982, more than 1000 gharials had been raised and released into protected areas or sanctuaries. Local fishermen living within these sanctuaries have been employed as guards. The salary paid to the fishermen is more than that offered by poachers for assistance in locating crocodiles, and since poaching is virtually impossible without the cooperation of local people; this has resulted in effective protection (FAO, 1983).

Similar schemes were also implemented for collection and raising of saltwater crocodile and mugger from eggs. As a result the population of all three species has considerably increased. Presently, due to the overwhelming breeding success, forest departments have concluded captive breeding of the mugger.

e) Project Rhino

The greater one-horned rhino is one of the two greatest success stories in rhino conservation (the other one being the southern white rhino in South Africa). With strict protection from Indian and Nepalese wildlife authorities, greater one-horned rhino numbers have recovered from fewer than 200 earlier in the 20th century to as

many as 2,850 today. However, even with population increases, poaching pressure has remained high in both India and Nepal. The species' recovery is precarious without increased and accelerated support for conservation efforts throughout its range.

The conservation of the Great Indian One horned Rhino (Rhinoceros unicornis) is being regarded as the epitome of conservation movement in the country and Assam in particular. Assam is also regarded as the last stronghold of the Indian Rhino with more than 2000 rhinos in the wild. Planned initiative in terms of rhino conservation in Assam by the Department of Forest with the help and support of many agencies including local populace made it possible to build up the population of rhinos to 1855 in Kaziranga National Park, 68 in Orang National Park and 81 in Pobitora Wildlife Sanctuary (Rhino census- 2006). While the successes in conservation of rhino was achieved in the above mentioned three protected areas, loss and subsequent extermination of rhino by poachers were witnessed in the other rhino bearing areas viz. Laokhowa-Bura Chapori Wildlife Sanctuary during the social unrest in early 1980's and in Manas National Park during the social unrest in 1990's.

For developing a vision and roadmap for long term conservation of the globally famous one horned rhinoceros in the state, the Government of Assam constituted the "Task Force for Translocation of Rhinos within Assam" commonly called "Rhino Task Force" in June 2005. The task force received immediate support from the two international organizations World Wildlife Fund for Nature (WWF) and International Rhino Foundation (IRF) to undertake activities for the conservation of rhinos in Assam and also to create new populations in Assam through translocation.

The task force set the goal to have a rhino population of 3000 in the wild in Assam in seven of its protected area by the year 2020 from the present population of more than 2000 in three of its protected areas. The goal set was to populate the potential rhino habitat areas identified viz. Manas NP, Dibru Saikhowa WLS, Laokhowa - Bura Chapori WLS with a viable population of rhino through translocations from Kaziranga NP and Pobitora WLS. With the mentioned vision and goal, a joint program was developed between the Forest Department, Government of Assam, WWF and IRF by the Task Force and was named as the "Indian Rhino Vision (IRV) 2020" program. This program was welcomed by many at the global as well as the local level and soon US Fish and Wildlife Services (USFWS) and Bodoland Territorial Council (BTC) extended their full support and co-operation for the success of the program.

f) Snow Leopard Project

Snow Leopard is globally an endangered species as well as the most important flagship species of the mountain region. They are at the apex of ecological pyramid and suffer the most on account of relatively smaller population size and also because of man-animal conflict. This situation further gets aggravated by the hostile landscape forming its habitat.

In 1972, the World Conservation Union (IUCN) placed Snow Leopards on the endangered species red list. Further in 1975, under the Convention on International Trade of Endangered Species (CITES) trafficking of live snow leopards and their fur or body parts was made illegal in much of its native habitat. Today, almost 40 years later, the population of these beautiful big cats is still declining dangerously.

Conservation Challenges:

Poaching:

Snow Leopards are poached illegally for their pelts, which have a huge market in Tibet. Their bones and other body parts are also in huge demand for their use in traditional Asian medicines.

Retribution Killings:

Due to continuous interference and intrusions by humans and domestic cattle, snow leopards at times stray from their habitat to enter the human territory to prey on domestic livestock. Herders in these areas live a precarious economic life and loss of even a single sheep, causes a real economic hardship. This has caused several cases of retaliatory killing of Snow Leopards in the past.

Habitat and Prey loss

As humans continue to push further into the mountainous areas with their livestock; the Snow Leopards' habitat is getting boxed-in by increasing human intrusion. As humans push further into the mountainous areas with their livestock, the snow leopard's habitat is getting degraded and fragmented. Overgrazing has damaged the fragile grasslands, leaving less food for the wild sheep and goats that are the Snow Leopard's main prey.

War and related military activites

Some of India's best snow leopard habitat lies within the disputed northwestern frontier province of Jammu and Kashmir. Militarization of this region and repeated skirmishes with Pakistan over the past several decades put snow leopards in danger and makes scientific studies and conservation programmes impossible to carry out.

Other challenges

Much of the Snow Leopards' habitat is extremely difficult to access. Found at very high altitude, studying the species and its current status and distribution is an extremely arduous task.

Referring to its globally endangered species status as well as the most important flagship species of the mountain region, India included Snow Leopard in the list of species under Recovery Programme to be funded through the umbrella scheme of integrated Development of Wildlife Habitats.

Thus WWF-India initiated the project, "Snow Leopard Conservation: An initiative", in the five Himalayan States viz. Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh with active support from wildlife institute of India and the Mysore based Nature Conservation Foundation.

The project stresses on a landscape approach to conservation wherein smaller core zones with relatively conservation values are identified and conserved with support. The larger landscapes are managed in such a way that it allows necessary development benefits to the local communities. The project thus places greater importance to careful and knowledge-based management planning of the landscapes. The adaptive management planning involves participation of all key stakeholders so that action is taken by incorporating local wisdom and support.

For facilitating effective planning and action, the project set up enabling administrative mechanisms from the village duster level to the Central Government. At the Central level, a Steering Committee chaired by Director General of Forests & Special Secretary to the Government of India help in guideing the project. Each State have a State Snow Leopard Conservation Society that coordinate work by the Landscape-level Implementation Committees, which in turn coordinates work by the village Wildlife Conservation Committees.

The Project Snow Leopard is an Innovative project that would help to arrest species declines in the Indian high altitudes and would lead to conservation based on sound scientific plans and local support. Species such as Snow Leopard, Asiatic Ibex, Tibetan Argali, Ladakh Urial, Chiru, Takin, Serow and Musk Deer will particularly benefit from this project.

COMMUNITY PARTICIPATION IN BIO-DIVERSITY CONSERVATION

It is being recognized that no legal provisions can be effective unless local communities are involved in planning, management and monitoring conservation programmes. Initiatives taken by the government and NGOs are:

a) Joint Forest Management

Joint Forest Management is a process in which protection and management of forests is jointly undertaken by Forest Department and the local communities. Joint Forest Management (JFM), a programme of peoples' participation in forestry had been initiated from a small village Arabari in Midnapore district of West Bengal in 1972. The objective was to involve the local communities in protecting the forests by sharing the benefits accruing from resources collected from the forest.

However, JFM was formally initiated in June 1990 after receiving an endorsement from the government of India on the JFM system. Certain guidelines like formation of Village Forest Committee (VFC) or Village Forest Protection

Committee (VFPC) and the role and functions of these committees were framed. All the state governments were advised to provide a formal framework for implementation of JFM.

Large financial support have been received for the programme from different funding agencies like World Bank, OECF-Japan, DFID-UK, and SIDA -Sweden, EEC and UNDP.

The participatory management of forests enables the communities to understand the capability of the forests in catering to their need and thus prompts them to have a realistic resource management plan, based on their requirements and priorities, for the forests entrusted with them. The empowerment of communities in planning and managing the common property resources in their vicinity evolves a sense of ownership of the forests and thus the responsibility of maintaining sustainability becomes a voluntary commitment. As all the villagers are involved in this process, unity and consensus for taking conscious decisions about collective (common property) resources along with wholehearted co-operation are evolved. These, as we know, are the crucial attributes for an ideal village society. Participatory management also ensures willing inputs from the communities in optimizing/ maximizing the productivity of forests.

The process of micro planning enables the villagers to understand and appreciate the resource related issues and the importance efforts required for conservation of natural resources.

b) Social forestry

The history of exploitation and destruction of forests in India goes back to the British period when the forests wealth was consumed for commercial gains. The trend continued even after independence and the forests were used not for imperative economic growth but for other various reasons. The denudation of forest land, however, has now slowed down in recent years despite human and commercial pressures due to efforts made by various agencies.

The Government of India and other agencies have launched promotional scheme "Social Forestry" all over the country for afforestation and fresh plantations to increase the forest cover in which the participation of local people has also been encouraged.

Social forestry as an instrument of sustainable development has the potential of resolving the three basic issues of rural poor simultaneously i.e. to provide food security, fuel security and livelihood security with eco-friendly approach to development.

Social forestry is a programme governed by the principle-of the people, for the people, and by the people.

The objectives of the programme are:

- Afforestation in lands outside forest areas.
- Increasing the number of trees in India.
- Promoting the participation of institutions and people in the field of growing of trees.
- Increasing the yield of timber and other non-timber forest produce like fruit, firewood, fodder, etc to ensure easy supply to people.
- Putting less fertile and unproductive land to productive use
- Augmenting the income of people by tree planting.
- Increasing the employment opportunities of rural poor.

Social forestry scheme can be categorized as:

I. Farm forestry

Under this programme individual farmers are being encouraged to plant trees on their own farmland to meet the domestic needs of the family. In many areas this tradition of growing trees on the farmland already existed. Non-commercial farm forestry is the main thrust of most of the social forestry projects in the country today. It is not always necessary that the farmer grows trees for fuelwood, but very often they are interested in growing trees without any economic motive. They may want it to provide shade for the agricultural crops; as wind shelters; soil conservation or to use wasteland.

II. Community forestry

Another scheme taken up under the social forestry programme, is the raising of trees on community land and not on private land as in farm forestry. All these programmes aim to

provide for the entire community and not for any individual. The government has the responsibility of providing seedlings, fertilizers but the community has to take responsibility of protecting the trees. Some communities manage the plantations sensibly and in a sustainable manner so that the village continues to benefit. Some others took advantage and sold the timber for a short-term individual profit. Common land being everyone's land is very easy to exploit. Over the last 20 years, large-scale planting of Eucalyptus, as a fast growing exotic, has occurred in India, making it a part of the drive to reforest the subcontinent, and create an adequate supply of timber for rural communities under the augur of 'social forestry'.

III. Extension forestry

Planting of trees on the sides of roads, canals and railways, along with planting on wastelands is known as 'extension' forestry, increasing the boundaries of forests. Under this project there has been creation of wood lots in the village common lands, government wastelands and panchayat lands.

IV. Agro- forestry

Planting of trees in and around agricultural boundaries, and on marginal, private lands, in combination with agricultural crops is known as agro-forestry.

Social Forestry was conceived as people-centred programme, a programme to empower the rural poor for their fuelwood, fodder and other timber needs. Major funds of social forestry were used in protected and reserved forests, and the only benefit to the poor was in terms of employment; it is sad to observe that even here, in some instance it was found that minimum wages were not paid.

Lack of appropriate policies, regarding access of land to the poor for afforestation purposes, defunctional Acts and laws, which hinder rather than motivate people, resulted in vested interests controlling the social forestry programme. Instead of fuelwood and fodder, social forestry has largely provided raw materials to paper, pulp and building industry, bypassing the rural poor.

Social forestry and massive afforestation by the people cannot be a programme of a single government department. Social forestry must be a people's movement. Schools, colleges, municipalities, government departments, and other identified institutions should share the responsibility to plant trees and maintain them either directly or through a contract system with local people.

c) Sacred Groves

Sacred groves comprise of patches of forests or natural vegetation - from a few trees to forests of several acres - that are usually dedicated to local folk deities or tree spirits (Vanadevatais). These spaces are protected by local communities because of their religious beliefs and traditional rituals that run through several generations.

The degree of sanctity of the sacred forests varies from one grove to another. In some forests even the dry foliage and fallen fruits are not touched. People believe that any kind of disturbance will offend the local deity, causing diseases, natural calamities or failure of crops. For example, the Garo and the Khasi tribes of northeastern India completely prohibit any human interference in the sacred groves. In other groves, deadwood or dried leaves may be picked up, but the alive tree or its branches are never cut. For example, the Gonds of central India prohibit the cutting of a tree but allow fallen parts to be used.

Sacred groves are scattered all over the country, and are referred to by different names in different parts of India. Sacred groves occur in a variety of places - from scrub forests in the Thar Desert of Rajasthan maintained by the Bishnois, to rain forests in the Western Ghats of Kerala. Himachal Pradesh in the north and Kerala in the south are specifically known for their large numbers of sacred groves. The Kodavas of Karnataka alone maintained over 1000 sacred groves in their region.

SOME OTHER INITIATIVES BY GOVERNMENT OF INDIA

a) People's Biodiversity Register

The People's Biodiversity Register contain Comprehensive information on the availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them; Data about the local 'vaids' and practitioners using the biological resources; Details of the access to biological resources and traditional knowledge granted, details of the collection fee

imposed and details of the benefits derived and the mode of their sharing.

Functions of Peoples' Biodiversity Register:

- Community regulation of access to biodiversity resources leading to sustainable harvests.
- Promoting knowledge-based sustainable management of agriculture, livestock, fish, forests and public health so as to enhance the quality of life of the community members.
- Promote biodiversity- friendly development in the emerging process of decentralized management of natural resources.
- Opportunities to generate funds through imposition of collection fees for access to biodiversity resources.
- Conserving valued resources.
- Value addition to biodiversity resources.
- Recording of biodiversity related knowledge, pertaining to management.
- Recording of biodiversity related knowledge, coupled to opportunities to generate funds through imposition of collection fees for access to local knowledge.
- Sharing in the benefits of commercial application of local knowledge.
- Perpetuate and promote the development of practical ecological knowledge of local communities and of traditional sciences such as Ayurveda and Unani medicine.

b) Science Express- Biodiversity Special Train

With a view to create awareness amongst masses in general and youth in particular about the exceptional biodiversity of India , the Ministry of Environment & Forests (MoEF) in collaboration with Department of Science & Technology (DST) and Indian Railways launched last year on World Environment Day from Delhi, an innovative exhibition on rail called Science Express Biodiversity Special (SEBS)Train. It has been re-launched in the 2nd phase of the programme on 9 April 2013 from Delhi.

A team of 40 young well trained and highly motivated post graduates in science, who remain on-board throughout the entire journey, will facilitate the visitors and explain the content of the exhibits and also answer their queries. Thereafter the train will halt at 60 more locations across India before returning to its base station- Gandhinagar Capital- on 28 October 2013.

The present run of the train is the 2nd Phase in the two phase programme envisaged to cover a minimum of 100 locations on Broad Gauge network of Indian Railways across the entire length & breadth of the country. Of the 16 coaches of Science Express- Biodiversity Special, 8 are solely dedicated to showcasing the myriad biodiversity spread across all the bio-geographical zones of India through a variety of interactive exhibits, short films & videos that are shown on Plasma & LED TV screens, large format displays, kiosks, backlit panels, and so on. The rest of coaches have interesting & informative exhibits on Climate Change, Energy and Water conservation and topical issues in science. The popular Joy of Science Lab is mounted in an exclusive coach in which students are guided to perform various experiments & activities to understand concepts of various themes projected in the train. In addition, on the railway platform where the train is halted, young visitors are encouraged to play several exciting games as well as participate in quizzes, painting competitions, elocutions, just-a-minute, etc. The window panes of the entire train have also been judiciously used to put up posters on the numerous species of flora & fauna found in India which keep the visitors engaged while waiting for their turn.

GLOBAL EFFORTS TOWARDS BIODIVERSITY CONSERVATION

a) Convention On Biological Diversity

The Convention on Biological Diversity (CBD) is an international legally-binding treaty with three main goals: conservation of biodiversity; sustainable use of biodiversity; fair and equitable sharing of the benefits arising from the use of genetic resources. Its overall objective is to encourage actions which will lead to sustainable future. The conservation of biodiversity is a common concern of humankind. The Convention on Biological Diversity Covers biodiversity at all levels: ecosystems, species and genetic resources.

It consists of two main protocols:

- The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an

international treaty governing the movements of living modified organisms (LMOs) resulting from modern biotechnology from one country to another. It was adopted on 29 January 2000 as a supplementary agreement to the Convention on Biological Diversity and entered into force on 11 September 2003.

- The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity is an international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components. It was adopted by the Conference of the Parties to the Convention on Biological Diversity at its tenth meeting on 29 October 2010 in Nagoya, Japan.

COP-11 in brief:

During the eleventh meeting of the Conference of the Parties to the United Nations Convention on Biological Diversity, which was held in Hyderabad, the developed countries agreed to double funding to support efforts in developing states towards meeting the internationally - agreed Biodiversity Targets and the main goals of the Strategic Plan for Biodiversity 2011-20.

The Saragasso Sea, the Tonga archipelago and key corals sites off the coast of Brazil are among a range of marine areas to receive special attention by governments as part of renewed efforts to sustainably manage the world's oceans agreed in Hydrabad. Many of these areas receive no protection at present.

Other key decisions taken at the 11th Conference of the Parties to the Convention on Biological Diversity (CBD COP 11) include new measures to factor biodiversity into environmental impact assessments linked to infrastructure and other development projects in marine and coastal areas.

Salient outcomes are:

For the first time, developing countries at COP 11, including India and several African states, pledged additional funds above and beyond their core funding towards the work of the CBD.

The conference also saw the launch of the Hyderabad Call for Biodiversity Champions. The programme will accept pledges from governments and organizations in support of the Strategic Plan for Biodiversity. The government of India committed over US$ 50 million as part of the programme.

The 193 Parties to the CBD agreed to classify a diverse list of marine areas, some renowned for containing 'hidden treasures' of the plant and animal world, as ecologically or biologically significant. Parties to the Convention also called for more research into the potential adverse effects of underwater noise from ships on marine and coastal biodiversity, and highlighted the growing concern on the adverse effects of marine litter. It also recognized the growing challenge of climate change impacts on coral reefs, which, Parties agreed, will require significant investment to overcome. There was also a call to fisheries management bodies to play a stronger role in addressing the impacts of fisheries on biodiversity.

COP 11 also agreed to a number of measures to engage the main economic sectors, such as business and development organizations, to integrate biodiversity objectives in their plans and programmes.

A decision on climate change and biodiversity called for enhanced collaboration between the CBD and UN climate change initiatives including Reducing Emissions from Deforestation and Forest Degradation (REDD+) Given that forests are home to more than half of all terrestrial species, initiatives such as REDD+, where developing countries can receive payments for carbon offsets for their standing forests, can potentially help achieve international biodiversity targets, as well as those concerned with cutting carbon emissions. The decision covers technical advice on the conservation of forests, sustainable management of forests, and enhancement of forest carbon stocks. However the COP also noted discussions around the need for biodiversity safeguards relating to REDD+

and similar incentives. Actions such as afforestation in areas of high biodiversity value, or the conversion of natural forests to plantations, for example, may have adverse impacts on biodiversity.

Further together with FAO and other organizations, the CBD Secretariat will establish a global 'Collaborative Partnership on Sustainable Wildlife Management' to support developing countries in the implementation of relevant CBD provisions.

The Conference welcomed the establishment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) earlier this year and recognized the potential contribution it could make to enhance the effectiveness of the Convention. COP requested IPBES to contribute to assessments of the achievement of the Aichi Biodiversity Targets. It was decided that the Convention's Subsidiary Body on Scientific, Technical and Technological Advice at its next meeting would provide additional explanatory information on the tasks requested from IPBES and that it would convey this information to IPBES before the its second plenary meeting at the end of 2013.

b) Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES)

Annually, international wildlife trade is estimated to be worth billions of dollars and to include hundreds of millions of plant and animal specimens. The trade is diverse, ranging from live animals and plants to a vast array of wildlife products derived from them, including food products, exotic leather goods, wooden musical instruments, timber, tourist curios and medicines. Levels of exploitation of some animal and plant species are high and the trade in them, together with other factors, such as habitat loss, is capable of heavily depleting their populations and even bringing some species close to extinction. Many wildlife species in trade are not endangered, but the existence of an agreement to ensure the sustainability of the trade is important in order to safeguard these resources for the future.

Because the trade in wild animals and plants crosses borders between countries, the effort to regulate it requires international cooperation to safeguard certain species from over-exploitation.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

CITES was conceived in the spirit of such cooperation. Today, it accords varying degrees of protection to more than 30,000 species of animals and plants, whether they are traded as live specimens, fur coats or dried herbs.

CITES Resolution

CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of IUCN (The World Conservation Union). The text of the Convention was finally agreed at a meeting of representatives of 80 countries in Washington in 1973, and in 1975 CITES entered into force.

CITES is an international agreement to which States (countries) adhere voluntarily. States that have agreed to be bound by the Convention are known as Parties. Although CITES is legally binding on the Parties - in other words they have to implement the Convention - it does not take the place of national laws. Rather it provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level.

How CITES works?

CITES works by subjecting international trade in specimens of selected species to certain controls. All import, export, re-exports and introduction from the sea of species covered by the Convention has to be authorized through a licensing system. Each Party to the Convention must designate one or more Management Authorities in charge of administering that licensing system and one or more Scientific Authorities to advise them on the effects of trade on the status of the species.

The species covered by CITES are listed in three Appendices, according to the degree of protection they need.

Appendix I

Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. Any trade in these species requires export and import permits. Notable animal species include

the red panda, gorilla, the chimpanzee species, tigers, Asiatic lion, Asian elephant, etc.

Appendix II

Appendix II includes species that are not necessarily threatened with extinction, but may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival. No import permit is necessary for these species under CITES. A non-detriment finding and export permit are required by the exporting Party.

Examples of species listed on Appendix II are the American black bear, Hartmann's mountain zebra, African grey parrot, bigleaf mahogany, etc.

Appendix III

This Appendix contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade. In all member countries trade in these species is only permitted with an appropriate export permit and a certificate of origin.

Examples of species are the two-toed sloth by Costa Rica, African civet by Botswana, and the alligator snapping turtle by the USA.

c) The Ramsar Convention

The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The treaty was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975.

The Convention's mission is:

- the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.
- uses a broad definition of the types of wetlands covered in its mission, including lakes and rivers, swamps and marshes, wet grasslands and peatlands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans.

The Ramsar List of Wetlands of International Importance now includes 1,869 sites (known as Ramsar Sites) covering around 1,836,000 km², up from 1,021 sites in 2000. The nation with the highest number of sites is the United Kingdom at 168; the nation with the greatest area of listed wetlands is Canada, with over 130,000 km², including the Queen Maud Gulf Migratory Bird Sanctuary at 62,800 km².

d) World Heritage Sites

World Heritage Sites are extremely exceptional cultural and natural properties nominated voluntarily by signatory nations, which have been approved for inclusion in the List by the World Heritage Committee.

In 1972, worldwide concern over the potential destruction of the Earth's cultural and natural heritage led the United Nations Educational, Scientific and Cultural Organisation (UNESCO) to establish an international treaty called the Convention Concerning the Protection of the World Cultural and Natural Heritage. More commonly known as the World Heritage Convention, it aims to identify, celebrate and protect the Earth's irreplaceable natural and cultural heritage, and to ensure it is conserved for all people, for all time.

For the purposes of the World Heritage Convention, the following are considered as "cultural heritage":

- **Monuments:** architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science;
- **Groups of buildings:** groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science;
- **Sites:** works of man or the combined works of nature and of man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological points of view.

For the purposes of the World Heritage Convention, the following are considered as "natural heritage":

- Natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view;
- Geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation;
- Natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.

Benefits

A key benefit of ratification, particularly for developing countries, is access to the World Heritage Fund. Annually, about US$4 million is made available to assist States Parties in identifying, preserving and promoting World Heritage sites. Emergency assistance may also be made available for urgent action to repair damage caused by human-made or natural disasters. In the case of sites included on the List of World Heritage in Danger, the attention and the funds of both the national and the international community are focused on the conservation needs of these particularly threatened sites.

Sites inscribed on the World Heritage List also benefit from the elaboration and implementation of a comprehensive management plan that sets out adequate preservation measures and monitoring mechanisms. In support of these, experts offer technical training to the local site management team.

Finally, the inscription of a site on the World Heritage List brings an increase in public awareness of the site and of its outstanding values, thus also increasing the tourist activities at the site.

The Convention sets out the duties of States Parties in identifying potential sites and their role in protecting and preserving them. By signing the Convention, each country pledges to conserve not only the World Heritage sites situated on its territory, but also to protect its national heritage. The States Parties are encouraged to integrate the protection of the cultural and natural heritage into regional planning programmes, set up staff and services at their sites, undertake scientific and technical conservation research and adopt measures which give this heritage a function in the day-to-day life of the community.

The Convention stipulates the obligation of States Parties to report regularly to the World Heritage Committee on the state of conservation of their World Heritage properties. These reports are crucial to the work of the Committee as they enable it to assess the conditions of the sites, decide on specific programme needs and resolve recurrent problems. It also encourages States Parties to strengthen the appreciation of the public for World Heritage properties and to enhance their protection through educational and information programmes.

A cluster of sites from the Western Ghats in peninsular India has been inscribed in the UNESCO list of World Heritage Sites. The clusters of sites are in the landscapes of Agasthyamalai, Periyar, Anamalai, Nilgiris, and Upper Cauvery in Kodagu, Kudremukh, and Sahyadri. These constitute the thirty nine sites in seven sub-clusters of the Western Ghats, identified and proposed as a potential UNESCO World Natural Heritage Cluster Site, in 2006. The proposal was made by the Ministry of Environment and Forests based on expert inputs from ATREE, Nature Conservation Foundation, Mysore and Wildlife Institute of India, Dehra Dun.

The Western Ghats are a biological hotspot harbouring 60 Important Bird Areas (IBA), 325 globally threatened species, many endemic species and sacred groves, across six states (Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala).

The area of 150,000 km^2 boasts a varied ecosystem with a historical Gondwanaland origin and significant global value. The Ghats can lay claim to a unique landform and biodiversity; however they are also under threat of increased developmental pressure from energy needs. Coffee, tea and rubber plantations too have grown over the years, leaving the area with less undisturbed space.

Under the title of a Natural Heritage Site, it is expected that areas of the Western Ghats pronounced World Natural Heritage sites will be able to restrict some development, allowing these areas to be better conserved.

e) Convention on the Conservation of Migratory Species of Wild Animals

Migration is a natural phenomenon by which individuals of a given species moves between areas which they inhabit at different times of the year. Migratory species of animals not only need good habitats for reproduction but also during their non-breeding and all along their migratory routes. In an ever-changing world, human pressure is high on some of those habitats, and also often on the animals themselves (hunting, incidental catch, etc). To conserve species whose movements regularly cross national borders, international cooperation is of vital importance.

The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention or CMS) was adopted in Bonn, Germany in 1979 and came into force in 1985. Contracting Parties work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species ; concluding multilateral Agreements for the conservation and management of migratory species which require or would benefit from international cooperation and by undertaking cooperative research activities.

To avoid any migratory species becoming endangered, the parties must endeavour:

- to promote, cooperate in or support research relating to migratory species;
- to provide immediate protection for migratory species included in Appendix I; and
- to conclude Agreements covering the conservation and management of migratory species listed in Appendix II.
- To protect endangered migratory species, the parties to the Convention will endeavour:
- to conserve or restore the habitats of endangered species;
- to prevent, remove, compensate for or minimise the adverse effects of activities or obstacles that impede the migration of the species; and
- to the extent feasible and appropriate, to prevent, reduce or control factors that are endangering or are likely to further endanger the species.

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ENVIRONMENTAL POLLUTION & DEGRADATION

CHRONICLE IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

Environment is the value of every ambient factor and influence that concerns the development and life of a human being and other organisms. It includes air, water, land and dynamically the inter-relationship that exists between these and other living creatures, plants, micro-organisms and property.

Today, the world is aware about how human beings dominate the operation or conservation of natural resources and how changes in ecological structure affect human beings. The natural environmental resources of air, water, soil, plant and animal life constitute the natural capital on which man depends to satisfy his needs to achieve his aspirations for development. The wise management of these resources demands positive and realistic planning that balances human needs against the potential the environment has for meeting them.

That is the reason why decision-makers, scientists, social workers and even laymen are becoming increasingly conscious of a variety of issues-global warming and its corollaries such as ozone-layer depletion, desertifiation, etc. air and water pollution, hazards of chemical and radiation toxicity, lifestyle characteristic of excessive and wasteful consumerism, etc, that not only results in unsustainable exploitation of natural resources, but also have a cumulative, disastrous and adverse effect on the ecology.

Thus this chapter concentrates on all forms of environmental crisis that are created by man and in turn affect his survival.

CAUSES OF ENVIRONMENTAL CRISIS

Population Explosion: The world population is growing by 92 million people annually with an addition to the Indian population every second. The greatest threat to the environmental crisis in India is the rapid growth of population. There is a direct relationship between increase in population and its impact on the environment. More people require more food, utilizing more land for cultivation, more minerals, more water and more energy, etc. The side effects include enhanced use of chemicals, chemical fertilizers, insecticides, pesticides, deforestation, increased pollution, heavy load on transportation, etc.

Poverty: The poor are the hardest hit by the loss of natural resources and pollution. They are also the people who cause most damage to the environment.

Industrialisation: Today, India has become the 10th largest industrial nation of the world. But, at the same time, it is one of the most polluted countries of the world as far as industrial pollution and hazardous wastes are concerned. The general indifference of industries, on aspects of environmental safety and protection, has led to the spread of air, water and soil pollution. The real problem faced by us is from unregulated industrial development. Moreover, a majority of industrial units are producing wastes in liquid, gaseous and solid forms, some of which are toxic and hazardous. The current methods of treatment and disposal of hazardous wastes need closer monitoring and follow up, with instances of untreated industrial waste released by several industrial houses.

Energy-Crisis: Population and economic growth has necessitated a corresponding expansion in energy requirements for various purposes. The energy usage in the country is such that India has been listed as the fifth biggest contributor of green-house gases by the World Resources Institute Washington D.C. and further, we are on the verge of running out of our fossil-fuel resources.

Illiteracy & Ignorance: Mass illiteracy and ignorance is yet another cause of environmental degradation not only in our country but globally. The low level of environmental literacy among people has impacted their limited comprehension of the future effects of environmental degradation.

Inequality: The chasm of inequality is a major cause of environmental deterioration in the entire world. Global inequality is gradually becoming more sharpened, as inequitous growth has promoted over consumption at the top and worsened starvation at the bottom. People at

either end of the income spectrum are more likely than those in the middle to damage the ecological health of the planet. It is believed that the need of the poor and the greed of the rich are more responsible for the environmental crisis.

TYPES OF ENVIRONMENTAL CRISIS

POLLUTION

Pollution is the introduction of contaminants into the natural environment that causes instability, disorder, harm or discomfort to the ecosystem i.e. physical systems or living organisms. Pollution can take the form of chemical substances or energy, such as noise, heat, or light. Pollutants, the elements of pollution, can be foreign substances, energies or naturally occurring constituents. When occurring naturally, they are considered contaminants on exceeding their natural levels.

Types of Pollution

a) AIR POLLUTION

Air, which is a mixture of gases, moisture and some inert materials, controls life on earth. It is a reservoir of oxygen needed by man and other animals and of carbon dioxide which is essential for plants. Any contamination in air may disturb the entire atmospheric system, which is an insulating blanket around the earth. Air pollution may be defined as an imbalance in the quality of air so as to cause ill effects. The industrial, automotive and domestic activities have resulted in increasingly outrageous injuries to the atmosphere. The different types of pollutants are continuously introduced into the atmosphere and are removed by natural processes of cleansing. But when pollution exceeds the atmosphere's self-purifying capacity, accumulation of pollutants occurs, causing serious harm to every living being.

Normal composition of clean air (by volume) is as follows:

Gases	Per cent
Nitrogen	78%
Oxygen	21%
Argon	0.93%
Carbon dioxide	0.03%
Other gases	Negligible

But due to air pollution, the composition of the air is changing all over the world, particularly in most industrialized countries. Air pollution results from gaseous emission from industry, thermal power stations, domestic combustion, etc. Most of the gaseous and particulate air pollutants are products of burning of fuels. Burning of coal mainly produces carbon dioxide, sulphur dioxide and fly-ash. Lead, carbon monoxide and nitrogen oxides are added to the atmosphere from automobile exhaust.

The most conspicuous cause of environmental degradation is air pollution. As the air grows perceptibly darker and respiratory diseases increase in Indian metros, the presence of air pollution cannot be ignored. A recent study by the Centre for Science and Environment (CSE) has revealed that air pollution in India has been killing nearly 52,000 people every year prematurely while hospitalizing about 26 million. Premature deaths are the results of infection in respiratory system, cardio-vascular diseases, asthma, bronchitis, eye irritation, hypertension, neurological damage, loss of IQ in children, heart diseases, etc. These diseases are more common among women, the aged people and children below five years.

Common Air Pollutants

Contaminants in the air are present either in gaseous form or as particles.

Gaseous Pollutants:

- **Sulphur oxides, Hydrogen sulphide:** These are released by the biological decomposition and from volcanic eruptions, smelting of sulphide-containing ores, combustion of sulphur containing fuels such as coal and oil, petroleum refining and geothermal energy sources are some of the important contributors.

  While high concentrations of sulphur dioxide cause interveinal damage, necrosis of leaves and cellular collapse, lower amounts result in chlorosis of the leaves and still lower quantity suppresses the overall vegetative as well as reproductive growth and yield. Exposure to hydrogen sulphide results in leaf lesions, mottling, defoliation and reduced growth. Sulphur dioxide paralyzes or destroys bronchial cilia in air passages of man, constricts bronchi, damages lungs, lowers resistance to pneumonia and influenza and causes

bronchitis, emphysema and irritation of the mucous membranes. Sulphur dioxide and other pollutants also bring about coalescence of alveoli and reduce the amount of surface area available for the transport of oxygen. Constrictions in the branches of bronchial tubes also reduce the rate at which air is exchanged between alveoli and the external environment.

- **Hydrogen fluoride:** Active volcanoes are natural sources of fluorides in the atmosphere. These are also emitted from aluminium, steel and electrochemical reduction plants, blast furnaces, brick, tile and superphosphate fertilizer industries and from the combustion of coal.

  Fluoride burns the tip of leaves, low amounts impair plant growth, result in excessive dropping of bloom and young fruits, development of small, partially or completely seedless fruits and premature formation of soft red flesh and splitting of peach.

- **Nitrogen oxides:** Anaerobic breakdown of nitrogenous compounds by bacteria, forest fires and lightning constitute the natural causes. Chief sources however are power generators and motor vehicles, burning of organic wastes and manufacture of explosive and nitrogenous fertilizers further add to this problem.

  Nitrogen dioxide brings about bifacial necrosis leading to collapse of leaves, enhancement of green colour followed by chlorosis and extensive leaf drop, as well as increase in fruit drop and decrease in fruit yield. In man it produces general and pulmonary edema and haemorrhage.

- **Hydrogen chloride:** It is infrequently expelled by accidental spills from chemical manufacturing plants. Besides, it is released from combustion of coal, paper, plastics and chlorinated hydrocarbons and ignition of solid-fuel rocket engines.

- **Hydrocarbons:** Biological decomposition of organic matter seepage from natural gas and oil-fields and volatile emissions from plants are major causes for the release of hydrocarbons such as methane, ethylene and aniline. Incomplete combustion of fuels, motor vehicle exhaust, petroleum refineries, agricultural burning, manufacture of explosives and cracking of natural gas in petrochemical plants constitute the anthropogenic sources that emit hydrocarbons.

- **Ammonia:** Refrigerator, cooler systems of cold storages, manufacture of ammonium fertilizers and nitric acids, domestic incineration are the prime sources of ammonia.

  It induces bleaching of leaves, rusty spots on leaves and flowers, reduction of root and shoot growth, browning and softening of fruits, development of dark, corky lenticels in apples and reduction in the rate of seed germination.

- **Carbon-monoxide:** It is released chiefly from automobile engines and defective furnaces. It produces headache, dizziness, inability to distinguish time intervals and other observable physical effects and cardiac and pulmonary changes. It forms carboxy haemoglobin in RBC which prevents them from carrying oxygen to all parts of the body.

- **Photochemical Oxidant:** These are secondary pollutants which are mainly formed by photochemical reactions between primary pollutants and hydrocarbons. The major oxidants are ozone and peroxyacetyl nitrate (PAN). Minor amounts of ozone are also added to the atmosphere by electrical discharges such as lightning flashes by vertical flux of stratospheric ozone and by tropospheric electric storms.

  In human beings oxidants cause stinging of eyes, coughing, headache, severe tired feeling, oedema haemorrhage, dry throat, disorientation and altered breathing.

- **Tobacco smoke:** It is mainly produced by smoking cigarettes. It is gradually becoming a potent pollutant especially in closed atmosphere. It causes lung cancer and pulmonary and coronary heart diseases. It brings about thickening of bronchial epithelial layer, loss of ciliated cells and appearance of cells with bizarre nuclei which are probably the precursors of cancerous cells.

Particulate Pollutants

- **Fluorides:** The particulate fluorides originate in the same way as the gaseous fluorides. However, these are less phyto-toxic. They cause an increase in the fluoride content of the leaves and occasional tip burn but the growth and yield are not greatly affected. The ingestion by cattle of various fluorine compounds falling on forage causes abnormal calcification of bones and teeth called fluorosis, eventually resulting in loss of their weight, and in lameness.

- **Lead:** Its chief source is tetraethyl lead used as an antiknock additive in fuels of motor vehicles.

  That is why its concentration is higher in urban areas, where automotive and industrial exhausts are more, significant deposition also comes from smelting complexes, ceramic paints, pesticides and solder used for sealing lead accumulates in considerable amounts in the leaf tissues as also in the tissues of human body where it interferes with the development and maturation of RBC. Chronic exposure leads to damage to red cells. Being a cumulative poison it disrupts the functioning of cells and organs of the muscular, circulatory and nervous systems by binding with the cellular enzymes also causing coagulation of proteins. It damages liver, kidney and gastro-intestine and induces abnormalities in fertility and pregnancy.

- **Sodium Chloride:** The de-icing salts mainly sodium chloride used to remove ice and snow in winters have been recognized to cause damage to the road side trees in the form of leaf necrosis, defoliation and suppression of flowering.

- **Agricultural Chemicals:** Several chemicals such as insecticides, herbicides, fungicides and pesticides used widely in agriculture are known to produce foliar lesions, chlorosis and abscission of leaves and reduction in fruit set.

Sources of Air Pollution

1. Urbanisation: Urbanisation has unveiled before us an alarming situation. Expanding urbanisation has influenced the atmosphere in different ways, such as growth of vehicle population, sanitation, multiplying industrialisation, power consumption, etc. Urbanisation leads to development of industrial centres without a corresponding development in civic amenities and pollution control mechanism.

Vehicular pollution accounts for nearly 70 per cent of the total air pollution in India.

Urbanisation has spelt out greater comforts in luxurious living with dramatic improvements in the technology used. However, this development in technology accentuates the problem of indoor air pollution. Scientific evidence has indicated that air within homes and other buildings can be more seriously polluted than the outdoor air, particularly in the largest and the most polluted cities. Similarly, research indicates that women spend nearly 90 per cent of their time indoors. Thus, for many people, risks to health may be greater due to exposure to indoor air rather than to air outdoors. There are many sources of indoor air pollution:

Environmental Tobacco Smoke (ETS) is a major source of indoor air pollution because it contains carbon monoxide, formaldehyde and many other harmful gases. ETS is often referred to as 'second hand smoke' and the exposure to ETS is called 'passive smoking. Some building materials like asbestos, furnishings and household products like aerosol sprays, adhesives, paints, etc. release volatile organic pollutants continuously which cause diseases ranging from scamming of lung tissues to visual disorder, abdominal cancer and memory impairment. Other sources include, use of unvented stoves or space heater, solvents for cleaning products and housekeeping which release pollutants intermittently.

2. Industrialisation and other Developmental Activities: The rapid rate of industrialisation has resulted in more and more air pollution. Various industrial processes release almost all types of pollutants into the air. Some industries like cement, iron and steel, fertilizer, petrochemical, etc. are of great concern because of the difficulty in controlling the emission of pollutants from them. Acid rain has become a great threat to the environment. The use of solvents is increasing with the growing use of paints, spray, polish, etc. Due to the presence of hydrocarbons in these materials, air pollution is caused which is dangerous for health. Similarly,

the use of pesticides in agriculture is also responsible for air pollution in rural areas.

In India around 60 per cent of energy needs are met by conventional energy sources, while non-conventional and renewable fuels meet the remaining 40 per cent. Energy consumption in the Indian industrial sector accounts for 74 per cent of total commercial energy consumption. Similarly, energy related carbon emission in India has grown nine-folds over the past four decades.

India's reliance on low-grade coal with high carbon content is the prime cause for large-scale carbon emission. Carbon emission has been exacerbated by the low energy efficiency of coal-based plants. Chemical industries, including manufacturers of cement, fertilizers, textiles, iron and steel, non-metal products, paper, food production, printing and publishing, leather industry, pesticides, etc. release a host of harmful gases and compounds into the atmosphere.

3. Deforestation: The burning of fire wood is one of the major source of air pollution in India. Intense use of fire wood, mainly for domestic chores contributes to high level of air particulate matter and has caused the depletion of forest resources. Besides, deforestation is aided by an ever increasing urban infrastructural demands, such as metalled highways, better places of dwelling, etc. As a result, large-scale utilisation of forest resources cause serious economical, environmental and social hazards. It is now a serious national problem and has invited the attention of national planners and environmental advisers. The statistics of forest coverage in India give a clear picture of how far India lags behind the minimum standard of forestation. The destruction of forest resources, the presence of harmful gases like sulphur dioxide and monoxide and dioxides of carbon in the atmosphere are increasing steadily resulting in acid rain, global warming and other such dreaded phenomena.

4. Vehicular Exhaust: The automobile is man's greatest achievement in minimizing distances. The number of automobiles is increasing day by day and has become a cause of air pollution and degradation of the environment. The automobile, with its internal combustion engine, emits poisonous gases that are harmful to human health and is the most serious polluter of the technological age.

Exhaust emissions from diesel engines include carbon monoxide, hydrocarbon oxides, organic acids, etc. The two primary pollutants are carbon monoxide and nitrogen dioxide, both of which are extremely poisonous gases. Lead is a toxic compound and its main source in the environment is believed to be from leaded gasoline used as fuel for internal combustion engines. The presence of lead in the atmosphere is a threat to the environment as well as for all living organisms.

5. Poverty: A closer look at the statistics reveals that more than two thirds of the total population in India still lives below the poverty line, striving hard to make both ends meet. Since their number is considerably large, their contribution to air pollution cannot be ignored. These people mostly use cow dung cakes, leaves, twigs and wood as fuel which being solid fuels emit more smoke in comparison to gaseous fuels. Improper disposal of garbage in the open causes decay of organic wastes, liberating harmful gases like methane and carbon monoxide into the atmosphere.

It becomes clear from the above analysis that the problem of air pollution is increasing with the growth and expansion of industries and automobiles. It is high time we know the harmful effects of air pollution and analyse our technology to control it.

Effects of Air Pollution

Pollution and smog unveil before us a list of dreaded diseases wrecking havoc on our health. Prolonged exposure to toxic pollutants from various sources affects the normal functioning of life. Growing level of nitrogen dioxide and other corrosive gases have caused multiplication of the incidence of allergic diseases like nausea, vomiting and chronic skin and eye irritations. The toxic elements in the atmosphere are responsible for asthma, bronchitis and related respiratory disorders. Nearly 80 per cent of cancer cases are attributed to environmental pollution especially due to contamination caused by toxic and hazardous chemicals. Organic lead emitted from automobiles gets absorbed in brain, liver, kidney and blood, causing convulsions, muscular paralysis, brain damage and even death. Radon gas introduced into the atmosphere from Uranium-containing soil can result in lung cancer after long exposure. More and more people are falling prey to digestive ailments and weakening of the body's immune system. The victims of airborne pollutants are mostly infants and children.

1. Effects on Human Health, Animals and Plants: Some environmental poisons can cause immediately and acute illness and even death. Others may be harmful, but the disease may take years or even decades to appear. Air pollution mainly affects the respiratory system. Bronchitis, emphysema, asthma and lung cancer are some of the chronic diseases caused due to exposure to polluted air. It is feared that lung cancer is caused mainly due to polluted air because carcinogens are found in the polluted air. Its mortality rate is higher in urban areas.

Sulphur dioxide is the most serious and widespread air pollutant. Its lower concentration is a cause of spasms in the smooth muscle of bronchioles and its higher concentration induces increased mucus production. Sulphur dioxide is also considered to cause cough, shortness of breath, spasm of the larynx and acute irritation to the membranes of the eyes. SO_2 also acts as an allergenic agent. When it reacts with certain compounds, sulphuric acid is formed which may damage lungs.

Generally speaking susceptibility to the effects of air pollution is great among infants, the elderly and the infirm. Those with chronic diseases of the lungs or heart are thought to be both sensitive and specifically reactive to air pollution's health effects. Another point to be noted is that the effect of air pollution's on human health is worst during the winter season, when pollution levels reach a maximum.

Carbon monoxide often affects the oxygen carrying capacity of blood. Nitric oxide is reported to be a pulmonary irritant and its excess concentration may cause pulmonary haemorrhage. Hydrogen sulphide is also toxic. Lead emitted from automobile exhausts is a cumulative poison, dangerous particularly to children and may cause brain damage.

2. Global Warming: The temperature at the surface of the earth is maintained by the energy balance between the sun's rays that strike the planet and the heat that is radiated back into space. Some of the heat is absorbed and retained by the earth or objects on the surface. Much of this does not pass through the air envelope to outer space but is absorbed by the carbon dioxide and water vapour in the atmosphere and adds to the heat already present. Thus, carbon dioxide acts like the glass of a greenhouse, on a global scale, which tends to warm the air in the lower levels of the atmosphere. This is called the greenhouse effect which is also responsible for the increase in temperature over the earth's surface. Volcanic eruptions are also responsible for the increase of carbon dioxide.

3. Depleting Ozonosphere: Ozone is normally present in the atmosphere at about 0.05 ppm at sea level. It is produced naturally in the atmosphere by the action of electric discharges on oxygen. Until 1974, atmospheric scientists were proceeding in their research on the possible impact of nitrogen oxide jet engine exhausts on the ozone layer. But later it was found that a new threat to the ozone layer had emerged from synthetic chemicals called chlorofluorocarbons. Recent scientific studies indicate that if chlorofluorocarbon production continues to grow at the present rate, the compound will enter the stratosphere in quantities capable of seriously depleting the ozone layer, normally termed as 'holes' in the ozone layer.

The use of chlorofluorocarbon is increasing because of the demand of 'personal care products' such as deodorants, hair sprays, shaving creams and countless other consumer cosmetic products, as well as refrigeration. The ozone layer serves as a shield protecting the troposphere and the earth's surface from most of the ultra violet radiation found in the sun's rays. If these ultra violet rays reach the earth's surface in full intensity, all exposed bacteria would be destroyed; plants and animal tissues would be severely damaged. In this protective role, the presence of the ozone layer is an essential factor in the environment.

4. Acid Rain: Pronounced as the most dreaded effect of air pollution, acid rain, as the name suggests refers to the precipitation of carbonic, sulphuric and nitric acids during rainfall. Acidic fumes of sulphur dioxide and trioxide, carbon dioxide and nitrogen dioxide emitted from industrial establishments combine with rain water and snow in the atmosphere to form corresponding acids which come down as rain. The analysis of rain water in polluted regions would confirm acidic character with pH value less than 7.

Acid rain pollutes the drinking water sources, such as wells, ponds and lakes. It causes fertile lands to grow barren since excessive acidity is deterrent to plant growth. Acid rain is highly corrosive and causes blisters and burns, on contact with human skin. The Taj Mahal at Agra was prone to corrosion due to sulphuric acid rain.

5. Smog: 'Smog' is the name given for 'smoke fog'. The most irritating and injurious components of smog are the products of reactions in the atmosphere between oxygen, ozone and emission pollutants. The mixture of these products is called photo-chemical smog. These are reactions in which oxygen, ozone, nitrogen and hydrocarbons produce those compounds which are toxic and irritating.

The constituents of smog are quite toxic and are responsible for respiratory and cardiac difficulties. Eye irritation is the most common symptom of smog injury. It is also injurious to animals and plants and is one of the main causes of environmental degradation

Controlling Air Pollution

The following steps should be taken to control air pollution:

1. The forest cover should be protected by restricting deforestation and through adoption of afforestation programmes. Trees are the best controllers of air pollution. It must be ensured that 33 per cent of the land area remains under forest cover. It will help in controlling air pollution and also help in maintaining the ecological balance.
2. There must be a 'green belt' around every township and village. Similarly, industrial areas should be surrounded by green belts.
3. The main source of air pollution are automobiles. Therefore, their engines should be redesigned in such a way that their emissions cause minimum pollution. Several steps have been taken and some technology has also been developed, but it is still in a preliminary stage.
4. In developing countries traditional use of wood fuel should be controlled.
5. In industries, arrangements for pollution control should be made. Only after arrangements for effluent treatment are made, should permission for production be given.

Air Fingerprinting: Technique to Measure Pollution

A technique that revolutionizes the speed and accuracy by which air composition can be tested and has potential applications in the environmental, industrial and medical worlds has been developed. The new air fingerprinting technique can detect in less than a minute, the ingredients of air, including that of an individual's breath. The new development may have application in the forensic field.

A new method for fingerprinting the characteristic signature of volatile organic compounds (VOCs) in air has been developed. VOCs are produced naturally in the body and some are expelled in our breath. The presence or absence of specific VOCs may be a rapid indicator of certain illness. A wide range of VOCs are also emitted from man-made sources and these can have a damaging effect on the environment and on human health. Chemical plants, oil refineries, gas platforms, vehicle and aircraft emissions, are all major sources of atmospheric VOCs. Many of the hundreds of different VOCs emitted by these man-made products are toxic and/or carcinogenic and, although usually present in very small quantities, their constant emission into poorly ventilated buildings mean that human safety levels are often exceeded. This technique is also used as a method for urban pollution monitoring.

Asian Brown Cloud

The United Nations Environment Programme (UNEP) had published a report about the presence of a 3km thick layer of pollutants dubbed "Asian Brown Cloud" over South Asia. In order to notice this environmental hazard the Govt. of India has decided to launch a study to determine how far India and other countries are responsible for it. The study would involve the deployment of a network of what is called sky scanner radiometers across the country.

Meanwhile, the thick brown haze which till now was largely seen in the South Asian skies is spreading to newer areas like the Gulf region. It has been revealed that the West Asian region, too, is being sucked into the global pollution circuit moving several kilometres above the ground.

The haze is a cocktail of ash, aerosols and black soot that result mainly from diesel, dirty coal and biomass burning. This could be coming locally or from several hundred kilometres away. The impact of oil refineries along the Gulf coastline might prove an accelerating factor for this.

The United Nations Environment Programme (UNEP)-supported research efforts have come in for severe criticism from the Indian government. Consequently, the blanket of pollution, originally termed the 'Asian Brown Cloud,' has now been given the name 'Atmospheric Brown Cloud' by the UNEP.

b) WATER POLLUTION

Water pollution is a phenomenon that is characterized by the deterioration of the quality of land water (rivers, lakes, marshes and group water) or sea water as a result of various human activities. Water pollution is any physical or chemical change in water that can adversely affect organisms. It is a global problem, affecting both the industrialised and the developing nations. The water pollution problems in the rich and the poor nations, however, are quite different in many respects. Heat, toxic metals, acids, sediment, animal and human wastes and synthetic organic compounds foul the waterways of developed nations. Human and animal wastes, sediments and pathogenic organisms head the list in the non-industrialised nations. In these countries, unsanitary water and malnutrition account for most instances of illness and death.

Sources of Water Pollution

i) Agriculture

Agriculture has been a victim of water pollution in many instances, but sometimes it is also responsible for polluting water. Water pollution caused by agricultural activity is mainly an outcome of fertilizers and agricultural chemicals such as insecticides and herbicides.

(1) Water Pollution by Fertilizers

Fertilizers given to crops are not always fully consumed. and part of them remain in the soil by being absorbed by soil colloid, which influences the quality of underground, river and sea waters when it is dissolved. Chemical fertilizers mainly consist of relatively simple compound of nitrogen, phosphorus and potassium which are the nutritive elements of plants. Their runoff coefficients vary depending on the solubility of the fertilizer itself, the rate of absorption by plants, and rate of decomposition. It is generally believed that the runoff coefficient of nitrogen is 5-30 per cent and that of phosphorus is 0.05-5 per cent. Especially, nitrogen having a high runoff coefficient tends to cause the eutrophication of lakes and enclosed sea areas.

Organic fertilizers such as compost, farmyard manure, human waste and fish meal produce nitrogen and phosphorus when they are decomposed, and also become the source of pollution. These organic fertilizers do not contain, in general, any toxic substance.

(2) Water Pollution by Agricultural Chemicals

Agricultural chemicals are considered as a source of peculiar pollution which cannot be overlooked. Agricultural chemicals comprise a variety of chemicals such as insecticides, sterilizers and weed killers, that have played an important role in the operation of modern agriculture, but have also caused serious environmental pollution.

The characteristics of agricultural chemicals as water-polluting substances lie in that (1) almost all of them are special compounds not occurring at all in nature, and many of the behaviours and change of such chemicals at the time of discharge into the natural environment are known;(2) their influence on the human body because of their inherent characteristics; (3) when they are ingested into the human body, they tend to accumulate or concentrate in it;(4) they are available in a variety of kinds, and new products are developed constantly;(5) some of them are extremely stable as chemicals, and remain in nature or in the human body for a long time thereby eventually afflicting the human body;(6) it is common to all such chemicals to contain additives that can continue to affect the environment through they do not have a strong toxicity; (7) many of them require a special method of analysis.

ii) Mining Industry

In many countries, water pollution related to the mining industry can be tracked to olden times compared with those caused by other industries. The characteristics of wastewater from mining industries vary greatly depending on the kind of mine.

The characteristics of industrial pollution of mining industries can be summarized as follows:

(1) In many instances, the development of a mine itself changes its natural environment artificially, and such a change first affects the quality of water of the environment even if any kind of wastewater is not discharged from mining activities.

(2) In areas where mines can be developed, very often, even before the development of the mine, the quality of river water or underground water is different from that of other areas. For instance, river water or underground water in such areas contain special metals of high concentration and is strongly acidic. Thus, it is rather difficult to measure the direct influence of mining activities on the quality of water. Moreover, geological features and the ways of land use are usually very peculiar in mining areas. These conditions should be taken into consideration prior to surveying the quality of water.

(3) Mining activities generate large quantities of solid wastes in most cases, and such wastes form large heaps. These waste not only pollute water by exudation of toxic substances, but also cause, the rapid generation of suspended solids in water when the heap is washed away by a heavy rainfall or a flood.

iii) Urban Activities

In a sense, the existence of human beings itself is a source of water pollution. In primitive ages, the purifying of nature was much greater than the rate of water pollution caused by human living. But as time passed, men began to settle near water areas for the convenience of living; then they developed various industries, which provided them with the foundation of civilized life. The emergence of various industries coupled with the development of civilization has constantly increased the quantity of wastewater contaminations . The rate of environmental pollution has exceeded the rate of natural purification.

The type of water pollution in a city varies largely depending on the characteristics of the city, life style of the inhabitants and degree of civilization, degree of development of sewage treatment plants or sewerage systems. Although, it is very difficult to investigate these conditions in detail, they can be estimated by investigating the following:

(1) ***Population of the city:*** This is the most essential datum to be obtained first.

(2) ***Consumption of water and quantity of wastewater:*** where a city water system is well established, it is relatively easy to obtain data concerning the consumption of water. For example, the consumption of city water in a modern civilized city is said to be about 500 litres per man per day. However, it is usually difficult to know the quantity of wastewater even if it is only an estimate.

(3) ***Condition of sewage treatment:*** This can be measured in terms of the availability of sewage treatment plants and sewage works including their capacities and efficiency.

(4) ***Condition of municipal or public facilities and private facilities:*** In a large city, there are a number of public facilities and all these facilities can be the sources of water pollution, such as: (public facilities) government and municipal offices, schools, hospitals, public bath houses, public lavatories, markets, ports, power plants, city gas facilities, sewage treatment plants, etc. and (Non-public facilities) Factories, stores, offices, gas stations, restaurants, bars, hotels, etc.

(5) ***Condition of sewage:*** Municipal sewage mainly consists of a mixture of human waste, household sewage and wastes from other facilities, and its condition varies depending on the characteristics of the city, degree of civilization, precipitation and the condition of road surface.

The quantity and condition of wastewater resulting from human activity, mainly consisting of household wastewater, generally vary depending on the time of the day; however, the "product of the concentration multiplied by the quantity" tends to remain within a relatively fixed range. Such a value is defined as "pollution loading amount," and is used as the basic data for the sewage treatment planning.

The most conspicuous characteristics of municipal sewage are that the organic content (indicated as BOD) is extremely high; the content of ammoniacal and organic nitrogen, phosphates and sulphides are considerably high; and normally, hazardous substances are not contained.

Industrial wastewater tends to contain hazardous substances; therefore, its discharge into the municipal sewerage system should be strictly controlled. This is necessary because ordinary sewage treatment plants not only do not have an equipment to remove hazardous substances, but also there is a possibility of getting its activated sludge processing function damaged by such hazardous substances.

The modern sewage treatment technique is capable of removing organic pollutants very efficiently, but it is difficult economically to remove nitrogen and phosphorus contents efficiently with existing facilities. For example, only about 30% of the nitrogen and phosphorous contents can be removed through the currently employed two-step treatment method, which mainly applies the activated sludge method, and the remainder of such contents causes the eutrophication of water areas.

iv) Other Human Activities

Aside from the various human activities already discussed in previous sections, there are other types of human activities which also cause water pollution. These activities sometimes become social problems as sources of environmental pollution. These types of human activities are as follows:

(1) Construction Work / Infrastructure developement

Construction works, especially those large-scale land development projects or forestry conservation and flood control projects aimed at preventing natural disasters, can sometimes cause water pollution. Water pollution caused by such construction projects can be divided into those occurring incidental to the progress of construction works and those occurring due to the change in natural conditions as a result of the construction works. The latter is more important than the former. Construction works for a dam, river improvement (including those for the alteration of basins), port facilities, creation and reclamation of land and gravel gathering from river-bed are enumerated as examples of the above-mentioned causes.

(2) Various Tertiary Industries

Various Tertiary industries can be considered to cause water pollution such as cleaning and laundry businesses, public bath houses, hotels, printing businesses, photographic film development businesses, hospitals, laboratories or research institutes, tourist businesses, transportation facilities and so forth. An increase in the load of municipal wastewater as a result of the increase in the working population of cities also has become one of the factors directly related to water pollution. Of various transportations, ships, especially tankers which discharge waste cleaning water, have come to the fore as sources of water pollution in coastal regions.

(3) Errors, Accidents and Disasters

Accidental damages to public sewage works or drainage of industrial effluent, as well as poor planning of sewage treatment plants and erroneous operations of these facilities can also cause water pollution. Speaking of water pollution caused by accidents, pollution of the ocean due to oil- spills resulting from the collision of tankers on the high seas has become an object of public attention in recent years.

Measures to Prevent Water Pollution

(i) All domestic and municipal effluents should be drained in water bodies only after proper treatment.

(ii) As far as possible domestic waste water be used for irrigation, it is very useful for horticulture.

(iii) There must be strict regulations for industrial effluents, that they must not discharge highly toxic water into water bodies. Every industry should develop its own effluent treatment plant.

(iv) Only standard quality pesticides should be used.

(v) There should be a complete ban on the disposal of dead bodies in rivers. The bank of water bodies are often used as public latrines. This should be strictly checked.

(vi) Algae and other water borne vegetation should be cleaned regularly.

(vii) Chemicals such as potassium permanganate should be spread regularly in order to protect water from micro organisms.

(viii) In order to avoid the release of night soil into the city drains which eventually join the river, the unsewered areas should be sewered forthwith.

(ix) The existing laws for the prevention and control of water pollution need to be implemented forcefully.

c) OIL POLLUTION

Human activities on the environment have resulted in pollution of environment. Pollutants

are stored and transported through the atmosphere, the hydrosphere and the lithosphere and influence biotic communities. Pollution of environment especially marine pollution is a worldwide phenomenon. Spectacular oil spills and conspicuous acts of dumping hazardous wastes e.g. radioactive material into the sea have attracted greater attention in recent years to the dangers of oceanic pollution. Some of the major marine pollutants are mercury, lead, pesticides, petroleum, and radioactive elements.

Marine pollution is a worldwide phenomenon. Most marine pollutants originate on the continent and reach the oceans via the atmosphere and rivers. Marine pollution cannot be separated from global pollution generally. It is an avoidance of reality which will assure failure of any such effort. To turn one's back on the land to ignore the atmosphere and then to try to develop effective means for the international control of pollution of the marine environment is bound to result in failure.

Oceanic pollution cannot be controlled unless the release of the materials that pollute the oceans is controlled. These materials are generated mainly by activities entirely within the boundaries of states and they are transported primarily by the atmosphere, secondarily by rivers and only tertiarily by specific acts of man. Thus, pollution control requires the control of human polluting activities everywhere. The importance of controlling oil pollution at sea lies not only in its short-term effects but also the long-term effects on marine life and environment. Crude oil is one of the most complex mixtures of natural product with different degrees of toxicity.

The short term effects of an intact cohesive film of crude oil over the water surface are detrimental for the following reasons:

- Marine fowl are particularly vulnerable to oil spills and it is estimated that about 10,000 birds were killed as a result of grounding of Torrey Canyon.
- Shore properties and beaches can be extensively contaminated.
- Slow moving crustaceans and inter-tidal marine life can be physically damaged by heavy spills of oil.
- The oil film forms a barrier to the transfer of oxygen into the water to support marine life, particularly planktonic species that resides less than a half to one meter below the surface.

The long term effects of oil pollution are two-fold. Once incorporated into a particular marine organism, hydrocarbons are stable and pass through many members of the marine food chain without alteration eventually reaching organisms that are harvested for human consumption. One consequence of this may be the incorporation into food of materials which produce an undesirable flavour. Far more serious is the potential accumulation in human food of long term poisons derived from crude oil, for instance carcinogenic compounds.

Measures to Prevent oil Pollution

Today a number of methods have been evolved to combat oil spills - with varying degrees of efficacy. Some of them are:

- The first course of action in containing the spill is generally to prevent it from hitting the shoreline, where it threatens the wildlife. Mechanical booms or barriers are generally spread around the oil slick to check its progress. But high waves can always splash the oil over the boom. Or the oil may even pass below the boom, after piling up against the barrier. So once the oil is contained, it is scooped up from the surface by vessels known as skimmers. This is a slow process and useful only in the early stages.
- Dispersants are chemicals that break up oil - are used routinely on small spills. Dispersants are similar to soap in their action on oils, and can disperse oil through large volume of water. Dispersants reduce the surface tension between oil and water and break up the oil in small droplets, which then disperse in the water body. But though highly visible damage is prevented, toxic components like toluene and benzene linger on and enter the food chain with disastrous effects.
- Absorbents, like polystyrene, polypropylene and polyurethane are often used to absorb the oil and prevent it from spreading. But again it has had limited success.
- Burning oil slicks has also been tried. Unfortunately, water removes heat faster than it can be created to support combustion. Also, it creates air pollution.

- Perhaps, the safest method of degrading oil spills is by using microbial surfactants. They mix with the oil, emulsify it and disperse it. This speeds up the process of evaporation and degradation of oil through other natural means.

Remedies: It is essential to have sewage treatment plants for every town and city so that the biodegradable as well as non-biodegradable pollutants can be removed from it and pure water obtained for recirculation.

Currently water hyacinth, an otherwise pernicious weed has come into prominence for purifying domestic and industrial waste waters. The plant regenerates rapidly and has a tremendous capacity to accumulate heavy and even radioactive metals. It is efficient in adsorbing nitrogen, phosphorus and other similar chemical pollutants. The polluted water fed into reservoirs or lagoons with water hyacinth becomes markedly clean and free from 75-90 per cent of its pollutants. Besides, this plant has been used as a new source of food, fertilizer and energy (biogas).

Although the enactment of Water Pollution Control Act has helped to a certain extent to prevent water pollution in the country, adequate legislative measures by every state are a must to ensure:-

(a) Proper disposal of sewage and industrial wastes.

(b) Prevention of abuse of water resources.

(c) Recycling of waste waters through proper methods of purification.

(d) Punishment to erring industries which do not install effluent devices in their factories.

Synthetic herbicides and pesticides pose a challenge to the natural degradation process, therefore judicious, efficient and optimum use of organic manures requires to be encouraged. The use of microbes for the breakdown of these synthetic compounds is another answer to this problem.

As per the Geneva Convention (1958) every state must draw its regulation to prevent pollution of seas through discharge of oil from ships, pipelines, and from exploitation and exploration of the sea-bed and its sub-soil. It must take measures to prevent pollution of seas from the dumping of radioactive waste and other harmful agents. The coastal state is obliged to undertake in the safety zones (around island / installations) all appropriate measures for the protection of living resources of the sea from harmful agents.The oceans are in a certain sense mankind's last frontier. We know so little about them yet we feel that if we could but exploit the various resources of the sea for food, for energy and for raw materials, the development of the world could be accelerated.

d) NOISE POLLUTION

The planet earth is unique because it is perhaps the only known human habitat so far. Man's environment is the basis of human existence and survival. Rapid technological developments no doubt have helped civilization but at the same time have led to environmental degeneration. This in turn has threatened human survival. Noise is one of the constituents of overall environmental pollution. The menacing proportion in which it is growing in our environment these days is becoming a matter of concern for all of us. It has been established that excessive noise is not only adversely affecting the health of human beings but is also a health hazard to all living beings. Even non-living things are not left unaffected by the high intensity of noise. Noise pollution is something which man has added to his miseries himself, by not properly understanding the effects which noise has on public health. The necessity of a healthy environment is well recognized for human health and happiness. Galbraith has rightly said, "In the world into which economics was born the four most urgent requirements were food, clothing, shelter and an orderly environment in which the first three might be provided." It is true it is difficult to have an orderly environment in the technologically advanced modern age.

Noise as pollutant has become a great nuisance these days. It is a shadowed public enemy whose growing menace has increased in the modern age of industrialisation. Noise is unwanted or undesired sound. Pollution is 'any man induced change in the environment as a result of his activities, which has a measurable and generally detrimental effect upon the environment'. Pollution from a legal point of view is the wrongful contamination of the atmosphere. or of water or of soil, to the material injury of the right of an individual. Thus, noise as pollutant

contaminates the environment which affects adversely the health of a person and produces ill effects on living, as well as on non-living things.

Sources of Noise Pollution

The Sources of noise pollution can be divided into two categories:

Industrial Sources

In Industries noise is a by-product of energy conversion. Cotton, mills, foundries and many other industries where big machines are working at a high speed have high noise pollution levels which require our urgent attention in its minimization.

Non-Industrial Sources Non-industrial noise pollution sources can further be divided into the following categories.

(a) Loudspeakers: One of the common factors creating noise pollution is indiscriminate use of loudspeakers. In India no function or ceremony is complete without a loudspeaker which has all the characteristics of creating public nuisance. The recent spate in 'Jagrans' and 'Jagratas' and completion of religious ceremonies in temples or in private, which go on for whole nights, mark the unabated use of loudspeaker without a moment's pause. The situation at the time of Ram Lilas or electioneering is much more shocking. One is forced to hear the discourses whether one likes it or not. Most people bear it and are reluctant to lodge a complaint for fear of unpleasant neighbourhood relations and fears of bringing the wrath of the users on them. Is this competitive religious fervor from every place of worship necessary? Is it not torturous for a person who wants to rest and sleep, for a student who wants to study? The agony of a patient in such a situation is beyond imagination.

(b) Automobiles: Automobiles constitute the largest single group of noise menace. In a city, 60 to 70 per cent of noise may come from road traffic. Slow speed of five to ten kmph during peak hours increase the emission rate of atmospheric and noise pollution. In India in cities road lengths are much less than desired, being 7 per cent of the total area, instead of 20 to 30 per cent. So the vehicle densities become alarmingly high resulting in increased noise level.

(c) Trains: The impact of noise pollution by trains is maximum in those areas where railway tracks are situated in residential areas. With the introduction of fast trains, the noise pollution has been substantially increased.

(d) Aircrafts: Higher the speed of an aircraft, greater is the noise pollution. The supersonic aircrafts have added more noise especially for living beings who live near aerodromes. The noise of these planes can break windowpanes, crack plaster and shake buildings. By evaluating these effects of noise one can easily understand the effects of such noise on the human body. Major cities around the world have banned flights at night to prevent citizens having to put up with the deafening roar of jets. As our geographical position does not permit banning of night international flights, we will have to wait till we can enforce this legislation.

(e) Construction Work: Demolition and construction for urban renewal and expansions always make the urban man a victim of noise pollution. During demolition of old sites and construction of new buildings, huge machines which produce a lot of noise are commissioned and have become a common scene in every big city where construction work is in progress. Construction work may be unavoidable for social needs but the resultant noise produced may be hazardous for the health of persons subjected to the noise.

(f) Projection of Satellites in Space: A new source of noise pollution is Satellites projected into the space with the aid of high explosive rockets. Application and use of these rockets produce deafening noise at the time of 'lift off'. Tons of TNT and other explosives are used in these operations, which create noise pollution as well as air pollution.

(g) Radio, Microphones: Radio and micro-phones can cause noise pollution if they are switched on, on a high volume. Present day interest of yougsters in western music and dance with high volume causes noise pollution.

Effects of Noise Pollution

Noise is one of the main pollutants of the environment causing various hazardous

consequences for human life. Noise not only impairs our sensibility to auditory stimuli by masking effects, but has other consequences too.

Researchers have proved that a loud noise during peak marketing hours creates tiredness, irritation and impairs brain activities so as to reduce thinking and working abilities. Noise pollution was previously confined to a few special areas like factories or mills, but today it engulfs every nook and corner of the Universe, reaching its peak in urban areas. Industries, automobiles, rail engines, airplanes, radios, loudspeakers, tape recorders, lottery ticket sellers, hawkers, etc. are the main ear contaminators of the city area. The regular rattling engines and intermittent blowing of horns emanating from the caravan of automobiles do not allow us to have any respite from irritant noise even in suburban zones. However, the most apparent victims of noise pollution today are the residents of neighbourhoods near larger airports. The introduction of jet planes has considerably increased their misery.

Its general effect on human beings is that it causes disturbances in sleep which lead to other side effects. It also has auditory effects like loss of hearing. Broadly speaking it has:

a) Physiological Effects

This form of environmental degradation has implications on health, as serious as air or water pollution. It can change man's physiological state by speeding up pulse and respiratory rates. It can impair hearing either permanently or temporarily. Millions of industrial workers are threatened with hearing damage. Medical evidence suggests that noises can cause heart attacks in individuals with existing cardiac injury, and that continued exposure to loud noise could cause chronic effects such as hypertension or ulcers, and of course deafness. Audiograms of pop musicians show typical hearing loss in both the ears. For the connoisseur of this music, it takes 20 to 50 hours of silence to make the loss of hearing caused by a four-hour-rock concert.

The adverse effects of noise pollution on the human beings are manifested through physiological indications such as loss of hearing, occupational deafness and noise induced diseases. Empirical research conducted on pregnant female mice revealsed that aircraft take off which records 120 to 160 decibels caused miscarriages in them. If the findings on mice are made applicable to human beings, high noise is equally capable of creating similar disturbances in human beings also.

Several birds have been observed to have stopped laying eggs. Apart from this animals change their places. It has been observed that less and less number of migratory birds move to a particular place if the noise level at that place increases. Prolonged chronic noise can also produce stomach ulcers as it may reduce the flow of gastric juice and change its acidity. It may lead to abortions and other congenital defects in unborn children.

b) Psychological Effects

Many behavioural changes are recorded as a result of exposure to high noise in human beings as well in animals. Certain symptoms can be observed outrightly. The undesired sound may cause annoyance. Intolerable agony may result when the source of the sound is not known. Interruptions in speech communications may impair performance, lead to errors and lower output and efficiency. Noise can cause tension in muscles, nervous irritability and strain. No doubt the noise reaction varies to large extent in different individuals.

Noise Control: Noise exposure reduction may be achieved by the application of engineering control techniques, or by the regulation of exposed personnel. Engineering control methods are usually preferred. This refers to the alteration of design, changes in the mounting or operation of a noise source, or the construction of sound barriers, sound absorbers, etc.

The control of noise is most economically achieved in the planning stage. Avoiding a problem in this manner presupposes a knowledge of the noise characteristic of each machine or process activity while "on the drawing board". When noise potential information is available, or can be obtained with judicious investigation, it may be applied to engineering design, process development or plant layout. At this time, equipment or process noise specifications can be stipulated to suppliers. The design of quieter equipments by means of plant planning can be evaluated.

Equipment is designed primarily for the productive task to be performed. There are no "standard methods" by which a noise-free machine can be fabricated. Building in a quiet

operation requires knowledge of the mechanics of sound generation and the path of sound transmission. Regardless of the equipment involved, the fundamental mechanics of sound wave generation may be classified as either a vibrating surface or as turbulence in a fluid medium. Generated sound may be transmitted by several paths other than direct radiation to the atmosphere. A moving part may set up vibrations in some adjacent solid that could, in turn, become a noise generator. Likewise, air-borne sound waves may induce vibrations in solid surfaces that could, reradiate noise into the air. The control method applied will be dependent upon the paths of "noise flow", and the sound energy being carried by each path. Application of fundamentals regarding sound generation and transmission could prevent a noisy design. A similar application of fundamentals to plant layout could avoid objectionable noise. Even with the most careful design, certain equipment may create an objectionable condition. Isolation of the potential problems during the planning stages could prevent costly renovations.

Noise problems resulting from equipment that has been installed and in operation may be solved by the substitution of quieter equipment, or the substitution of quieter process activities and quieter materials. A few examples of these methods include the use of a centrifugal fan, where it is practical to replace an axial flow fan (such as a propeller fan which produces, more high frequency noise); the use of welding to replace a noisier riveting process; the substitution of rubber tyres to replace steel wheels on vehicles.

Engineering control methods may be imaginatively applied to reduce noise by making some modifications to an existing noise source. The fundamentals of sound generation and transmission are again applied. Control of a vibrating surface can be achieved by damping or isolation of the forces responsible for the vibration. A common example is the isolation of vibrating parts by the use of resilient materials. Using springs or rubber cushions to isolate vibrating equipment from their mounting surfaces will reduce the noise that result from the continuous impact of vibration.

Relatively large vibrating surfaces, such as sheet metal sections, are frequent noise sources. Control may be achieved by reducing the vibrational response by such means as damping the material, improving its support or increasing its mass. This type of material may be subject to resonance (vibration at its natural frequency). In this condition the driving forces are "in phase" with the member's vibration and large surface displacements are common. Damping of surface vibrations is achieved by dissipating vibratory energy, thereby reducing the amplitude of motion. This may be achieved by covering the area from the surface to the member with felt, mineral wool, etc.

Prevention and Control of Pollution

There are about 30 major enactments related to protection of environment, now being administered by the central and state governments. Prominent among these are: The Water (Prevention and Control of Pollution) Act, 1974, The Air (Prevention and Control of Pollution) Act, 1981, the Factories Act and the Insecticides Act. Taking into account, the widespread concern regarding danger to environment from hazardous substances, the Government has enacted The Environment (Protection) Act, 1986, to provide a single focus for environmental issues in the country.

Its salient features are-

(a) Conferring powers on Central Government to:
- **(i)** Take all necessary measures for protecting quality of environment.
- **(ii)** Coordinate actions of states, officers and other authorities under this Act or under any actions of states, officers and other authorities under this Act.
- **(iii)** Plan and execute a nationwide programme for prevention, control and abatement of environmental pollution.
- **(iv)** Lay down standards for discharge of environmental pollutants.
- **(v)** Establish or recognize environmental laboratories.
- **(vi)** Lay down standards for quality of environment.
- **(vii)** Restrict areas in which any industry, operations or processes may not be carried out or shall be carried out subject to certain safeguards.

(b) It confers powers on persons to complain to courts regarding any violation of the provisions of the Act, after a notice of 60 days to prescribed authorities.

(c) The Act makes it obligatory for the person in charge of a place to inform the prescribed

authorities regarding any accidental discharge or apprehended discharge of any pollutant in excess of prescribed standards. Authorities, on receipt of such information or otherwise, shall take remedial measures to prevent or mitigate pollution caused by such accidents and expenses incurred by the authorities in respect of remedial measures are recoverable with interest from the polluter.

(d) It prescribes stringent penalties for violation of the provisions of the Act.

(e) Jurisdiction of civil courts is barred under the Act.

The Policy Statements on Abatement of Pollution, adopted in 1992, provides instruments in the form of legislation and regulation, fiscal incentives, voluntary agreements, educational programmes and information campaigns to prevent and control pollution of water, air and land. Since the adoption of the policy statement, the focus of activities has been on issues such as promotion of clean and low waste technologies, waste water minimization, reuse/recycling, improvement of water quality, environment audit, natural resource accounting, development of mass-based standards, institutional and human resource development, etc. The whole issue is dealt with by a combination of command and control methods as well as voluntary regulations, fiscal measures, promotion of awareness and involvement of public.

Eco-Mark Scheme

The adoption of eco-mark scheme marks the beginning of a new phase in environmental legislation in India. So far, environmental measures have been mostly confined to saving our flora and fauna and checking pollution. This has at best limited or delayed the catastrophe, for "legal loopholes and conniving officials saw to it that the exploitation of natural resources "continues unabated. The prospects of quick profit conveniently suppressed nagging "ethical and rational consideration for a better ecology".

Eco-Mark is an eco-labelling scheme which was constituted by the Government of India in 1991 for easy identification of environment-friendly products. An "Eco-mark" label has been introduced to label consumer products that are environment friendly. So far, the Government has issued 18 notifications on different products criteria. To facilitate industries in preparing environmental statements, sector-specific environmental audit manuals have been prepared. Waste Minimization Circles (WMCs) are being established to promote group efforts in increasing productivity and improving the environmental conditions in small and medium scale industries through adoption of waste minimization techniques.

Objectives of the Scheme:

The specific objectives of the scheme are as follow:

- To provide an incentive for manufacturers and importers to reduce adverse environmental impact of products.
- To reward genuine initiatives by companies to reduce adverse environmental impact of their products.
- To assist consumers to become environmentally responsible in their daily lives by providing information to take account of environmental factors in their purchase decisions.
- To encourage citizens to purchase products which have less harmful environmental impacts.
- Ultimately to improve the quality of the environment and to encourage the sustainable management of resources.

Central Pollution Control Board

The Central Pollution Control Board (CPCB), statutory organisation, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981. The CPCB is the national apex body for assessment, monitoring and control of water and air pollution. The executive responsibilities for enforcement of the Acts for Prevention and Control of Pollution of Water (1974) and Air (1981) and also of the Water (Cess) Act, 1977 are carried out through the Board. The CPCB advises the Central Government on all matters concerning the prevention and control of air, water and noise pollution and provide technical services for implementing the provisions of the Environment

(Protection) Act, 1986. Under this Act, effluent and emission standards in respect of various categories of industries have been notified.

Air Quality Monitoring

Air Quality Monitoring is an important part of the air quality management. The National Air Monitoring Programme (NAMP) has been established with objectives to determine the present air quality status and trends and to control and regulate pollution from industries and other sources to meet the air quality standards. It also provides background air quality data needed for industrial setting and town planning.

Besides this, CPCB has an automatic monitoring station in New Delhi. At this station Respirable Suspended Particulate Matter (RSPM), Carbon Monoxide (CO), Ozone (O_3), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Suspended Particulate Matter (SPM) are being monitored regularly.

Water Quality Monitoring

Fresh water is a finite resource essential for use in agriculture, industry, propagation of wildlife & fisheries and for human existence. India is a riverine country. It has 14 major rivers, 44 medium rivers and 55 minor rivers besides numerous lakes, ponds and wells which are used as primary source of drinking water even without treatment. Most of the rivers being fed by monsoon rains, which are limited to only three months of the year, run dry throughout the rest of the year often carrying wastewater discharges from industries or cities/towns endangering the quality of our scarce water resources. The Parliament of India in its wisdom enacted the Water (Prevention and Control of Pollution) Act, 1974 with a view to maintaining and restoring wholesomeness of our water bodies. One of the mandates of CPCB is to collect, collate and disseminate technical and statistical data relating to water pollution. Hence, Water Quality Monitoring (WQM) and Surveillance are of utmost importance.

Heavily polluting industries

Seventeen categories of heavily polluting industries have been identified. They are: cement, thermal power plant, distilleries, sugar, fertilizer, integrated iron and steel, oil refineries, pulp and paper, petrochemicals, pesticides, tanneries, basic drugs and pharmaceuticals, dye and dye intermediates, caustic soda, zinc smelter, copper smelter and aluminium smelter.

Laws enforced by of Pollution Control Boards

The Central and State Pollution Control Boards were set up for enforcement of the Water (Prevention & Control of Pollution) Act, 1974. Over the years, the Boards have been assigned additional responsibilities which include the following:

- Water (Prevention & Control of Pollution) Cess Act, 1977.
- Air (Prevention & Control of Pollution) Act, 1981.
- Environment (Protection) Act, 1986 and Rules made thereunder.
- Hazardous Waste (Management & Handling) Rules1989.
- Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989.
- Bio-medical Waste (Management & Handling) Rules, 1998.
- Municipal Solid Waste (Management & Handling) Rules, 2000.
- Plastics wastes Rules, 1999 and Coastal Regulation Zone Rules, 1991.
- Public Liability Insurance Act, 1991.

LAND DEGRADATION

Land is the most important basic natural resource. It is a dynamic and complex combination of geology, topography, hydrology, soil and influences every sphere of human activity. Land degradation is the decrement in the fertility of soil which leads to poor productivity.

Soils have been degraded by human activities like intensive irrigated agriculture, overgrazing, deforestation, industrial growth and contamination which has lead to soil compaction, salinisation, loss of nutrients and toxicity problems.

Some factors for land degradation are explained below.

a) Salinisation of Soil:

Salinisation refers to a buildup of salts in soil, eventually to toxic levels for plants. Salt level of

3000-6000 ppm results in trouble for most cultivated plants. Salt in soils decreases the osmotic potential of the soil so that plants can't take up water from it. When soils are salty, the soil has greater concentration of solute than does the root, so plants can't get water from soil.

As we know that the water contains some salts, in dry areas evaporation of water leaves the salt behind. These salts start accumulating and lead to salinisation. Salinisation is likely to become a problem on poorly drained soils when the groundwater is within 3 m or less of the surface (depending on the soil type). In such cases, water rises to the surface by capillary action, rather than percolating down through the entire soil profile, and then evaporates from the soil surface.

Salinisation decreases the crop yield and converts fertile land to barren with passage of time.

Over irrigation is also the cause of salinisation as found in Punjab and Haryana. Over irrigation leading to water logging and by capillary action salts start moving towards the top and after evaporation salts are left behind ultimately leads to salinisation of soil which decreases soil fertility.

The "treatment" for salinisation is to flush the soil with lots of water. However, this results in salinization of the river and groundwater where the flush water goes.

b) Acidification of Soil:

Soil acidification is a process by which soil pH decreases. Acidification can occur under natural conditions over thousands of years, with high rainfall areas the most affected. However, rapid acidification can occur over a few years under intensive agricultural practices.

Acidification can affect either the surface soil only or the subsoil as well. Surface acidity can be relatively simple to treat, and brings considerable benefits in plant growth and yield. Sub-surface acidity is difficult and costly to correct.

Factors that accelerate acidification include:

- Applying ammonium-based nitrogen fertilizers to naturally acid soils at rates in excess of plant requirements.
- Leaching of nitrate nitrogen, originally applied as ammonium-based fertilizers, out of the root zone.
- Continual removal of plant and animal produce and waste products from the paddock.
- Growing plants remove alkalinity from the soil. When harvested products are removed, the soil becomes more acidic.

Acidification of soils causes following problems:

- Reduction in the amount of nutrients being recycled by soil micro-organisms (e.g. nitrogen supply may be reduced);
- Phosphorus in the soil may become less available to plants ;
- Induced deficiencies of calcium, magnesium and molybdenum;
- The ability of plants to use subsoil moisture may be limited;
- Aluminum, which is toxic to plants and micro organisms, may be released from the soil;
- Manganese may reach toxic levels;
- Uptake of cadmium (a heavy metal contaminant) by crops and pastures may increase.

c) Overgrazing:

Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. Overgrazing reduces the usefulness, productivity and biodiversity of the land and is one of the causes of desertification and erosion.

Overgrazing typically increases soil erosion. Reduction in soil depth, soil organic matter and soil fertility impairs the land's future natural and agricultural productivity. Soil fertility can sometimes be mitigated by applying the appropriate lime and organic fertilizers. However, the loss of soil depth and organic matter takes centuries to correct. Their loss is critical in determining the soil's water-holding capacity.

It is the main cause of land degradation in Rajasthan, Madhya Pradesh, etc.

Types of Land Degradation:

1. Desertification:

These are the manifestations of the environmental deterioration in semi-arid and

arid regions. The causes include the loss of regenerative capacity of the soil resulting from (i) extreme depletion or absence of moisture or water, (ii) alkalinisation-salinisation, (iii) water logging and deep erosion that divests the soil of their nutrients. Although climate is one of the most important factors, the abuse of land and over exploitation of its vegetation and water resources are primarily responsible for the expansion of deserts.

In Asia, more than 16,500 sq km area is affected with arid to semi-arid conditions. 5.7 percent of the landmass of India is desert. More than one fifth of the population living in 63 countries of Asia and Africa are threatened with the consequences of the march of the desert at a rate of 600 million hectares per year. The land lost annually due to desertification is about equal to the land brought under irrigation each year. In Sudan, the Sahara desert has expanded by 100 km in the last 20 years. New areas in countries like Senegal, Ethiopia and Tunisia have been threatened with desertification. In all about 20 million sq. km area (equal to the combined area of USA and Australia) is now on the brink of severe desertification. If this rate of desertification continues, one-third of the world's cropland would disappear in the near future.

In India the drylands, comprising the hot arid, semi-arid and the dry sub-humid climate zones, account for 203 million hectares or 61.9 per cent of the total geographical area. Ironically these regions are undergoing a steep rise in population, with attendant demands from the limited land and water resources, and attracting many new industries, which release toxic elements into its atmosphere, soil and water. The net result is degradation of more land, as well as a gradual deterioration of the production potentials of these climatically handicapped fragile regions.

Causes

Some studies have been carried out at the Central Arid Zone Research Institute (CAZRI), Jodhpur to understand the processes and their manifestations in the arid western part of India, using remote sensing and field information.

a. **Water Erosion:** Soil erosion through fluvial processes affects large areas in the Saurashtra and Kuchchh uplands, and along the eastern margin of the Thar desert where the average annual rainfall varies from 350 to 500 mm.

The manifestations can be deciphered from the pattern of sheet, rill and gully erosional features. Increased ploughing and destruction of vegetation cover for fuelwood, overgrazing and other destructive uses, have accelerated the erosion in recent decades.

b. **Wind Erosion/Deposition:** The most vulnerable landforms to wind erosion/ deposition are the sand dunes and other sandy landforms in the Thar. A closer look, however, indicates that the sandy landforms in the east are more stable than the similar landforms in the west.

The introduction of tractors for deep ploughing, instead of the traditional animal-driven wooden plough, has increased the sand load manifold for the aeolian processes in large parts of the desert and has accelerated the mobility of sand.

Increased destruction of the natural plant cover in grazing lands for fuel and fodder and enlarging the frontiers of cultivation to less suitable sandy areas are also the responsible factors.

c. **Industrial Effluents:** In recent years industrial effluents have become a major source of land and water pollution in the arid western India. Use of toxic water for irrigation has also degraded the land.

STATE WISE AREA IN GULLY EROSION

State	Area (Lakh Hect.)
Uttar Pradesh	12.30
Madhya Pradesh	6.63
Bihar	6.00
Rajasthan	4.52
Gujarat	4.00
Himalaya foot hills regions	1.93
Punjab	1.20
Orissa	1.13
W. Bengal	1.04
Tamil Nadu	0.60
Maharashtra	0.20
TOTAL	**39.55**

d. **Mining:** In western Rajasthan about twenty major minerals and nine minor minerals are being mined. More than 90 per cent of the

mine owners have open cast mining. The rest are underground mines. The area occupied by the mines is increasing constantly.

The surface mining activity causes immediate degradation of land. The mining sites are abandoned after the excavation work is over, without adopting any reclamation measure.

Mining activity restricts the subsurface movement of water. With the removal of vegetation, the rate of evapotranspiration is reduced. As a result, there is a change in the hydrological balance in the area. Due to this change, the water table rises and causes salinity.

e. **Vegetation Degradation:** One of the first reasons of desertification is destruction of natural vegetation. With increasing pressure on land vegetation degradation is increasing at an alarming rate. The common grazing lands around the villages are now some of the most severely degraded sites, as these have been highly exploited and neglected. Many good grazing lands have also been encroached upon for agriculture. Some studies in the Rajasthan part of the desert suggests that vegetation cover in areas with good grass species in the less than 300 mm average annual rainfall zone has declined from about 7 per cent to 1 per cent. Based on these studies, and using large-scale satellite imagery and ground-based information, it has been found that 32 per cent area in western Rajasthan is slightly affected by desertification, while 40 per cent is severely affected.

f. **Climatic Changes:** A belt of high atmospheric pressure, which prevails between 15° and 30° North and South latitudes, prevents the entry of moisture bearing winds into this region. Since the sky over the dryland remains clear of clouds, solar radiation heats the ground surface excessively and causes very high potential evaporation at a rate of 6 mm per day. This inhibits the formation of rains. It also explains the deficiency or absence of rains in the low latitude subtropical belts. The drought in many parts of the world is concerned in some ways with the anomalies of surface water temperature. The very small amount of rainfall over the Thar is also connected with the surface temperature anomalies over the Arabian Sea. Mountain barriers, such as the Himalayas and the Andes induce localized subsidence of most air across the barriers and inhibit condensation of moisture. This is the cause behind the desertification in Central Asia, Chile, Peru and Atacama. The Himalayas prevent the moist humid air streams from reaching the Tibetan plateau. As a consequence, "the roof of the world" has become a cold desert.

The present climate of the world is the result of the rapid warming up of the earth about 11,000 years back. At that time the Sahara and Thar deserts probably had moist climate. Subsequently, the land was overwhelmed by the process of desertification which began around 3500-1500 year's back. Even at present the aridity is increasing and the atmospheric temperature is rising as a result of increase in dust, aerosols, hydrocarbons and carbon dioxide in the lower atmosphere and the reflection of heat from deforested land. This makes the threat of desertification very real in the dry arid and semi-arid tracts.

Measures to Control Desertification

a. **Preparation of a Desertification Hazard Map:** The first step towards controlling desertification is the preparation of desertification hazard map. This includes the identification of areas vulnerable to desertification on the basis of prevalent environmental stress and regular monitoring of changes occurring in the desert-prone eco-system. The map depicts degree of vulnerability and the extent of desertification in terms of injury or destruction of vegetal cover, erosion of land, decrease in surface flow or discharge of sub-surface water, decline or loss of productivity of soils, etc. The monitoring of eco-system provides early warning of the trend of changes taking place and helps in identifying areas of maximum distress. The most suitable way for monitoring is the remote sensing technique. The map should be supplemented by surveys related to socio-economic condition of the people.

b. **Changes in Grazing Practices:** Livestock should be prevented from grazing freely in

order to allow the soil to regenerate and nurture vegetation. The cattle should be permitted to graze only in the specially fenced reserves. Planting of fodder trees inside and around the fencing of the grazing land would save the pastures and would lead to growth of protective and beneficial vegetal cover on the loose soil.

c. **Water Harvesting:** In this, the rainwater is gathered by converging channels on the hill slopes and diverted to settlement areas. Flood waters are also diverted. The stored water is covered with a film to prevent evaporation. This technique has been used in various rainfed areas especially in Rajasthan and Gujarat.

d. **Sand Dune Stabilization:** About 58 per cent of arid Rajasthan is under different types of sand dunes. CAZRI has now developed appropriate technology for sand dune stabilisation. These include:

(i) Protection of dunes from biotic interference,

(ii) Development of micro windbreaks from the crest to the base of the dunes in the form of parallel or chessboard pattern and

(iii) Reseeding of grass and creeper seed in between the micro windbreaks and transplanting of nursery-raised trees.

e. **Shelterbelt Plantation:** Considerable soil erosion takes place from the flat cultivated areas due to sandy nature of the soil and high wind velocity which during summer months is sometimes as high as 70-80 km/hr. The soil loss is sometimes as much as 5 tonnes per hectare. If shelterbelts with 3-5 rows of trees are planted across the land in the wind direction, soil erosion can be minimized.

f. **Aerial Seeding:** Due to sandy nature of the soil, the water holding capacity is very low, with the result that sowing of seeds needs to be completed within 2-3 days to favour germination. Conventional methods of afforestation are inadequate for revegetation of such a large and inaccessible tract having low moisture, erratic rainfall and lose sandy soil. Therefore, aerial seeding could be practised.

g. **Silvipasture Systems:** Indiscriminate cutting of vegetation for meeting fuel and fodder requirements is accentuating desertification. In order to control it, there is a need to follow a systematic approach. This helps in reducing salinisation and wind erosion and thus increases productivity on long term basis, besides conserving resources and providing economic stability.

h. **Minimum Tillage:** Tillage of agricultural land is necessary, particularly from the point of view of seed bed preparation, moisture conservation and weed control. Excessive tillage under dry conditions, however, breaks unstable clouds and exposes the soil to wind action.

i. **Strip Cropping:** Strip cropping for wind erosion control is alternate plantation of erosion-susceptible and erosion tolerant crops, perpendicular to the prevailing wind direction. The main advantage of the system is that erosion tolerant strips reduce the velocity of the prevailing wind, trap sand particles and thereby control soil avalanching. Therefore, narrow strips are more effective in reducing wind erosion in lighter soils.

j. **Judicious use of Irrigation Water:** Irrigation plays a significant role in arresting desertification through its effects in promoting the establishment and growth of vegetation. In highly sandy and dune covered areas, sprinkler system of irrigation could be effectively used for raising crops and other vegetation. This has been found to economize water and increase the production.

Global Environmental Facility: Combating Deser tification

The GEF unites 183 countries in partnership with international institutions, civil society organizations (CSOs), and the private sector to address global environmental issues while supporting national sustainable development initiatives. Today the GEF is the largest public funder of projects to improve the global environment. An independently operating financial organization, the GEF provides grants for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants.

Since 1991, the GEF has achieved a strong track record with developing countries and countries with economies in transition, providing $11.5 billion in grants and leveraging $57 billion in co-financing for over 3,215 projects in over 165

countries. Through its Small Grants Programme (SGP), the GEF has also made more than 16,030 small grants directly to civil society and community based organizations, totaling $653.2 million.

The GEF also serves as financial mechanism for the following conventions:

- Convention on Biological Diversity (CBD)
- United Nations Framework Convention on Climate Change (UNFCCC)
- Stockholm Convention on Persistent Organic Pollutants (POPs)
- UN Convention to Combat Desertification (UNCCD)

The GEF, although not linked formally to the Montreal Protocol on Substances that Deplete the Ozone Layer (MP), supports implementation of the Protocol in countries with economies in transition.

UN Convention to Combat Desertification (UNCCD)

Desertification, along with climate change and the loss of biodiversity, were identified as the greatest challenges to sustainable development during the 1992 Rio Earth Summit. The United Nations Convention to Combat Desertification (UNCCD) in those countries experiencing serious drought and/or desertification, particularly in Africa is an agreement to combat desertification and mitigate the effects of drought through national action programmes that incorporate long-term strategies supported by international cooperation and partnership arrangements. To help publicize the Convention, 2006 was declared as "International Year of Deserts and Desertification".

The Convention addresses specifically the arid, semi-arid and dry sub-humid areas, known as the drylands, where some of the most vulnerable ecosystems and peoples can be found. In the 10-Year Strategy of the UNCCD (2008-2018) that was adopted in 2007, Parties to the Convention further specified their goals: "to forge a global partnership to reverse and prevent desertification/land degradation and to mitigate the effects of drought in affected areas in order to support poverty reduction and environmental sustainability".

In a concerted effort to help over 900 million people around the world fight the life and death battle against the degradation of their fragile drylands, the process known as desertification, more than 100 Governments concluded negotiations on 18 June 1994 in Paris on a global legal agreement to address the situation. The Convention is an important step forward towards improving life in the drylands, in that it establishes a framework for national, sub-regional and regional programmes to counter desertification, which is occurring worldwide at an accelerated rate, affecting some 2 5 per cent of the Earth's land area. Caused by overgrazing, over-cropping, poor irrigation practices, deforestation and other unsustainable socio-economic practices, as well as by climate variations, this is especially serious in Africa, where 66 per cent of the continent is desert or dry land. The treaty was opened for signature on October 14, 1994 and entered into force on December 26, 1996. At present there are 195 parties (194 states + EU) of the convention, including India.

As the dynamics of land, climate and biodiversity are intimately connected, the UNCCD collaborates closely with the other two Rio Conventions; the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC), to meet these complex challenges with an integrated approach and the best possible use of natural resources.

Indian Scenario

Serious research and development work to combat desertification of the Thar Desert has been going on for several decades. Remote sensing techniques have been utilized for delineating vulnerable areas, sand-piling and salinity encroachments and to monitor biotic disturbances. The Central Arid Zone Research Institute (CAZRI), Jodhpur, has prepared maps of Rajasthan desert indicating the pattern of soil, sand form, vegetation, pattern of human activities and the resources potential of an area for development planning.

Natural resource survey in Rajasthan desert, part of Haryana, Gujarat and Andhra Pradesh are being extensively used by various development agencies for natural resources and land use management. In NW India, serious efforts have been made to generate technologies for revegetating the desert. CAZRI has developed

viable and feasible strategies for sand dune fixation, soil-conservation & pasture management, large areas are being covered by farm forestry, silvipastoral plantation, village fuel wood plantation and shelter-belt cum road-side & canal bank plantation.

These massive programmes are being implemented through the Drought Prone Area Programme (DPAP), the Desert Development Programme (DDP) and the Rural Development Programme (RDP), co-ordinated by the Desert Development Commissioner.

Agricultural practices adopted in low rainfall arid areas are injurious to land and aggravates sand movement. As a consequence emphasis has been laid on high yielding forage grass and legumes, improved grassland and livestock production.

Over exploitation of ground water in the dry zone as well as unplanned use of the surface water pose serious problems. The Thar desert case study in the Luni-Development block revealed that the discharge potential of over 83 per cent of the wells had greatly dropped over a decade. Most of the wells, moreover, had been highly saline and irrigation with such water had wasted large tracts of land. Likewise excessive irrigation along Rajasthan Canal has caused water logging. The number of technologies have been developed by CAZRI to improve the irrigation system.

Early maturing high yielding seeds with low water requirements have been released by CAZRI for cultivation in North-West desert of India. These includes millet, minor millet, sorghum, moong, sesame (oil seed), etc. A number of techniques for harvesting and conserving rain water are being used very successfully for raising orchards which have been developed by CAZRI to provide the farmers an assured income even in years of drought.

The drip irrigation system standardized at CAZRI for vegetable crops and orchards has not only increased production but it also made it possible to use saline water without serious hazards.

Better grazing practices have been introduced through DDAP and DDP and in the Rajasthan Canal Command Areas which have helped in the increase of livestocks. Now it is the main stay of the desert people, provides employment to about 2/3 rd of Rajasthan's population. Yet it produces only 12 per cent of the State's income. CAZRI and its sister institutions, the Central Seed Research Institute of Avikanagar near Jaipur have taken up extensive cross breeding of sheep for production of better carpet and apparel wool.

In order to combat desertification, it is essential to have comprehensive, phased action plan of development with clear priorities backed by people's participation and political and administrative will.

Desert Development Programme

The Desert Development Programme was started in 1977-78 in hot desert areas as well as in cold desert areas like those of Jammu & Kashmir and Himachal Pradesh. From 1995-96, the coverage has been extended to a few more districts in Andhra Pradesh and Karnataka. At present 232 blocks in 40 districts in seven states are covered under the said programme. This programme aims at mitigating the adverse effects of desertification and adverse climatic conditions on crops, human and livestock population, and combat desertification and restore ecological balance in the area.

2. Soil Erosion

The term erosion simply means the loosening and removal of soil from its previous resting-place by the action of water and wind. The rapidity with which modern developments have taken place, often led to the employment of agricultural methods conducive to erosion and, in consequence, large tracts of land have already been rendered unproductive, while much larger tracts are threatened.

Soil erosion is almost universally reorganised as a serious threat to man's well-being. The two main agents of erosion are wind and water. In the case of erosion by water, the major erosive agents are impacting raindrops and run-off water flowing over the soil surface. Erosion and sedimentation embody the processes of detachment, transportation and deposition of soil particles. Detachments are the dislodging of soil particles from the soil mass by erosive agents.

Erosion occurs in agricultural lands, construction sites, road-ways, disturbed lands, surface mines and in areas where natural or geological disturbances take place. Erosion may be classified as:

(i) Sheet erosion- the removal of a thin, uniform layer of particles.

(ii) Rill erosion- erosion in numerous small channels that is small enough to be altered by normal tillage.

(iii) Gully erosion- larger upland channels.

(iv) Stream channel erosion- erosion caused by stream flow.

(v) Mass erosion- mass movement takes place at the base of concave slopes.

Extent of Soil Erosion

Most of the land area in the country shows evidence of degradation thus affecting the productive base of economy. Out of the total geographical area of 329 million hectares, 175 million hectares are considered degraded.

Although soil-erosion is frequent throughout the country, it occurs most intensely in the hilly regions. The precipitation often occurs in torrents which instead of sinking into the ground as the light drizzles, wash away the top layers of the soil. The steep slopes of the hills further stimulate the eroding power of the rain water. The soils are very thin and all exposed slopes are susceptible to serious sheet erosion or gullying.

Erosion may be of little consequence for hilly tracts, but is of great significance to the plains. The whole basin of Kosi river is threatened by this erosion, as a result of which the rivers bring with them millions of tonnes of sand and debris annually. When the rivers reach the plains and below and the stream flow slackens the load is dropped and gets deposited in their beds. This leads to choking of river channels, which in turn increase the flood danger and induces shifting of the course which brings disaster in train to the whole countryside.

Both surface erosion and deep gullying are considerably influenced by the type of soil in India, although a given soil type may not behave consistently under all conditions and no type of soil is entirely safe from erosion. Thus, sandy porous soil in the country are in general least subject to gradual weathering down by water action, since they are capable of absorbing a great amount of water in ordinary rains. On the other hand, if the rate of percolation is prevented by frost or by even thin strata of clay, the very lack of "binding" qualities in the sandy soils permit them to be moved at a very rapid pace. Again, however, the coarseness of the material may cause it to be deposited before it has been carried to any great distance.

The most potent and common causes of erosion in India are deforestation and overgrazing. Throughout the country, as population has increased, more and more forests have been destroyed, mainly by grazing cattle feeding on grass, herbs and green bushes.

Under a natural vegetative cover, a certain amount of erosion takes place; but the rate of soil formation largely balances the loss. "Under a cover natural vegetation erosion is restricted to the geologic norm," that is, the rate of soil formation is generally at least as great as that at which it is washed away.

Conservation Methods

Control runoff: One of the most common methods of reducing runoff velocity is to break a slope by terracing.

Contour cultivation: Ploughing along the contours on the sloping lands reduces the soil loss.

Crop-rotation: The aim of the farmers in crop rotation should be to keep the land under protection cover for as great a proportion of the total time as possible, lessening thereby the soil loss by erosion.

Increased use of manure: Through manuring, the Indian farmers can check the deflection of soil nutrients, which takes place with continous cropping. Manures can be animal and plant residues. They ensure yet another aspect of soil conservation viz, the building up of soil productivity.

Keeping the soil covered: Grasses are even more firm protectors of soil than the trees.

River embankments: By making river embankments, soil erosion can be reduced along the bank of the rivers.

3. Deforestation:

It is a matter of serious concern that the present economic man has forgotten the environmental and ecological significance of natural vegetations mainly forests and grasslands and has destroyed the forests so rapidly and alarmingly that the forest areas at global, regional and local levels have so markedly decreased that

several serious environmental problems such as accelerated rate of soil loss through rain splash, sheet wash, rill and gully erosion; increase in the frequency and dimension of floods; greater incidence of drought due to decrease in precipitation, etc. have plagued the modern human society. From ecological point of view, at least one third of the total geographical area of a country should be under rich forest cover but this general rule of environmental significance has been flouted in many of the countries. Deforestation has immediate adverse effects on soils and land because of exposure of ground surface to high intensity-rainfall.

Many of the developing countries of the tropical and subtropical regions have lost substantial portions of their forest covers due to conversion of forested land into agricultural land in order to feed the teeming millions. According to the Report of the Forest Survey of India, the following is the present status of different land used under forest covers in India.

Number of tree species in IUCN red list

- Critically endangered: 50
- Endangered: 98
- Vulnerable: 98

Causes of Deforestation

The major causes of deforestation at global and regional levels are -

a) **CONVERSION OF FOREST LAND INTOAGRICULTURAL LAND**:population growth increment at fast rate mainly in the developing countries have put enormous pressure on forested land because it became necessary to clear the virgin forest covers and convert them into agricultural land so that agricultural production can be substantially increased and food security may be provided to hungry human population.

b) SHIFTING OR JHUMING CULTIVATION is a major cause of forest loss in the hilly and mountainous areas of north-eastern states. The loss of virgin forest cover due to shifting cultivation is increasing every year. In shifting cultivation forest dwellers clears a patch of land and start cultivation. Once the productivity of land decreases they shift to new place. The land left behind becomes a patch which cannot support any vegetation.

c) TRANSFORMATION OF FORESTS INTO PASTURES has been responsible for rapid rate of loss of virgin forests. The main factor behind large-scale conversion of woodland into pasture land is expanding dairy farming and cattle ranching for meat.

d) OVERGRAZING of forests of moderate cover by animals mainly in the tropical and subtropical and arid and semi-arid areas has resulted into large-scale degradation of natural vegetation of not the complete destruction of forests. Very low yielding (low per capital yield of both meat and milk) but large numbers of cattle in the country have consumed most part of the ground cover and bushes and herbaceous plants. The deforested areas have been worst affected by grazing animals because no fresh regeneration of plant has been allowed by large herds of grazing animals.

e) FOREST FIRES whether natural or manmade, are effective destroyers of forest covers. Atmospheric lightning is the major source of natural forest fires. Besides, man causes forest fires through his intentional/advertent and unintentional actions. He burns forests and grasses in the next season. Deliberate burning of vegetation to get rich and fresh grasses in the next season leads to several types of changes in the surface materials. The herdsmen also throw burning 'bidies' inadvertently which causes forest fires. Besides destroying vegetations, forest fires harden the ground surface which decreases the porosity of the soils and consequently there is little infiltration of rainwater. Thus most of the rainwater becomes effective surface runoff which accelerates the rate of soil erosion. Secondly, the frequent forest fires destroy the leaf litters on the ground and thus the soil nutrients and humus contents are markedly reduced and sometimes are completely destroyed. Besides, forest fires kill all of the micro-organisms living in the leaf litters mainly decomposers and in the soils and plant roots. Thus forest fires not only destroy natural vegetation and retard and taboo regeneration of trees but also cause tremendous damage of the biological communities and thus cause ecological imbalance.

f) LUMBERING for domestic and commercial purposes is the real cause of large-scale destruction of forest covers. Ever increasing demand of timber for various purposes due to industrial expansion, urban growth and rapidly

increasing human population has done great damage to natural forest covers all over the world. The reckless felling of trees from the very beginning of the present century without caring for environmental and ecological consequences to assure regeneration of forests has depleted the forest resources to such an extent that the possible gruesome consequences of deforestation are looming large over the human society all over the globe and even the existence of human beings stands threatened. Collection of fodder and firewood by rural populations from the depleted and poor forest covers mostly in the developing countries has further degenerated already impoverished forest covers.

In spite of the provision of Forest Policy in force since 1894 and implementation of National Forest Policy since 1952 and despite the guidelines issued by the Union Government of India for not diverting the forest area to non-forestry uses there has been remarkable loss of 91,70,000 hectares of good forest area in India between 1972 and 1980. This colossal loss of precious ecological resource despite the guidelines issued by the Government of India that forest area should not be converted into other forms of land uses and in case of any inescapable diversion (of forest land to non-forestry uses) it should be done with the concurrence of the states and the loss of forests be adequately compensated by providing, as far as possible, equivalent alternative land for afforestation and reforestation, clearly indicates the noncompliance of the government directives by the government officials and greedy and selfish contractors. Developmental projects such as construction of dams, reservoirs and canals and mining operations are damaging even the dense forests.

g) MULTI-PURPOSE RIVER PROJECTS require larger areas to be submerged for the reservoirs constructed behind the dams. Thus submergence of forested riverine areas completely destroys the natural forests. Tehri Dam Project on the headwaters of the Ganga and Narmada River Project in Madhya Pradesh and Gujarat, are under serious public protests. Tehri Dam on the headwaters of the sacred Ganga River, in Garhwal Himalaya, Uttar Pradesh, India, is meant to generate hydroelectricity to meet out the growing demand of power in Uttar Pradesh the adjoining states and Union Territory of Delhi but its construction is frequently stopped because of protest by noted environmentalist and CHIPKO MOVEMENT leader, Sunder Lal Bahuguna. It is feared that storage of millions of acre feet of water in the reservoirs behind the Tehri Dam will submerge hundreds of square kilometres of forested land which will destroy rich forest cover and displace local inhabitants. It is also feared that if the dam breaks in, for which there is every likelihood because the Tehri Dam is being constructed in the lower Himalayas which come under maximum seismic intensity zone, Rishikesh (an important holy pilgrim centre on the bank of the Ganga) will be flooded in 57 minutes and Hardwar (another important holy pilgrim center) in just 63 minutes. It is believed that is case of sudden breach in Tehri Dam major cities on either side of the Ganga in its downstream section in the alluvial plants of Uttar Pradesh will be submerged within 72 hours. Similarly, there is strong protest from general public to abandon the proposed projects of Sardar Sarovar and Indira Sagar on Narmada River is the states of Madhya Pradesh and Gujarat. The ecologists believe that the submergence of thousands of square kilometres of areas will destroy regional forest covers and animal community and thus will cause serious environmental and ecological problems.

Adverse Effects of Deforestation on Environment

Deforestation gives birth to several problems encompassing environmental degradation through accelerated rate of soil erosion, increase in the sediment load of the rivers, siltation of reservoirs and river beds, increase in the frequency and dimension of floods and droughts, changes in the pattern of distribution of precipitation, intensification of greenhouse effects, increase in the destructive force of the atmospheric storms etc; economic loss through damages of agricultural crops due to increased incidence of floods and drought, decrease in agricultural production because of loss of fertile top soils, decrease in the supply of raw materials to the industries are building materials (timber) to the urban and rural areas, marked decrease in fodder to animals, etc. and social problems in the form of economic poverty, crimes and increased legal litigation.

As already stated forests are natural umbrella for ground surface because these protect the ground surface from erosion caused by falling raindrops and control radiation balance of the earth and the atmosphere by consuming increased amount of carbon dioxide released from ever-increasing 'human volcanoes' (chimneys of the factories) and thus prevent the earth from becoming too hot. Removal of forest cover exposes the ground surface to the atmospheric processes. It may be pointed out that forests intercept falling raindrops and thus split them and reduce their (of raindrops) kinetic energy. Intercepted rainfall reaches the ground surface slowly in the form of 'AERIAL STREAMLETS' through the leaves, branches and stems of trees. Thick leaf litters on the ground surface alter decomposition provide humus content to the soils and also make the soils friable. Thus the ground surface allows maximum infiltration of rainwater and minimum surface runoff. On the other hand deforestation exposes the ground surface to falling raindrops with full kinetic energy. This results into maximum erosion of soils because the infiltration of rainwater is markedly reduced and surface runoff is increased. Thus deforestation causes a chain of effects which adversely affect the natural environmental conditions as given below.

Accelerated rate of soil erosion, through rain splash, rain-wash, sheet wash, rill erosion and gully erosion, consequent upon deforestation, increases sediment load of the rivers. Increased suspended and bed loads of the rivers cause rapid rate of siltation of alluvial rivers which results in gradual rise of the river beds. Thus increased surface run-off and reduced water accommodation capacity of the river valleys due to siltation increase the frequency and dimension of floods of alluvial rivers as flood waters easily overtop the river banks and spread over large areas.

It is supposed that decrease in vegetation cover mainly forest cover reduces precipitation but no significant studies at global and regional levels have demonstrated positive correlation between deforestation and decrease in the amount of average annual precipitation. Deforestation also results in the increase of the concentration of carbon dioxide in the atmosphere because forests consume carbon dioxide during the process of photosynthesis for the manufacturing of their food but absence of forests allows more concentration carbon dioxide in the atmosphere because of its non-consumption. It is, thus, obvious that deforestation increases greenhouse effect of the atmosphere which raises the temperature of the earth's surface and the atmosphere.

Increased rate of soil erosion caused due to deforestation results in colossal loss of fertile topsoil and agricultural land which ultimately causes marked reduction in agricultural production. Rapid rate of rill and gully erosion in the intervening zone between the Ganga plains and the northern foreland of Indian peninsula has resulted into the conversion of thousands of hectares of good land into ravenous land which has displaced the affected inhabitants from their agricultural land. The development of circuitous network of dense mesh of gullies ranging in depth from a few metres to 80 m has rendered vast expanse of agricultural and forest land into waste land on the one hand and has deprived millions of people of their livelihood on the other hand. Thus the increased rate of soil erosion consequent upon deforestation and destruction of grassland has been responsible for social pollution in addition to land degradation. The zigzag network of deep gullies of the riverine tract of the Yamuna, the Chambal, the Betwa rivers etc. (Fatehpur, Etawah, Agra, Banda, Jhansi, Jalaun districts of Uttar Pradesh and Bhind, Morena, Gwalior, Tikamgarh, Chhatarpur districts of Madhya Pradesh, India) offers easy and safe shelter to dacoits and bandits. This has alarmingly increased the rate of crimes, including theft, dacoity and murder in the said areas and thus has social implications.

Deforestation has also increased the rate of aeolian erosion through deflation and desertification through desert spreads. Many of the tribal areas of the forested land of India have lost the forest stands in their immediate surroundings and thus are facing the acute problem of fuels and fodder. The destruction and alteration of habitats due to deforestation causes ecological imbalance in the region concerned.

Conservation Measures

The protection and conservation of forest resources are not only desirable but are also necessary for the economic development of a nation and maintenance of environmental and ecological balance from local through regional to global levels. Forest conservation measures include (i) increasing productivity of remaining forest covers, (ii) increase in the forest cover so as to

cover 33 percent of the total geographical area of a country by forests through afforestation in the open wasteland and reforestation of already deforested areas particularly in those deforested areas which are not suitable for cultivation such as mountainous and hilly areas

Selective felling instead of mass felling of trees according to the justified demand may save unnecessary destruction of valuable forest resources. It is very interesting to note that generally main cause of the rapid rate of destruction of tropical rainforest is assigned to the increasing demand of timber by industrialized countries but according to UNESCO's report only about fifteen percent of the felled trees are exported to the developed and industrialized countries. Through the demand is more for certain species of trees only but unfortunately hundreds of species of trees of lesser values are destroyed to get access to the desired expensive trees. In the process the building of roads and clearance of forests for having spaces for loading areas and logging camps destroy larger tracts of forests without any use.

The National Forest Policy of India has also laid down certain basic principles for proper management and conservation of the forest resources of the country such as (i) classification of forests according to functional aspects into protected forests, reserved forests, village forests etc., (ii) expansion in the forest cover by planning trees in order to ameliorate the physical and climate conditions for the welfare of the people, (iii) provision for ensuring progressive increasing supplies of fodder for animal and timber for agricultural implements and firewood to local inhabitants nearer to the forests, (iv) opposition to reckless extension of agricultural land at the cost of forest land, (v) extension of forested area by massive plan of tree plantation on a large-scale at war-footing so as to bring 33 percent of the country's geographical area under forest etc. Though there is strict guideline from the Government of India that forest should not be diverted to non-forestry uses and in case if the diversion of forested area to other forms of land uses is necessary and unavoidable (such as construction of dams and reservoirs, installation of industrial plants, construction of houses, roads etc.) it should be done with the approval and concurrence of the state government and the loss of forests due to their diversion to other forms of land uses should be suitably compensated by planting trees in other proportionate areas but this guideline is seldom followed either by the government machinery or private sector. Recently, the government has banned the cutting of green trees by the public without having prior permission of the government. This law does not allow a person even to cut down his own trees in the premises of his house or in his agricultural farm without the permission from appropriate government authority.

Thus the movement against the destruction of natural forests undertaken by the women of Reni of Uttarakhand division of U.P. Himalayas (India) has awakened the general public of India and of the world towards the importance of natural forests for maintaining the environmental (natural) and ecological balance. They started plantation of oak trees in their deforested land because they knew that oak trees would provide the basis for water, fodder and fertilizers and would help in maintaining the environmental balance and ecosystem stability of their hill region. Small MAHILA MANDALS (Women's groups) are now organizing the tree-planting in hundreds of villages and protecting trees on community lands. They are introducing improved cooking stoves and biogas programmes are being implemented for fuel conservation. The messages of the movement started by the women of Reni and the popular CHIPKO MOVEMENT of noted environmentalist Sunderlal Bahuguna and his followers have reached different parts of India. Similar movements are being organized by several groups of environmentalists of voluntary organizations and some forceful and effective environmental slogans have awakened the local public such as 'Save the Western Ghats', 'Save the Ganga and the Himalayas' (launched by Sunderlal Bahuguna against the construction of Tehri Dam on the upper reaches of the Ganga at Tehri town). 'Save the Narmada watersheds and their ecology' (launched by Baba Amte) against the implementation of Narmada Valley Project and the construction of Sardar Sarovar (reservoir) and Indira Sarovar in Madhya Pradesh and Gujarat, India. The messages of the movement have crossed the Indian border and reached the African and Latin American women folk who have many of the problems and hardship similar as experienced by the women of Reni. They have also started movement against the destruction of natural forests. For example, widespread movement has

been started against the destruction of forests through the expansion of mining activities, giant multi-purpose project in the rainforests of the Amazon basin. It is evident that the people themselves may become environmental mediators, guardians and protectors of natural forests if their sentiments are aroused for the conservation and protection of natural forests.

The second important measure of effective conservation of natural forest is to adapt scientific and judicious method of cutting of trees by following selective approach. In other words, only mature and desired trees should be cut and unwanted trees of low economic value should be avoided. It may be pointed out that cutting of mature trees is also ecologically desirable because the old saying 'use them or lose them' holds good because if mature trees are not removed they will automatically perish and may damage other trees.

The third significant measure of forest conservation is to cover more and more wasteland and already deforested land with forests through vigorous planning of afforestation. The afforestation programme must be based on the principle of plantation of multi-species of trees rather than single species of trees because biotic diversity is ecologically more significant than mono-culture. Secondly, ecologically sound trees should be given more preference than the commercial trees at least in the areas of fragile environment. For example, deforested areas of the Himalayas are being planted with more pine saplings than oak because of commercial purposes. The main purpose behind vigorous planting of pine trees is to obtain resin but oak is environmentally more sound than pine because relatively larger leaves of oak trees make thick ground leaf litters which after being decomposed enrich the soils by producing humus and more organic content. Thus the humus-rich soils become friable and contain more moisture. Such soils allow rich undergrowth of other varieties of plants and thus provide habitats for numerous varieties of animals and microorganisms. Thirdly, only those trees should be given preference under the scheme of afforestation that are suitable for the local environmental conditions. For example, planting of eucalyptus trees (an exotic species) on large-scale almost in all parts of India is not advisable because eucalyptus is suitable for certain combinations of environmental conditions only such as 'Terai' region of India. Furthermore, eucalyptus is not of much ecological and environmental significance because of less branching, small size of leaves, less number of leaves and long roots. Fourthly, forests should not be replaced by commercially important fruit orchards. For example, cultivation of apples in many parts of the Himalayas in general and Himachal Pradesh (India) in particular has done great damage to the original stands of natural forests. Apple cultivation causes deforestation in two ways viz. (i) Apple cultivation requires clearance of land from vegetal cover and (ii) Huge quantity of wood is required for packing of apples every year. According to an estimate the clearance of forest for apple cultivation accelerates the rate of soil erosion by 250 times of normal rate of soil erosion. It has been estimated that one hectare of apple farm damages 7 to 10 hectares of forests.

4. Wastelands

Wastelands are those lands where the production of biomass is less than its optimum productivity. These waste lands are economically unproductive and ecological unstable. Here the life supporting systems are under tremendous pressure. The increasing deterioration of land due to soil erosion, injudicious use of chemical fertilizers, water logging, salinity, shifting cultivation, etc. are causing concern. The National Remote Sensing Agency, Department of Space, Hyderabad, on the basis of satellite pictures has reported 75.5 million hectare of land as wasteland.

The rapid expansion of wastelands in the country poses a big threat to the productive resource base and vital life support systems. To overcome it, an integrated interdependent land management system is to be developed with a view to increasing productivity, restoring fertility and generating more employment opportunities.

Land water and biological resources which support agriculture and animal husbandry and provide essential requirements of food, drinking water and fuel have come under severe pressure while meeting the requirements of increasing population. The non-forest public lands like pastures, grazing lands, etc. which were expected to meet the requirements of fuel wood and fodder of the rural people have suffered degradation, encroachment and depletion with the result that one-third of the total land mass of the country stands badly degraded.

This rapid expansion of wastelands in the country is seriously undermining the productive

resource base and endangering vital life support systems. Even the available land is being eroded at an average rate of 16.35 tonnes per ha per year which is far more than the highest tolerance limit of 12.5 t/ha/yr.

National Wasteland Development Board

The National Wasteland Development Board (NWDB) was established in May 1985 under the Ministry of Forests and Environment with the primary objective of undertaking wastelands development through a massive programme of afforestation and tree planting with the people's participation. During the Seventh Plan period an equivalent of 88 lakh hectare of public and private lands was covered under various schemes implemented through the state governments and non-government organizations. In the year 1992, the new Department under the Ministry Of Rural Development (now Ministry of Rural Areas and Employment) was created and the National Wasteland Development Board was placed under it. The Board was reconstituted in August 1992 and was made responsible for mainly development of wastelands in non forest areas in totality by involving local people at every stage of development. It aims at creating a scenario where the Government acts as a facilitator and the people at the grass roots level become the real executioner of the programme. Major programme implemented for improving the productivity of waste & degraded lands keeping in view the poverty, backwardness, gender & equity is Integrated Wasteland Development Programme.

The wasteland development programme was revised towards the end of the Seventh Five Year Plan. It was found that the programme did not adequately address the issues with regard to developing a thrust in favour of fuelwood and fodder production. Also, problems of land degradation and deforestation had not been adequately addressed and people's participation remained limited. Accordingly, the National Mission on Wasteland Development was launched with the goal of checking land degradation and helping to restore the ecological balance on the one hand and putting wastelands to sustainable use, especially to increase bio-mass availability, in particular fuelwood and fodder, on the other hand. The National Wasteland Development Board was given the responsibility for the Wasteland Development Programme with a mandate of enlisting people's participation harnessing the inputs of science and technology and achieving the requisite inter-disciplinary coordination in the planning and implementation of the programme.

The NWDB also functions as a nodal agency for bilateral and multilateral cooperation in the field of Forestry Development Programmes. As such, financial assistance is being received from the World Bank, European Economic Community (EEC), Swedish International Development Agency (SIDA), Overseas Development Agency (ODA) and Overseas Economic Cooperation Fund (OECF) for implementing forestry projects in various states.

HAZARDOUS WASTES

As more and more new products and processes are developed, new chemicals produced, and materials created, more and more such waste is generated which could be hazardous. The term hazardous waste was initially used to differentiate highly toxic or offensive wastes from the familiar wastes such as sewage and household garbage. With the passage of time and continual increase in the quantities and types of toxic wastes, it became necessary to define the term. More importantly it becomes necessary to develop ways and means of analyzing, handling and treating hazardous wastes.

Definition

The task of realistically defining hazardous waste is extremely complex, presenting the first stumbling block in hazardous waste control programmes. As per the definition of the Resource Conservation and Recovery Act (RCRA) of USA, "hazardous waste is a solid, liquid or gaseous waste, or combination of wastes, that because of its quantity, concentration or characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness and pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of or otherwise managed. In short a hazardous waste is one which is potentially harmful to the eco-system unless properly managed.

The US Environmental Protection Agency (EPA) has defined a waste to be hazardous

under the legislation if it:

i) exhibits characteristics of ignitability, corrosivity, reactivity and/or toxicity);

ii) is a specific source waste (from specific industries);

iii) is a specific commercial chemical product;

iv) is a mixture containing a listed hazardous waste or,

v) is a substance that is not excluded from regulation under RCRA (Wentz 1989).

Hazardous materials are those which are toxic, persistent, ignitable, corrosive, bio-accumulative, infectious or pathogenic. Examples include wastes from plastic, pesticide, herbicide, medicine, paint and petroleum industries.

Impact of hazardous wastes on the ecosystem-acute and chronic

A few classic cases in point, highlighting the danger posed by hazardous wastes, are enumerated below:

Love Canal: An area of about 16 acres in Niagra Falls was used from 1942 to 1953 as dump-site for approximately 22,000 tonnes of chemicals. The area was capped with clay and later houses and a school were built up to the edge of the site.

In 1978-79 over 200 families were evacuated as potential teratogenic, mutagenic and oncogenic chemicals were identified from the area leading to increased abortion and birth defects.

Times Beach: In the winter of 1982-83, over 2,200 people were evacuated from Time Beach, Missouri, owing to the presence of toxic waste in the soil and water. The toxins belonged to Dioxin (TCD) group, a class of over 75 chemicals, known for their hazardous nature. They are unwanted by-products of organic compounds-chlorinated phenols, widely used in the manufacture of plastic, herbicides and pesticides.

Another group of hazardous wastes found there were PCBs (Polychlorinated Biphenyls) used as coolant liquids in the electrical industry. PCBs are known to damage skin, eyes and lungs and cause birth defects and cancer.

Hardeman County: In Tennessee, 60 miles north of Memphis, is a 200-acre hazardous waste dump, which was operational between 1964 and 1972. Up to 25 million gallons of solid and liquid wastes were deposited, which eventually contaminated surface and ground water with chlorinated organic compounds and other chemicals.

Delhi: Nearer home, a noxious nightmare assailed the residents of Kardampuri colony in East Delhi in the wee hours of 13 November 1994. Toxic fumes from a heap set aflame by a local junk dealer created the panicky exodus. The people complained of severe breathing distress, irritation and pain in the throat, vomiting and dizziness. Many people, including infants, were seriously affected and a few succumbed to the poisoning. Tests revealed that the chemicals responsible were cyanide, cadmium, selenium and arsenic. Traces of lead, aluminum and copper were also found. It is widely suspected that the burning of metals like cobalt and manganese along with pesticides like organophosphates and carbonates caused the noxious fumes.

Gujarat: The catalogue of disasters will be incomplete without the inclusion of the recent Surat plague epidemic. The bubonic plague epidemic, which descended on the city of Surat in 1994, owed its origin to the woefully inadequate waste-management strategies. The waste heaps which were allowed to rot resulted in the proliferation of rodents and vermin, which ultimately triggered off the pestilence of plague which had been thought of as having been eradicated long back. As the people were caught unaware, the disease wrought wide-spread havoc. This episode illustrates the fact that, at times, even those solid wastes, which do not come under the definition of 'hazardous wastes', can become extremely hazardous!

Health Hazards

The evaluation of the health effects of hazardous wastes depends upon three basic problems:

i) availability of toxicological data on chemicals;

ii) toxicity of mixtures of chemical wastes and the physical, chemical and biological factors that influence toxicity; and

iii) estimation of the level and duration of exposure to the population.

The toxic effects induced by hazardous wastes can be differentiated into two different

groups: responses that result from genetic effects and those associated with target organs. In addition to epidemiological methods used in assessing health effects, several basic issues need to be reconciled prior to data interpretation. These include latency period, multiple causative factors, population diversity and mobility, and socioeconomic and urbanization conditions.

If the expected baseline frequency of specific health effect is low, a large population base will be needed, especially for risk assessment.

Secondary (Health) Hazards

The wastes in the natural environmental conditions can become toxic, explosive or even become the breeding ground for disease germs and vectors. For example, cooked meat can become a lethal source of pathogens within a few hours. Vectors like house flies, mosquitoes, rats, etc. are indicators of conversion of normal wastes into hazardous ones.

When organic materials are amassed even less flammable materials undergo spontaneous combustion, e.g. hay, saw dust, coal, etc. Anaerobic decomposition of organic wastes produces methane (CH_4), hydrogen sulphide (H_2S), carbon monoxide (CO), carbon dioxide (CO_2), etc. They may form explosive mixtures. The recent explosion due to leakage of gas accumulated in a choked sewage in Mexico is noteworthy.

Leachate from even normal municipality wastes can assume gigantic proportions. The Biochemical Oxygen Demand (BOD) of leachates from landfill may exceed 20,000 mg per litre, i.e. 100 times stronger than raw waste. Thus, secondary hazards of normally safe wastes are also studies as a special case of hazardous wastes.

Hazardous Waste Generation

A review of the available literature points to four major pathways for hazardous waste generation and their escape into the environment. The first and most significant pathway is the continuous discharge of hazardous wastes onto land which include:

- Wastes which, due to environmental restrictions, have been removed from air or water effluent streams;
- Wastes generated by industry as losses or as by-products of various processes;
- Products which become wastes as a result of governmental regulations or restrictions;
- Wastes from government or other institutional operations.

The second source is the accidental spilling of hazardous substances resulting in damage to the environment. Another source is the discharge of hazardous wastes in small quantities leading to its concentration, from numerous sources, including waste effluent and air emission streams that are not subject to pollution control procedures. The fourth pathway consists of mine tailings and abandoned dumping and disposal sites contributing to slow environmental degradation. The problem is looming large as its deleterious effects are slowly being manifested globally.

The International Scenario

In 1984, the US alone produced over 260 million metric tonnes of hazardous wastes equivalent to over 70 billion US gallons. There were about 1400 installations that generated waste and the majority (96 per cent) managed them onsite. The industrial sector produced 92 per cent of all hazardous material with 68 per cent of the total from chemical industries alone. 99 per cent of the material is liquid at the time of generation. The machinery and transportation industries, each contribute about 6 per cent. By 1986 USA had over 22,000 hazardous waste sites. More than 500 have been identified as posing serious long-term hazards to public health and the environment.

Accurate determination of the amount of waste produced by other countries are generally not available. In the Netherland there are almost 3000 known abandoned dumps, of which 300 pose imminent threat to human health. In Great Britain some counties have been hesitant to accept waste whereas others operate at a more liberal policy. Britain has been estimated to have produced 11 metric tonnes waste during 1980. France produces almost 2-3 million metric tonnes of toxic wastes annually and ships 4000 tonnes of chlorine to be burned at sea. In China, medium to large industries generate approximately 80 million tonnes of solid waste.

Hazardous Waste Management

Appropriate management techniques have to take into account the various options based on the nature, quantity and location of the waste. The desirable options for managing hazardous wastes are listed below, on priority basis. The

figure given below is a schematic representation of the prioritized options.

i) Minimization of the amount generated by modifying the industrial processes involved.
ii) Transfer of the waste to another industry that can utilize it.
iii) Reprocessing of the waste to recover energy or materials.
iv) Separation of hazardous waste from non-hazardous waste at the source and its subsequent concentration, which reduces the handling, transportation and disposal costs.
v) Incineration of the waste or its treatment to reduce the degree of hazard, and
vi) Disposal of the waste in a secure landfill, one that is located, designed, operated and monitored in a manner that protects life and environment.

Let us examine the different disposal and treatment methods currently in use.

Landfill

Landfills for the disposal of hazardous wastes evolved from sanitary landfills.

Site Selection

The selection of a site for waste disposal is governed by climatic, geologic and hydrological factors. Arid conditions are favourable as little leaching occurs. Sites made up of impermeable material, such as clay till, are preferable because such material retards the movement of contaminants from the site and attenuates the effect by adsorption and filtration. On the other hand, a site close to the recharge zone is not suitable because the ground water gets affected. Likewise, if the discharge flows into a stream because of a high water table, the ground water gets contaminated.

Design and Construction

The design and construction of a hazardous landfill incorporates an impermeable cover, an impermeable bottom liner, a system of drainage pipes to collect and remove any leachate that may accumulate, and a system of monitoring wells.

The cover prevents infiltration of precipitation into the landfill. The bottom liner serves to reduce the rate of leachate migration. The leachate collection and recovery system checks leachate migration and hydrostatic pressure. This is accomplished by a system of perforated pipes buried in the lower part of the landfill, from where the liquid is pumped out. Regular monitoring of the wells can detect, before hand, the effects of groundwater contamination. The NAS (National Academy of Sciences) has decided that at least 500 years is realistic as a period of concern for wastes in landfills.

Landfill gas generation is a major concern in organic waste dumping. The emission rate from landfill depends on a number of factors, such as vapour pressure, diffusion coefficient, mass transfer coefficient and solubility. Several control techniques have been proposed regarding toxic gas emission from landfills.

Wastes that are explosive or have high vapour pressure, such as organic sludges, volatile organic wastes and liquids, should not be landfilled. Many types of waste should be pre-treated to make them more innocuous and less volatile. Gas collection device should be installed. The site should be capped.

Hazardous wastes are now stored in separate cells i.e. discrete storage areas, which are highly suitable for incompatible wastes. Also, when a cell is full, it can be quickly sealed and revegetated. The Office of Technology Assessment has concluded that complete protection from migration, even for the operating life of the fill, is probably unattainable.

Land treatment

This is a biological method in which, hazardous wastes are deposited either on the land or injected just beneath it and degraded naturally by aerobic organisms. Oxygen levels may be maintained by periodic ploughing.

Although the basic concept of land treatment is simple, its planning and implementation are exceedingly complex, involving an understanding of microbiology, soil science, chemistry, hydrology, geology and climatology. In order for organic constituents to be suitable for land treatment, they must degrade at a rate faster than volatization, leaching or runoff. The mobility, toxicity and accumulation of heavy metals must also be considered in facility design.

Acceptable sites for landfill may also prove most acceptable for land treatment. If bio-degradable hazardous wastes are eliminated, and toxic metals and other hazardous materials immobilized in surfacial material, land treatment could prove to be superior to landfill.

Selection of the kind of hazardous waste treated by this technique, combined with careful site monitoring, will reduce the danger of environmental contamination by the biodegradable fraction of the waste. The ultimate fate of toxic materials that remain in the treated ground is more questionable.

Deep-well Injection

The use of injection wells for industrial waste disposal began around 1950. In a typical injection well, depths to the disposal zone commonly range between 600 to 1800 m but may by shallower or deeper.

The major difference between an injection well and a normal well is the closed annular space between the injection tubing and the inner or long string casing. This space is filled with a fluid under pressure which preserves the casing and tubing, and which is monitored by a pressure gauge at the surface. On completion, the well is plugged to prevent the release of liquids and also any change in reservoir pressure.

Underground injection of hazardous wastes requires a very careful appraisal of factors, including subsurface stratigraphy, lithology, subsurface structure, fresh-water geohydrology, extent of disposal zone area, pressure conditions of disposal zone, density, toxicity, chemistry and reactivity of wastes, etc.

An ideal disposal reservoir has a thick, porous and permeable blanket of sandstone underlying an entire basin and confined from above and below by impermeable beds. A waste that is lighter than the interstitial water would be effectively contained in an anticline. In contrast, a fluid denser than the interstitial water would be best contained in a syncline.

Another important factor in underground disposal is the selection of an injection pressure high enough to displace the interstitial fluids with the waste but is not so high that the containing impermeable beds are fractured.

Incineration

The safest and most effective alternative to land-based disposal of hazardous wastes is incineration. This process is widely used in Europe, chiefly in Germany.

About 240 facilities in the US incinerate 17 million metric tonnes of waste. Another 3-5 million metric tonnes are burned in industrial boilers and 3, 50,000 metric tonnes by other means like cement kilns.

Many incinerators have been shut down as they failed to meet air pollution standards. To obtain a permit for an incinerator, the company must demonstrate a removal efficiency of 99.99 per cent for PCBs and 9.99 per cent for other pollutants.

Many organic toxic wastes are broken down to harmless CO2 and H_2O at high temperatures. Small amounts of HCl, SO_2, dioxins etc, may be produced depending on the efficiency of the incinerator. These can be removed using special equipment.

The effectiveness of incineration depends upon temperature, turbulence and residence time. PCBs can be incinerated with 99.99 per cent efficiency at 750° C. The chief breakdown product, hexachlorobenzene (HCB), decomposes after 800° C and persists at low levels even at 1000° C. Fine particulate matter, metal aerosols and hydrogen halide gases that escape incineration also pose a problem. New methods like ionizing wet scrubbers, supersonic steam injection and electrostatic precipitation will lead to an increased treatment of these wastes.

A new experimental method involves heating a mixture of water and organic wastes to 400°C at high pressure. Air is passed through this mixture. All organic compounds, including dioxins, break into water and CO_2. High incinerator temperatures result in an increased emission of heavy metals. An increase in vapour pressure of cadmium, copper, lead and chromium with temperature, has been shown.

Incineration at sea: This is attractive because of its low cost, roughly half that of incineration on land. Interest in sea disposal began in the early 1970s when Volvanus-I went into operation in the North Sea. The largest amount to be incinerated was 1.5 million gallons of PCB in the Gulf of Mexico. To date, incineration at sea can be described as a cheap and effective method.

Other treatment methods

In many instances, these methods are still under development and are not presently cost effective. Heavy metals, if not recycled, poses a potentially long-term toxicologic problem for waste disposal. They can be solidified into granular form, mixed with cement-based grouts and pumped into underground disposal caverns.

Thermoplastic techniques using poly-ethylene, paraffins and bitumen are popular as the wastes are tightly bound and the leaching rate is low due to the water resistant media.

Several other waste treatment processes that are either under research or in use include:

Physical treatment: Physical treatment of hazardous wastes includes a number of separation processes commonly used in industry. For a waste containing liquids and solids, physical separation is of great value as it is simple and very economical. The physical processes for the separation of liquids and solids are :

The selection of a particular treatment process depends upon the nature of the constituents and their amenability to the technique.

Biological treatment: This method is now increasingly being used as an efficient, cost-effective way to remove hazardous substances from waste water effluent.

Aerobic organisms (microbes which utilize oxygen directly) are commonly used to treat waste streams and anaerobic organisms (microbes which use oxygen present in chemical combination with other elements) are used in the treatment of strong organic wastes or organic sludges.

1. Screening
2. Sedimentation and clarification
3. Centrifugation
4. Floatation
5. Filtration
6. Sorption
7. Evaporation and distillation
8. Reverse osmosis
9. Stripping

The ability of bacteria to consume organic matter is measured by the bio-chemical oxygen demand which is the quantity of oxygen utilized by micro-organisms in the aerobic oxidation of organics at 20° C. Hazardous waste materials are toxic to some of the micro-organisms. But a substance that is toxic to one group of organisms may be an essential nutrient for another. By achieving the proper distribution of organisms, biological treatment can be effectively harnessed.

e- WASTE DUMPING

What is e-dumping?

The export of e-wastes to developing countries without adequate environmental regulations is not recycling but dumping. It is a way for the electronics industry of industrialized countries to pass on downstream costs to those living in developing countries.

A separate Directorate on Anti-Dumping was set up in the Ministry of Commerce in April 1998 to deal expeditiously with investigations of dumping cases. In addition to infrastructure support to anti-dumping mechanism, a facilitation cell was also created to assist the domestic industry.

What is e-waste?

- Electronic waste, e-waste, e-scrap, or waste electrical and electronic equipment (WEEE) describes discarded electrical or electronic devices.
- As for example computers, televisions, VCRs, stereos, copiers, and fax machines are common electronic products.
- All electronic scrap components, such as CRTs, may contain contaminants such as lead, cadmium, beryllium, or brominated flame retardants.

Even in developed countries recycling and disposal of e-waste may involve significant risk to workers and communities and great care must be taken to avoid unsafe exposure in recycling operations and leaching of material such as heavy metals from landfills and incinerator ashes.

e- Waste (Management & Handling) Rules, 2011

The e-waste (Management & Handling) Rules, 2011 came into effect from May 1, 2012. The rules were notified in May 2011 and aim at reduction in the use of hazardous substances in electrical and electronic equipment by specifying threshold for use of hazardous materials, including lead, mercury and cadmium. The rule is applicable to every producer, consumer or bulk consumer, collection centre, dismantler and recycler of e-waste involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components. The rules place the main responsibility of e-waste management on the producers of the electrical and electronic equipment by introducing the concept of "extended producer responsibility" (EPR).

As per the guidelines of hazardous waste management division of Central Pollution Control Board, an arm of the Union Environment

Ministry, there is a need to encourage recycling of all useful and valuable material from e-waste so as to conserve the ever depleting natural resources.

The e-waste (Management & Handling) Rules, 2011 will not apply to :

- Lead acid batteries as covered under the batteries (Management and Handling) Rules, 2001,
- Micro and small enterprises as defined in the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006)
- Radio-active wastes as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962).

e-Waste Mining

Electronic waste is a valuable source for secondary raw materials, if treated properly, however if not treated properly it is a major source of toxins. Rapid technology change, low initial cost and even plan obsolescence have resulted in a fast growing problem around the globe. Technical solutions are available but in most cases a legal framework, a collection system, logistics and other services need to be implemented before a technical solution can be applied.

Due to lower environmental standards and working conditions in China, India, Kenya, and elsewhere, electronic waste is being sent to these countries for processing - in most cases illegally. Delhi and Bangalore in India and Guiyu in Shantou region of China have electronic waste processing areas. Uncontrolled burning, disassembly, and disposal are causing environmental and health problems, including occupational safety and health effects among those directly involved, due to the methods of processing the waste. Trade in electronic waste is controlled by the Basel Convention.

Electronic waste is of concern largely due to the toxicity of some of the substances if processed improperly. The toxicity is due to lead, mercury, cadmium and a number of other substances. The unsustainability of discarded electronics and computer technology is another reason for the need to recycle - or perhaps more practically, reuse - electronic waste.

Electronic waste processing systems have matured in recent years following increased regulatory, public, and commercial scrutiny, and a commensurate increase in entrepreneurial interest. Part of this evolution has involved greater diversion of electronic waste from energy intensive, down-cycling processes where equipment is reverted to a raw material form. This diversion is achieved through reuse and refurbishing. The environmental and social benefits of reuse are several: diminished demand for new products and their commensurate requirement for virgin raw and larger quantities of pure water and electricity for associated manufacturing, less packaging per unit, availability of technology to wider swaths of society due to greater affordability of products, and diminished use of landfills.

e-Waste Recycling: E-waste is one of the fastest growing forms of waste around the world. The UN Environment Programme estimates that up to 50-million tonnes of e-waste is generated worldwide every year. Despite the fact that the trade in e-waste is controlled by the Basel Convention, a global environmental agreement on the transboundary movement of hazardous wastes, e-waste from developed countries is being shipped to Asia or Africa, where it often ends up as a dangerous toxic waste problem.

Potential in India: E-waste is often richer in rare metals than their ores, containing 10 to 50 times higher copper content than copper ore. A cell phone contains five to 10 times higher gold content than gold ore. One tonne of scrap from discarded computers contains more gold than can be produced from 17 tonne of gold ore. Mumbai alone throws away 19,000 tonne of electronic waste a year, excluding the large e-waste imports from developed nations through its port. The trend is likely to increase manifold in proportion to the growth in the electronics industry. The projected growth for the e-waste generation for India is about 34 per cent year per year. The industry seems to be waking up. Domestic and international entrepreneurs are interested in setting up plants in the country. Multinationals such as HP and Sony Electronics are also showing keen interest in setting up plants in the country.

CHRONIC METALLIC POISONING

Poisoning may be acute or chronic. Actuate poisoning is the poisoning having a short and relatively severe course. Poisoning persisting over a long period of time is known as chronic poisoning.

Common metallic poisons include Arsenic, Mercury and Lead. These metals have extensive uses in industries, agricultural, commercial and for domestic purposes. As exposure to these metals is unavoidable, particularly in urban, semi- urban and industrial areas, some amounts are constantly absorbed and remain accumulated in the body. Thus, incidents of chronic poisoning by these are far more than the incidents of acute poisoning.

Arsenic: Arsenic is a persistent, bio-accumulative and toxic substance also classified as a carcinogen and is among the top 20 most toxic substances. WHO guideline value for arsenic in drinking water is 0.01 mg/1. Arsenic has been discovered in ground water in several countries in all five continents, but the worst is recorded from West Bengal in India and Bangladesh. This happens because arsenic is also a natural part of the Earth's crust in some parts of the world and seeps into water, which has flowed through arsenic-rich rocks.

Arsenic poisoning is common in persons working in industries manufacturing sheep-dips, weed killers, insecticides, dyes, paints, cosmetics and in those using these products.

The commonly encountered signs and symptoms of chronic arsenic poisoning are loss of appetite, indigestion, nausea, vomiting, constipation, diarrhoea, loss of weight and brownish pigmentation of skin. It also causes hypertension and neurological effects. It can also cause about half a dozen types of cancers, including cancer of the skin, bladder, lung, liver and kidney. In China it has been found to cause a severe disease of the blood vessels leading to gangrene. It is called 'black foot disease'.

Chronic arsenic poisoning is very different from acute poisoning. Immediate symptoms of acute poisoning include vomiting, Oesophagal and abdominal pain and bloody 'rice water' diarrhoea. Chelation therapy may be effective in acute poisoning.

Lead: Lead is a highly toxic metal that was used for many years in products found in and around our homes. Lead may cause a range of health effects from behavioral problems and learning disabilities, to seizures and death. Children of 6 years old and under are most at risk, because their bodies are under quick growth phase. The Primary sources of lead exposure are deteriorating lead based paint, lead-contaminated dust and lead-contaminated residential soil. If not detected early lead poisoning can lead to damage to the brain and nervous system, behavioral and learning problems (such as hyperactivity), delayed growth and impaired hearing in children. Lead is also harmful to adults and may cause reproductive problems in both men and women. Symptoms of poisoning also include, high blood pressure, digestive problems, nervous system disorders, memory loss and muscle and joint pain.

Mercury: Mercury occurs naturally and is also released by human activities. Mercury has been commonly used in dental amalgam, and other medical devices, light switches, fluorescent lights, batteries and paints. Mercury is also used in industrial process such as chlorine production, cement manufacturing and copper and lead smelting. Because there is such devastating health risk associated with mercury and organic mercury compounds, widely used in industry as catalysts and in agriculture, the WHO has placed limits on the allowed mercury content in food. Important signs and symptoms of chronic mercury poisoning are : gingivitis, salivation, constipation, diarrhoea, anaemia, loss of weight, loosening of teeth, restricted field of vision, insomnia, anxiety, irritability and tremors of hand and tongue. Mercury chelating compounds remain the first line of treatment.

Phytofiltration

Recent research reveals that 'Pteris vittata', a fern, can readily purify water poisoned with arsenic. In other words water contaminated with arsenic can be cleaned by growing ferns in it. This particular fern species reduces the concentration to below the safety limit. The procedure, called 'phytofiltration', could provide a cheap way to remove arsenic from water supplies. The ferns would be grown directly in the water, similar to the reed-bed systems currently used to remove organic waste.

Arsenic pollution of drinking and irrigation water has emerged as a massive health threat in India and Bangladesh, where wells drilled into aquifers have turned out to be tapping poisoned water. When the water is used to irrigate rice paddies, arsenic also accumulates in the crops. According to one estimate, 3000 people may be dying in Bangladesh each year because of arsenic contamination.

Bioremediation

It is often used to describe a variety of quite different microbial processes that occur in natural ecosystems, such as mineralization, detoxification, co-metabolism or activation. It can be defined as breakdown of organic compounds in nature by the action of micro organisms, such as bacteria, actinomycetes and fungi. Since bioremediation uses naturally occurring microorganisms to transform harmful substances to non-toxic compounds, its role in restoring the contaminated soils to their original health and thus serving the environment from pollution is highly significant. Some of the more common genera involved in bioremediation of oil products include Nocardia, Pseudomonas, Acetobacter, Flavobacterium, Micrococcus and Arthrobacter.

Features of Bioremediation

Remediate means to solve a problem, and "bio-remediate" means to use biological organisms to solve an environmental problem such as contaminated soil or groundwater. In a non-polluted environment, bacteria, fungi, protists, and other microorganisms are constantly at work breaking down organic matter.

- An ecologically sound, natural process; residues are usually harmless products.
- Instead of merely transferring contaminants from one environmental medium to another (e.g. from water to the air or to land) bioremediation completely eliminates the target chemicals.
- Bioremediation is far less expensive than other technologies that are often used to clean up hazardous waste.
- Bioremedition can often be accomplished where the problem is located (in-situ). This eliminates the need to transfer large quantities of contaminated waste off-site, and the potential threats to human health and the environment that can arise during such transportation.

RADIOACTIVE WASTES

Liquid, solid and gaseous wastes are produced in the mining of or in the production of reactor fuel materials, reactor operation, processing of irradiated reactor fuels and numerous other related processes. Wastes also result from the use of radioactive materials in research laboratories, industries and medical treatment.

Based on radioactivity, the radioactive wastes can be classified as-

Mildly radioactive: residues from filter and purification processes, contaminated equipment, gloves, sewage sludge from wastewater separation.

Moderately radioactive: component parts of nuclear power stations rendered active by neutrons, radioactive residues from purification plants.

Highly radioactive: includes decaying fissile materials e.g. those of strontium (90Sr), Caesium (137Cs), Iodine (129 I.). The half-life periods of these radioactive isotopes are 26, 30 and 17,200,000 years, respectively.

For disposal purposes, nuclear wastes are separated into two groups:

High- level Radioactive wastes (HLRW) which include:

i) Spent nuclear fuel after irradiation, fission products and TRU (Trans Uranic);

ii) Trans Uranic wastes which are x-emitting TRU isotopes, with half lives of over a year;

iii) High-level wastes (HLW) which are by-products of spent-fuel reprocessing, especially to extract plutonium for warheads.

Low level Radioactive Wastes (LLRW) includes:

i) Low level wastes, defined as wastes containing less than 10 nCig-1 (nCig-1= nanocuries/gm) of trans-uranic elements;

ii) Uranium (U) and Thorium (Th) by-product materials are the tailings produced by the extraction or concentration of U or Th from processed ore.

Until recently, a criterion of 10 nCi g-1 served as a cutoff between shallow land burial and other modes of disposal for TRU high-level wastes. Proposed standards define concentration limits for specific radio-nuclides. For x-emitting TRU nuclides with half-life of over 20 years, the limit is 100 nCi g -1. All other radio-nucleides with a half-life of over 20 years have a maximum of 1 nCig-1.

Treatment of Radioactive Wastes

Approximately one-third and one-fourth of the spent fuel rods in Pressurized Water Reactors

(PWR) and Boiling Water Reactor (BWR) respectively, is removed and replaced. The main objectives of fuel reprocessing are the removal of HLW and TRU from fuel rods and the separation of plutonium. After the initial stages, a nitric solution of the fuel is put in contact with an immiscible solvent, like tributyl phosphate present in an organic diluent. This solution, Raffinate, is highly radioactive and is concentrated by evaporation. Raffinate is stored in special stainless steel containers. Approximately 10 cubic metres of concentrated waste is produced from each GW of electricity.

Reprocessing produces both solid and liquid wastes. Liquids can be solidified by spray calcinations and fluidized-bed calcinations. In fluidized-bed calcinations, liquid waste is continuously fed into a calciner containing a bed of small nucleation particles. The bed is heated to 500-600° C by kerosene combustion. A stream of air is passed through the particles so that they flow like a liquid contact between the liquid and particles, causing drying and calcinations. .

In spray calcination, the liquid waste is sprayed into the top of a tower that is heated in the furnace. At about 700° C, water is driven off resulting in calcinated solids, which is collected at the bottom of the tower. Heating them to 900° C drives off the remaining nitrates, whereas, if it is to be vitrified, the powder is heated to 1000-10000°C to form a mass of glass. The 'supercalcine' process produces a calcine with up to 23 per cent additional constituents like lime.

Radioactive Wastes Disposal

Storage in tanks above ground: The US has been practising this for over 20 years. There are over 200 steel and concrete tanks having over 3 million litres of highly radioactive liquid. These radioactive wastes generate heat, besides radiation and hence require constant cooling. The heat is transferred to the condenser by pipes carrying steam. Mixing of contents with compressed air ensures uniform heating and does not allow settling of solids.

A few serious loopholes in this method are listed below:

1. Strong radiation from wastes might lead to corrosion of the tanks and a consequent leakage of radioactive wastes e.g. Hanford, Washington, the prime deposit site in the US experienced seepage of 4,90, 000 litres of radioactive waste;
2. Fuming wastes require constant refrigeration. They produce 9 kW/m3 of highly radioactive waste. In case of a refrigeration failure, temperatures can easily shoot over 1000°C resulting in the explosion of the tank and a calamity. The University of California has estimated that if a storage tank containing 3 million litres of highly radioactive liquid were to explode, an area twice that of Switzerland would be rendered uninhabitable for several decades.

Radiolytic water disintegration produces H2 and O_2 at a fast rate. If proper ventilation is not provided, the H_2 produced, in the absence of dilution, will reach the lower explosion limit of 4 per cent in a few hours, resulting in an explosion by combining with the O_2.

Packaging of spent fuel: If spent fuel were the primary form of waste, the anticipated packaged waste through the year 2000 would be 2.2x106 cubic feet (68,000 cubic metres). If this were stacked as a solid cube, each side would measure nearly 40 metres. About 38,000 megacuries and 175 MW of heat would be produced by this mass of spent fuel.

According to a Swedish project (KBS 1977), spent fuel should be stored in a water pool in a granite cavern 30 metres below the surface.

After 40 years of storage to dissipate heat, bundles of 500 fuel rods would be loaded in copper canisters with lead and copper covers. Each canister, weighing 18 tonnes, will be transferred to the granite cavern 500 metres below the ground in holes 7.7 metres deep and 1.5 metres in diameter, lined with 40 centimetres of isostatically compressed bentonite.

Radioactive wastes reveal radical changes after few hundred years. First, the heat generation rate decreases by an order of magnitude in the period of 10-100 years and by another order of magnitude in 100-1000 years (the decrease in the heat generation rate depends on the half-life period of the particular radioactive waste). Secondly, the toxicity of HLW needed for 1 GW per year electricity decreases by about three orders of magnitude in the first 300-400 years due to the decay of short-lived fission products (1 Giga Watt=109 watts; a measure of consumption of electricity). Toxic levels drop to the level of average ores of toxic elements. After this time, toxicity diminishes slowly, a million years

being required for another two orders of magnitude. Thus, the first 300-400 years represent the most critical phase of disposal.

Use of salt mines: The idea originated in West Germany, as salt mines have very little connections with groundwater, thus conferring a high degree of storage security. Asse II, Germany, stores many small and large caverns filled and sealed with mild radioactive wastes. By AD 200, Asse II is expected to store upto 2, 50,000 cubic metres of mildly radioactive wastes.

Recent reports of ground water contamination questions the vulnerability of the system. Besides salt; granite, basalt and shale have been extensively studied. As a repository should contain and isolate these wastes, site selection involves the consideration of the properties of the host rock, the hydrologic properties of the site, its tectonic stability, its resource potential and the capability of the site geohydrology, to provide natural barriers to the movement of the waste.

Turning to the sea: UK deposits 80,000-90,000 Ci of LLRW into the ocean each year, which constitutes 90 per cent of the total waste deposited by Europe. Although US abandoned this method in the 1960s, it had deposited about 1, 00,000 Ci by then.

Sub-seabed geologic disposal: The abyssal hill regions in the centres of sub-ocean tectonic plates underlying large ocean surface currents, are vastly remote from human settlements, biologically unproductive, have weak and variable bottom currents and are covered with red clays to a depth of 50-100 metres. The clay has a high cation retention capacity, low permeability, vertical and lateral uniformity; and it becomes increasingly rigid and impermeable with depth. Only about 0.006 per cent of the area of central North Pacific would enable the disposal of HLW by the US till 2040.

Conclusion

Hazardous wastes should be disposed of as early as possible and with as little damage to the environment as possible. Currently cost-efficient technology for handling a large number of hazardous wastes is lacking.

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CLIMATIC CHANGE

CHRONICLE
IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

A planet's climate is decided by its mass, its distance from the sun and the composition of its atmosphere. Earth's climate is unstable and rather unpredictable as compared to other planets. Over the last 400,000 years the Earth's climate has been unstable, with very significant temperature changes, going from a warm climate to an ice age in as rapidly as a few decades. These rapid changes suggest that climate may be quite sensitive to internal or external climate forcing and feedbacks.

According to recent reports of the Intergovernmental Panel on Climate Change, the global average surface temperature over the 20th century has increased by around 0.60°C. This value is about 0.15° C more than the previous estimates. Global average land and sea surface temperatures in May 2003 were the second highest since 1880.

To date, the 10 hottest years in the 143 year old global temperature record have all been after 1990, with the three hottest being 1998, 2001 and 2002. Extreme weather events also increased during this period — there were 63 weather-related disaster declarations in 1998, far more than the average 21.7 disaster announcements made per year during the 1980s. For instance, there were 26 flood disasters worldwide in the 1990s, but just 21.7 per year during the 1980s. The frequency and intensity of extreme weather events increases due to a change in the distribution of heat, which disrupts the flow of energy through the climate system, altering the circulation patterns of the atmosphere and oceans, and modifying the Earth's hydrological cycle. Higher temperatures increase evaporation and transpiration, and raise the air's capacity to hold moisture, making more of it available to fall as rain and snow.

GREENHOUSE EFFECT

The earth's climate is driven by a continuous flow of energy from the sun. This energy arrives mainly in the form of visible light. About 30 per cent is immediately scattered back into space, but most of the remaining 70 per cent that is absorbed passes down through the atmosphere to warm the earth's surface. The earth sends this energy back out into space in the form of infrared radiation.

Greenhouse gases in the atmosphere block infrared radiation from escaping directly from the surface to space. Infrared radiation cannot pass straight through the air like visible light. Instead, most departing energy is carried away from the surface by air currents and clouds, eventually escaping to space from altitudes above the thickest layers of the greenhouse gas blanket.

The main greenhouse gases are water vapour, carbon dioxide, ozone, methane, nitrous oxide, halocarbons and other industrial gases. Apart from the industrial gases, all of these gases occur naturally. Together, they make up less than 1 per cent of the atmosphere. This is enough to produce a "natural greenhouse effect" that keeps the planet some 30°C warmer than it would otherwise be essential for life as we know it.

The level of key greenhouse gases (with the possible exception of water vapour) is rising as a direct result of human activity. Emissions of carbon dioxide (mainly from burning coal, oil, and natural gas), methane and nitrous oxide (mainly due to agriculture and changes in land use), ozone (generated by automobile exhaust fumes and other sources) and long-lived industrial gases such as CFCs, HFCs, and PFCs are changing the absorption pattern of atmosphere. Water vapour levels may also be rising because of a "positive feedback." This is all happening at an unprecedented speed. The result is known as the "enhanced greenhouse effect."

Meanwhile, industrially-generated "sulphate aerosols" may have an overall local cooling effect. Sulphur emissions from coal- and oil-fired power stations and the burning of organic material produce clouds of microscopic particles that can reflect sunlight back out into space and also affect clouds. The resultant cooling partly compensates for greenhouse warming. These

sulphate aerosols, however, remain in the atmosphere for a relatively short time compared to the long-lived greenhouse gases, so their cooling effect is localized. They also cause acid rain and poor air quality, problems that need to be addressed. This means we cannot rely indefinitely on the cooling effect of sulphate aerosols to keep the climate cool indefinitely.

Carbon dioxide is currently responsible for over 60% of the "enhanced" greenhouse effect. This gas occurs naturally in the atmosphere, but burning coal, oil, and natural gas is releasing the carbon stored in these "fossil fuels" at an unprecedented rate. Likewise, deforestation releases carbon stored in trees. Current annual emissions amount to over 23 billion metric tonnes of carbon dioxide, or almost 1% of the total mass of carbon dioxide in the atmosphere.

Methane from past emissions currently contributes to 20 per cent of the enhanced greenhouse effect. The rapid rise in methane started more recently than the rise in carbon dioxide, but methane's contribution has been catching up fast. However, methane has an effective atmospheric lifetime of only 12 years, whereas carbon dioxide survives much longer.

Nitrous oxide, a number of industrial gases, and ozone contribute to the remaining 20 per cent of the enhanced greenhouse effect. Nitrous oxide levels have risen by 16 per cent, mainly due to intensive agriculture. While chlorofluorocarbons (CFCs) are stabilizing due to emission controls introduced under the Montreal Protocol to protect the stratospheric ozone layer, levels of long-lived gases such as HFCs, PFCs and sulphur hexafluoride are increasing. Ozone levels are rising in some regions in the lower atmosphere due to air pollution, even as they decline in the stratosphere.

Rich countries generally emit more per person than do poor countries. However, countries of similar wealth can have very different emission rates depending on their geographical circumstances, their sources of energy, and the efficiency with which they use energy and other natural resources. If nothing is done to reduce emissions, current climate models predict a global warming of about 1.4 – 5.8°C between 1990 and 2100.

Measurement records indicate an increase of 0.6±0.2°C in global average temperature since the late 19th century. In the Northern Hemisphere (where there sufficient data to make such analysis), it is likely that the rate and duration of the 20th century warming has been greater than any other time during the last 1,000 years. In addition, the 1990s are likely to have been the warmest decade of the millennium in the Northern Hemisphere, and 1998 is likely to have been the warmest year. The mean sea level has risen by 10 to 20 cm. Snow cover has declined by some 10% since the late 1960s in the mid- and high latitudes of the Northern Hemisphere. In recent decades, the extent of Arctic sea-ice in the spring and summer has decreased by about 10–15%, and the Arctic sea-ice has thinned by 40% during late summer and early autumn. The way climate has changed over the 20th century is consistent with what we would expect as a result of increases in greenhouse gases and aerosols. Overall, there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.

MAIN GREENHOUSE GASES

Green House Gases	Pre-Industrial Concentraton	Concentration in 1994	Anthropogenic Source	Global Warming Potential (GWP)
Carbon-dioxide	278,000 ppbv	358,000 ppbv	Fossil fuel combustion, Land use conversion, Cement production	1
Methane	700 ppbv	1721 ppbv	Fossil fuels, Rice paddies, Waste dumps, Livestock	21
Nitrous oxide	275 ppbv	311 ppbv	Fertilizer, industrial processes, combustion	310
CFC-12	0	0.503 ppbv	Liquid Coolants, Foams	6200-7100
HCFC-22	0	0.105 ppbv		1300-1400
Perfluoromethane	0	0.070 ppbv	Production of Aluminium	6,500
Sulphur Hexafluoride	0	0.032	Dielectric fluid	23,900

PPbv: Parts Per billion by Volume

CONSEQUENCES OF CLIMATE CHANGE

Agriculture and Food Security

Global agriculture will face many challenges over the coming decades. Degrading soil and water resources will place enormous strain on achieving food security for the growing population. These conditions may be worsened by climate change. While a global warming of less than 2.5°C could have no significant effect on overall food production, a warming of more than 2.5°C could reduce global food supplies and contribute to higher food prices.

Higher temperatures will influence production patterns. Plant growth and health may benefit from fewer freezes and chills, but some crops may be damaged by higher temperatures, particularly if combined with water shortages. Certain weeds may expand their range into higher-latitude habitats. There is also some evidence that the poleward expansion of insects and plant diseases will add to the risk of crop losses. The productivity of rangelands and pastures would also be affected. For example, livestock would become costlier if agricultural disruption leads to higher grain prices. In general, it seems that intensively managed livestock systems will adapt more easily to climate change than crop systems.

Sea levels, Oceans and Coastal Areas

The global average sea level has risen by 10 to 20 cm over the past 100 years. The rate of increase has been 1 – 2 mm per year – some 10 times faster than the rate observed for the previous 3,000 years. It is likely that much of this rise is related to an increase of 0.6±0.2°C in the lower atmosphere's global average temperature since 1860. Related effects now being detected include warming sea-surface temperatures, melting sea ice, greater evaporation, and changes in the marine food web.

Models project that sea levels will rise another 9 to 88 cm by the year 2100. This will occur due to the thermal expansion of warming ocean water and an influx of freshwater from melting glaciers and ice. Coastal zones and small islands are extremely vulnerable. Flooding and coastal erosion would worsen. Salt-water intrusion will reduce the quality and quantity of freshwater supplies. Higher sea levels could also cause extreme events such as high tides, storm surges, and seismic sea waves (tsunami) to reap more destruction. Rising sea levels are already contaminating underground fresh water supplies in Israel and Thailand, in small atolls scattered across the Pacific and Indian Ocean and the Caribbean Sea, and in some of the world's most productive deltas such as China's Yangtze Delta and Vietnam's Mekong Delta.

Sea-level rise could damage key economic sectors making fisheries, aquaculture and agriculture particularly vulnerable. Other sectors most at risk are tourism, human settlements, and insurance (which has already suffered record losses recently due to extreme climate events). The expected sea-level rise would inundate much of the world's lowlands, damaging coastal cropland and displacing millions of people from coastal and small-island communities. Valuable coastal ecosystems will be at serious risk. Coastal areas contain some of the world's most diverse and productive ecosystems, including mangrove forests, coral reefs, and sea grasses. Low-lying deltas, coral atolls and reefs are particularly sensitive to changes in the frequency and intensity of rainfall and storms. Corals generally grow fast enough to keep pace with sea-level rise but may be damaged by warmer sea temperatures.

Biological Diversity

Biological diversity – the source of enormous environmental, economic and cultural value will be threatened by rapid climate change. The composition and geographic distribution of ecosystems will change as individual species respond to new conditions created by climate change. At the same time, habitats may degrade and fragment in response to other human pressures. Species that cannot adapt quickly enough may become extinct – an irreversible loss.

Forests play an important role in the climate system. They are a major reservoir of carbon, containing some 80 per cent of all the carbon stored in land vegetation, and about 40 per cent of the carbon residing in soils. Large quantities of carbon may be emitted into the atmosphere during transitions from one forest type to another if mortality releases carbon faster than regeneration and growth absorbs it.

Deserts, and arid and semi-arid ecosystems may become more extreme. With few exceptions, deserts are projected to become hotter but not significantly wetter. Higher temperatures could threaten organisms that now exist near their heat-

tolerance limits. Rangelands may experience altered growing seasons. Grasslands support approximately 50 per cent of the world's livestock and are also grazed by wildlife. Shifts in temperatures and precipitation may reshape the boundaries between grasslands, shrublands, forests and other ecosystems. In tropical regions such changes in the evapo-transpiration cycle could strongly affect productivity and the mix of species.

Mountain regions are already under considerable stress from human activities. The projected decline in mountain glaciers, permafrost and snow cover will further affect soil stability and hydrological systems (most major river systems start in the mountains). As species and ecosystems are forced to migrate uphill, those limited to mountain tops may have nowhere to go and become extinct. Agriculture, tourism, hydropower, logging, and other economic activities will also be affected.

Water Resources

Climate change will not only lead to more precipitation but also to more evaporation. In general, this acceleration of the hydrological cycle will result in a wetter world. Precipitation will probably increase in some areas and decline in others. Making regional predictions complicated by the extreme complexity of the hydrological cycle: a change in precipitation may affect surface wetness, reflectivity, and vegetation, which would then affect evapo-transpiration and cloud formation, which in turn would affect precipitation. In addition, the hydrological system is responding not only to changes in climate and precipitation but also to human activities such as deforestation, urbanization, and the over-use of water supplies.

Many climate models suggest that downpours will in general become more intense. This would increase runoff and floods while reducing the ability of water to infiltrate the soil. Changes in seasonal patterns may affect the regional distribution of both ground and surface water supplies. At the local level, the vegetation and physical properties of the catchment area will further influence how much water is retained. High-latitude regions may see more runoff due to greater precipitation. Runoff would also be affected by a reduction in snowfall, deep snow and glacial ice, particularly in spring and summertime when it is traditionally used for hydroelectricity and agriculture. Reservoirs and wells would be also affected. Surface water storage could decline as extreme rainfall and landslide encourage siltation and thus reduces reservoir capacity. An increase in extreme rainfall and flooding could also lead to more water being lost as run-off. In the longer term this could also affect aquifers. Reduced water supplies would place additional stress on people, agriculture, and the environment. Climate change will exacerbate the stress caused by pollution, the growing population and the economy. The most vulnerable regions are arid and semi-arid areas, some low-lying coasts, deltas and small islands.

Gangotri is Shrinking Every Year

A new study conducted by World Wide Fund for Nature (WWF) reveals that carbon dioxide, blamed for global warming, is not only affecting our population area but also adversely changing the mountain glacial pattern. Himalayan glaciers, including the Gangotri, are receding at among the fastest rates in the world 10 to 15 meters per year on average. Particularly, the Gangotri glacier is receding at an average rate of 23 meters per year. Himalayan glaciers are among the fastest retreating glaciers globally due to the effect of global warming. This will eventually result in water shortage for hundreds of millions of people who rely on glacier-dependent rivers in India, China and Nepal. Himalayan glaciers feed seven of Asia's greatest rivers - Ganga, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huang Ho. The rapid melting of Himalayan glaciers will first increase the volume of water in rivers using widespread flooding, but in a few decades this situation will change and the water level in rivers will decline meaning massive economic and environmental problems for people in Northern India, Western China and Nepal.

Corals in Trouble

By increasing the acidity levels of oceans, global warming could spell doom for corals by 2065. The level of carbon dioxide (CO^2) - the main culprit behind global warming - is very high. Most of this will eventually be absorbed by sea water, where it will react to form carbonic acid. The normal acidity of the ocean is around pH8, but because of the above process it will become 74. This increased acidification could have a particularly detrimental effect on corals and

other marine organisms, because it reduces the availability of carbonate ions in the water, which is used by corals to build coral reefs. There are 78,000 gigatonnes of carbon locked up in the ocean sediments compared with 750 gigatonnes of carbon in the atmosphere. Global warming could have very serious implications for the water bodies, but unfortunately the climate change research has primarily concentrated on its impact on land and atmosphere.

Infrastructure, Industry and Human Settlements

Climate change will affect human settlements. Settlements that depend heavily on commercial fishing, subsistence agriculture or on natural resources are particularly vulnerable. Though climate change will have less impact on this sector than on economic development, echnological change and other social and environmental forces, it is likely to exacerbate the total stress on settlements. Infrastructure will become more vulnerable to flooding and landslides. Tropical cyclones are expected to become more destructive in some areas.

Warming, dryness and flooding could undermine water supplies. Settlements in regions that are already water-deficient – including much of North Africa, the Middle East, Southwest Asia, portions of western North America and some Pacific islands, can be expected to face still-higher demands for water as the climate warms. There are no obvious low-cost ways to obtain increased freshwater supplies in many of these regions. In some regions, repeated flooding could create problems with water quality.

Sea-level rise will affect coastal infrastructure and resource-based industries. Many coastlines are highly developed and contain human settlements, industry, ports and other infrastructure. Many of the most vulnerable regions include some small island nations, low-lying deltas, developing countries and densely populated coasts that currently lack extensive sea and coastal defense systems. Several industries such as tourism and recreation – the principal earners for many island economies, are particularly dependent on coastal resources.

Islands in Danger

The pacific island nations of Tuvalu, Kiribati, Nauru, Niue, the Marshall islands and the Cook islands may all be wiped out in 50 years due to global warming. The rise in world temperature means a higher melting rate of glaciers and thus release of more water which had hitherto been trapped in the from of ice in the continents. This release of more water from glaciers has led to a rise in sea level and is threatening the very existence of these tiny islands.

The precarious position of these islands can be gauged from the fact that Tuvalu is just five metres above sea level at its highest point.

The six island nations met at the Annual Pacific Islands Forum and came down heavily on the US for not signing the Kyoto Protocol. The issue was discussed at the Earth Summit held in Johannesburg from August 26, to September 4, 2002. Tuvalu is contemplating suing the US and Australia over their failure to ratify the Kyoto Protocol.

Climate Disasters and Extreme Events

Climate change is expected to increase the frequency and severity of heat waves. More hot weather will cause more deaths and illnesses among the elderly and the urban poor. Together with increased summer drying, it will lead to greater heat stress for livestock and wildlife, more damage to crops, more forest fires and more pressure on water supplies. Other likely impacts are a shift in tourist destinations and a boost in demand for energy. More intense rainfall events may lead to greater flooding in some regions. In addition to floods, this could contribute to more landslides, avalanches and soil erosion.

Major climate patterns could shift. Although centered in the Southern Pacific, the El Nino/ Southern Oscillation (ENSO) phenomenon affects the weather and climate in much of the tropics. Climate change could intensify the droughts and floods that are associated with El Niño events in these regions. Similarly, new patterns could emerge for the Asian summer monsoon, which affects large areas of temperate and tropical Asia. Likely impacts would include a greater annual variability in the monsoon's precipitation level, leading to more intense floods and droughts.

WORLD RESPONSE

The First World Climate Conference recognized climate change as a serious problem in 1979. This scientific gathering explored how climate change might affect human activities. It issued a declaration calling on the world's governments "to foresee and prevent potential man-made changes in climate that might be adverse to the well-being of humanity." It also endorsed plans to establish a World Climate Programme (WCP) under the joint responsibility of the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP) and the International Council of Scientific Unions (ICSU).

A number of intergovernmental conferences focusing on climate change were held in the late 1980s and early 1990s. Together with increasing scientific evidence, these conferences helped to raise international concern about the issue. The key events were the Villach Conference (October 1985), the Toronto Conference (June 1988), the Ottawa Conference (February 1989), the Tata Conference (February 1989), the Hague Conference and Declaration (March 1989), the Noordwijk Ministerial Conference (November 1989), the Cairo Compact (December 1989), the Bergen Conference (May 1990), and the Second World Climate Conference (November 1990).

The Intergovernmental Panel on Climate Change (IPCC) released its First Assessment Report in 1990. Established in 1988 by UNEP and WMO, the Panel was given a mandate to assess the state of existing knowledge about the climate system and climate change; the environmental, economic, and social impacts of climate change; and the possible response strategies. In December 1990, the UN General Assembly approved the start of treaty negotiations. The Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change (FCCC) met for five sessions between February 1991 and May 1992. Facing a strict deadline – the June 1992 Rio "Earth Summit" negotiators from 150 countries finalized the Convention in just 15 months. The 1992 UN Framework Convention on Climate Change was signed by 154 states (plus the EC) at Rio de Janeiro. Twenty years after the 1972 Stockholm Declaration first laid the foundations of contemporary environmental policy, the Earth Summit became the largest-ever gathering of Heads of State. Other agreements adopted at Rio were the Rio Declaration, Agenda 21, the Convention on Biological Diversity and Forest Principles. The Convention entered into force on 21 March, 1994.

The Conference of the Parties (COP) held its first session in Berlin from 28 March - 7 April, 1995. They agreed that the commitments contained in the Convention for developed countries were inadequate and launched the "Berlin Mandate" talks on additional commitments. They also reviewed the first round of national communication and finalised much of the institutional and financial machinery needed to support action under the Convention in the years to come. COP-2 was held at the Palais des Nations in Geneva from 8 - 19 June 1996. The Kyoto Protocol was adopted at COP-3 in December 1997. Because there was not enough time to finalize all the operational details of how the Protocol would work in practice, COP-4, held in Buenos Aires from 2-13 November 1998, agreed a two-year Plan of Action for completing the Kyoto rulebook. The agenda of COP-5, which took place in Bonn from 15 October – 5 November, 1999, was based on this Plan. A political agreement on the operational rulebook for the Protocol was reached at COP-6. Meeting from 6 to 25 November, 2000, COP-6 made good progress but could not resolve all the issues in the time available. The meeting was suspended and then resumed from 16 to 27 July 2001 in Bonn. The resumed session reached agreement on the political principles of operational rulebook for the Kyoto Protocol. This agreement addressed the emission trading system, the Clean Development Mechanism, the rules for counting emission reduction from carbon "sinks." and the compliance regime. It also outlined a package of financial and technological support to help developing countries contribute to global action on climate change. The work of translating the Bonn Agreements into detailed legal texts was finalized at COP-7, which was held in Marrakech, Morocco, from 29 October to 9 November, 2001.

COP - 8 on climate change concluded in New Delhi on 1 November, 2002. After lots of efforts and several rounds of negotiations, the participating countries arrived at a near consensus to announce the Delhi Declaration. The issues on which there was no consensus were left out. Among the important points which were left out of Delhi Declaration were the issues of providing economic aid to countries most

severely affected by the global climate change. The emphasis on application of new technology in the field of energy was also left out due to the protests of the oil exporting countries. The Delhi Declaration is also noteworthy for its emphasis on the need for the United States, Russia and other developed countries, which are yet to ratify the Kyoto Protocol, on reduction of GHG emissions, at the earliest.

UNCONVENTION ON CLIMATE CHANGE

WARSAW MEET

The United Nations Climate Change Conference, COP19 or CMP9 was held in Warsaw, Poland from 11 to 23 November 2013.

The key outcomes of the Warsaw Convention are:

1. **Advancing the Durban Platform,** being the commitment to enter into a new climate agreement by 2015; The conference led to an agreement that all states would start cutting emissions as soon as possible, but preferably by the first quarter of 2015. It has set a pathway for governments to work on a draft text of a new universal climate agreement so it appears on the table at the next UN Climate change conference in Peru.

   In the context of 2015, countries decided to initiate or intensify domestic preparation for their intended national contributions towards that agreement, which will come into force from 2020. Parties ready to do this will submit clear and transparent plans well in advance of COP 21, in Paris, and by the first quarter of 2015.

   Countries also resolved to close the pre-2020 ambition gap by intensifying technical work and more frequent engagement of Ministers.

2. Establishing **the Warsaw Mechanism** for loss and damage associated with climate change impacts the conference also decided to establish an international mechanism to provide most vulnerable populations with better protection against loss and damage caused by extreme weather events and slow onset events such as rising sea levels.

3. The **Warsaw REDD+ Framework.** Under this the decisions have also been made on ways to help developing countries reduce greenhouse gas emissions from deforestation and the degradation of forests, which account for around one fifth of all human-generated emissions. The Warsaw Framework for REDD+ is backed by pledges of 280 million dollars financing from the US, Norway and the UK.

4. **Climate Financing Arrangements,**

   - ***Climate Finance***

In addition to those financial decisions relating to the REDD+ Framework, developments were also made in relation to the GCF and long term finance. Parties urged that predictable, adequate, sustainable and transparent funding was required to protect developing countries from the adverse effects of climate change.

- ***GCF***

The GCF is an independent body that is an operating entity of the financial mechanism of the UNFCCC. The aim of the fund is to provide financial resources to mitigation and adaptation activities in all developing countries.

At COP 17 in Durban, parties agreed that they would mobilise US$100 billion per year for the purposes of the GCF, yet no assurance or details were provided as to how this level of finance would be raised. The negotiations at Warsaw resulted in a commitment to mobilise these funds from a variety of public, private, bilateral and multilateral sources. The GCF decision calls for "ambitious and timely" contributions from developed countries that "should reach a very significant scale".

- ***Long-term Finance***

In relation to long-term finance, developed country parties are requested to prepare biennial submissions on their updated strategies and approaches for scaling up climate finance from 2014 to 2020.

- ***Adaptation Fund***

An Adaptation Fund was established as a mechanism under the Kyoto Protocol to finance concrete adaptation projects and programs in developing countries. At COP19, the UNFCCC acknowledged the progress made in building up the Adaptation Fund, with Austria, Belgium, Finland, France, Germany, Norway, Sweden and Switzerland having either paid or pledged US$100 million.

DOHA MEET

The 18th session of the COP to the UNFCCC held in Doha, Qatar which resulted in a set of decisions aimed at advancing the implementation of the UNFCCC and its Kyoto Protocol (KP) after 2012.

The key issues for the Doha conference were: amending the KP to implement the second commitment period under the Protocol; successfully concluding the work of the Bali Action Plan (BAP) within which there was urgent need for a clear path to climate finance; and planning the work under the Durban Platform (DP) for enhanced action.

The key outcomes are discussed below:

- It has been agreed that the KP, as the only existing and binding agreement under which developed countries commit to cutting emissions of GHGs, will enter a second commitment period that will run for eight years as of 1 January 2013. This decision has ensured that there will be no gap between the first commitment period under the KP ending on 31 December 2012 and the second one commencing on 1 January 2013.
- With the exception of Russia, New Zealand, Japan, and Canada, all other countries have entered into the second round, with some new countries joining as well. It has been agreed that the KP Parties will revisit their targets in 2014 with a view to increasing their ambition.
- Governments have agreed to speedily work towards a climate change agreement under DP applicable to all countries from 2020, to be adopted by 2015. Further governments have decided to find ways to scale up efforts before 2020 to meet the gap in global ambition for emissions reduction.
- The Work Programme on Long term Finance launched last year has been extended for another year to contribute to the ongoing efforts to scale up mobilization of climate finance.
- Developed countries have reiterated their commitment to deliver on promises of mobilizing US$100 billion both for adaptation and mitigation by 2020.
- Finance pledges of about $ 6 billion for period upto 2015 announced by Germany, the UK, France, Denmark, Sweden and the EU Commission.
- The EU will reduce its emissions by 20 per cent by 2020 compared to 1990.

DURBAN MEET 2011

All the countries at the UN climate change talks in Durban agreed to a work towards and adopt a new global pact, that would bring all major emitters-developed and developing-in its fold.

The agreements focus on four key areas:

1. The Kyoto Protocol (KP)
2. Green Climate Fund
3. A new agreement or treaty to come into effect in 2020 and
4. Technology Mechanism

The deal known as the Durban Platform for Enhanced Action requires that countries begin in 2012 to negotiate a new global regime for climate change. The new legal framework must be in place by 2015, and will be implemented from 2020. Most crucially, the Durban Platform does away with the differentiation between developed and developing countries, a move that India strongly opposed.

Kyoto Protocol: Second Commitment

African governments, the European Union and the G77 plus China argued in favour of making a second commitment to the Kyoto Protocol (KP) which expired at the end of 2012. They are in favour of KP because first of all, it imposes no obligations on developing nations and secondly because it is the only legally binding climate change treaty currently in effect.

European leaders have claimed the second commitment period to KP as one of their major successes, but as the world's biggest polluters, China and the United States, have not ratified the agreement.

The United States, Canada, Japan and several other industrialized countries rejected the second KP commitment period because they say it is based on the state of world economies in 1992 and is therefore out of date. These countries say they are fully committed to addressing the problems of global warming, but prefer to do so

in terms of the Cancun Agreements which require voluntary cut-backs of greenhouse gas emissions rather than the legally binding demands of the Kyoto Protocol.

Green Climate Fund (GCF)

Green Climate Fund consists of $100 billion annually from 2020. The GCF is aimed at channeling substantial sums of money from developed countries to those that are still developing. Much of this funding is directed at helping the poorer nations to adapt to changing climatic conditions brought on by climate change.

The GCF was agreed on in principle at the COP16 meetings held in Cancun, Mexico.

An agreement for 2020

The most difficult element of the Durban Platform was the negotiating process around a new treaty or agreement which is set to come into effect in 2020. Delegates agreed that the text of the new document would be ready for signing by 2015 and this would give the parties enough time to ratify the new agreement to come into effect in 2020.

Carbon Capture and Storage

The Durban talks ended six years of debate over whether and how the technology of carbon capture and storage could qualify for carbon offsets under the Clean Development Mechanism.

The Kyoto scheme rewards governments or companies who invest in clean energy projects in developing countries with carbon credits, which they can trade and sell for profit.

The new rules force project developers to put five percent of the carbon credits earned in a reserve, to be awarded to them only after site monitors have proved that no carbon dioxide has leaked from the underground store 20 years after the end of the crediting period.

Reduced Emissions from Deforestation and Degradation (REDD)

Delegates agreed to consider private funding and market-based mechanisms as options to finance the programme on reducing emissions from deforestation and forest degradation, paving the way for billions of dollars of private investment.

Technology Mechanism

The Durban Platform includes an agreement to create a Technology Mechanism. The purpose of this mechanism is to provide developing countries with appropriate technology to enable them to cope with the effects of climate change. The terms of reference for the operational arm of the Mechanism - the Climate Technology Centre and Network - are agreed, along with a clear procedure to select the host.

The future deal will replace the Kyoto Protocol, an existing legal framework that was enacted in 2007. Governments that are part of Kyoto, including the EU, agreed to a second commitment period to the protocol that will last five to eight years, though Russia, Japan and Canada have rejected the deal. The conference did not produce any immediate promises to further cut emissions blamed for climate change.

The Durban Platform as it stands now is clearly not a final document in the form usually produced at high level United Nations meetings, but it certainly provides a solid set of agreements that will enable the UNFCCC to continue to fight global warming.

The problem with the document is that only 35 countries have accepted limited legal obligations in terms of the second commitment to KP - and then only until 2017. Between 2017 and the expected implementation of a replacement for the Kyoto Protocol in 2020 - there will be absolutely no legally binding treaty in place to constrain the world's polluters.

The Durban meet on climate change seems to work out fine for India. The conference has decided on a roadmap to curb emissions of greenhouse-causing gases by both developing and advanced economies; the actual accord is to be firmed up by 2015 and take effect in 2020. The plan to fund green technologies for low-income economies also makes perfect sense. It would be impossible for India to cut absolute levels of emissions, but it is eminently possible and desirable for India to reduce the carbon intensity of its growth and curb emissions that cause global warming. Adopting green, environment-friendly technologies and practices would improve competitive advantage and shore up energy efficiency.

CANCUN SUMMIT 2010

The Cancun Agreements are a set of significant decisions by the international community to address the long-term challenge of climate change collectively and comprehensively over time and to take concrete action now to speed up the global response.

The agreements, reached on December 11 in Cancun, Mexico, at the 2010 United Nations Climate Change Conference represent key steps forward in capturing plans to reduce greenhouse gas emissions and to help developing nations protect themselves from climate impacts and build their own sustainable futures.

There was progress in several key areas in Cancun, which enabled decisions on core issues. In particular, the Cancun Agreements bring countries' greenhouse gas (GHG) emissions reduction targets under the UNFCCC process, ensure greater transparency in emissions reporting by all countries, and establish a "Green Climate Fund" to help facilitate financial support to developing countries.

What made Cancun summit successful?

- In contrast to Copenhagen, the majority of countries described the process run by the Mexican presidency as transparent, enabling a basis of trust to underpin the negotiations. Countries felt they were consulted in an inclusive manner throughout 2010 and were not worried that a "secret text" would emerge and trump their work in Cancun. This trust was fundamental to reaching agreement.
- A year after the decisions made by heads of state and government in Copenhagen, negotiators and ministers were able, throughout 2010 and in Cancun, to build on the political guidance they received to focus on operational details. This was most evident regarding the targets and actions that had been put on the table in Copenhagen, thus making Cancun about how to incorporate those targets and actions rather than what they would be.
- Major negotiating blocks and key countries were able to see at least one of their top priorities in the final agreement while remaining flexible on other pieces to find common ground. The Conference of the Parties (COP) Presidency managed to put together a package that required everyone to compromise, but not so much that a country could not agree to the final package.
- With other international priorities in the background, China and the United States were in a much more cooperative mode, avoiding blame games in the media and focusing on getting the job done.
- India tabled proposals that became central to the agreement, putting its Minister in a key leadership position in the lead-up to and during the meeting.

Cancun Agreements

The Cancun Agreements are made up of a set of decisions under two tracks, the Kyoto Protocol (KP track) and the UNFCCC, known as the Ad Hoc Working Group on Long-term Cooperative Action (or LCA track). Success was only possible when progress was shown under both tracks.

a) The Kyoto Protocol

With the first commitment period of the Kyoto Protocol on course to end in 2012, many countries wanted a second commitment period agreed to in Cancun. The Kyoto Protocol, adopted in 1997, includes economy-wide targets for Annex I Parties (i.e. all developed countries, except for the United States). Although Cancun did not reach agreement on a second commitment period, there were a number of steps taken that demonstrated progress under the Kyoto track and signal a way forward.

Annex I Parties as a group would have to reduce emissions in a range of 25-40 percent below 1990 levels by 2020. Urges developed countries to increase their level of ambition in reducing their greenhouse gas emissions.

b) Shared Vision

A shared long-term vision for the Cancun Agreements includes a goal to limit average global temperature warming below 2ºC in comparison to pre-industrial levels. It further recognizes the need to strengthen this goal, based on scientific advancements, and to consider a 1.5ºC goal at a future date.

c) Developed Country Emission Reduction Targets:

All **developed countries put forward "pledges" of GHG emission reduction targets.**

The COP decision in Cancun takes note of developed country, or Annex I Party, quantified economy-wide emissions reduction targets. The decision further urges Parties to increase their ambition on emission reductions.

The Cancun decision also sets in motion a process "for international assessment of emissions and removals related to quantified economy-wide emission reductions targets" for Annex I Parties. This should be done in a "rigorous, robust and transparent manner, with a view to promoting comparability and building confidence." The text goes on to focus on the issues of land-use, land-use change and forestry (LULUCF) and carbon credits from market-based mechanisms as key issues, taking into account international experience, i.e. the Kyoto Protocol and other agreements.

d) Developing Country Actions:

Developing countries were invited to submit information related to the estimated costs and emission reductions related to nationally appropriate mitigation actions. Developing countries were encouraged to develop low-carbon strategies or plans in the context of sustainable development.

e) Transparency and Reporting:

The Cancun Agreements create a new standard for transparency in which all major economies, including the United States and China, as countries will report on the progress they are making in meeting their national climate targets or actions.

In addition to the accounting provisions around the targets and the international assessment provisions and work plan for Annex I Parties noted above, developed countries have agreed to enhance reporting of their support to developing countries in the form of finance, technology and capacity building. Such contributions will be submitted through common reporting formats.

In return, developing countries have agreed to strengthen reporting on their mitigation actions and to accept "international consultation and analysis" of these actions. This will include not just reporting on the list of mitigation actions they wish to undertake, as was presented in the Copenhagen Accord, but also a review of the effect of these actions, along with the domestic provisions and timeline for implementation of these actions.

f) Finance:

In a major step forward for **climate finance,** the COP formalized the commitment made by developed countries in Copenhagen to mobilize $100 billion a year by 2020 to address the mitigation and adaption needs of developing countries. The Cancun Agreements include the establishment of a "Green Climate Fund," which will manage a portion of this funding. It was agreed that the Climate Fund will be composed of a Board with equal representation of developed and developing countries, though many details still remain.

g) Adaptation:

The Cancun Agreements create a new Climate Adaptation Framework and an associated Adaptation Committee. Together, these committees raise the **importance of adaptation** within the UNFCCC, and should make possible a more coherent, action-oriented treatment of adaptation.

More specifically, the Cancun Adaptation Framework identifies a broad set of priority areas for action on adaptation by Parties, including:

a) The development of plans, projects and programmes;

b) Strengthening institutions;

c) Improving research, observation and information management systems;

d) Impact, vulnerability and financial needs assessments; and

e) Adaptation technology.

h) Technology Mechanism:

The Cancun Agreements create a new Technology Mechanism, which is a significant step forward for **international technology cooperation.** It underlines that countries intend to elevate the importance of development and deployment of the clean technologies within the climate framework.

The mechanism will have two components, the Technology Executive Committee (TEC) and the Climate Technology Center and Network (CTCN). While the TEC can start its work immediately, negotiators will still need to

determine the detailed modalities for the CTCN next year.

The new TEC will consist of 20 experts - 11 from developing and 9 from developed countries - who will identify technology needs, coordinate international efforts, and make recommendations to make them more effective. To show they are serious about this new body, parties now need to nominate high-level experts for the committee. As they further refine the technology mechanism in 2011, they could also develop stronger qualification criteria to ensure TEC members have the expertise needed.

The CTCN will consist of a small center and large network, probably including regional units. This reflects the negotiators intent to create a mechanism that is nimble, builds on existing initiatives and coordinates them better. Where the center will be, what the network will look like, and how they will operate and interact still needs to be defined in 2011. Technology negotiators have put these questions in their work plan for next year, but it will be challenging to resolve them all.

COPENHAGEN SUMMIT 2009

The 15th session of the Conference of the Parties to the UNFCCC and the 5th session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol took place in Copenhagen and was hosted by the Government of Denmark.

The Copenhagen Climate Change Conference raised climate change policy to the highest political level. The Copenhagen Conference marked the culmination of a two-year negotiating process to enhance international climate change cooperation under the Bali Roadmap, launched by COP 13 in December 2007.

COP 15 / CMP 5 was a crucial event in the negotiating process as:

- It significantly advanced the negotiations on the infrastructure needed for effective global climate change cooperation, including improvements to the Clean Development Mechanism of the Kyoto Protocol.
- Significant progress was made in narrowing down options and clarifying choices needed to be made on key issues later on in the negotiations.
- It produced the Copenhagen Accord, which expressed clear a political intent to constrain carbon and respond to climate change, in both the short and long term.

Key points of the Copenhagen Accord

The Copenhagen Accord contained several key elements on which there was strong convergence of the views of governments.

- A commitment "to reduce global emissions so as to hold the increase in global temperature below 2ºC" and to achieve "the peaking of global and national emissions as soon as possible"
- Developed countries must make commitments to reduce greenhouse gas emissions, and developing countries must report their plans to curb greenhouse gas emissions to the UN by 31 January 2010.
- New and additional resources "approaching $30bn" will be channelled to poorer nations over the period 2010-12, with an annual sum of $100bn envisaged by 2020.
- A Copenhagen Green Climate Fund will be established under the UN convention on climate change, to direct some of this money to climate-related projects in developing countries.
- Projects to reduce greenhouse gas emissions in developing countries will be subject to international monitoring if they are internationally funded.
- Programmes to provide developing countries with financial incentives to preserve forests - **REDD** and **REDD-plus** - will be established immediately.
- Implementation of the accord will be reviewed in 2015 and an assessment will be made of whether the goal of keeping global temperature rise within 2ºC needs to be strengthened to 1.5ºC.

On the positive side, the Copenhagen Accord, for the first time, unites the US, China and other major developing countries in an effort to curb global greenhouse gas emissions. The Kyoto Protocol called on developed countries to reduce emissions but did not demand reductions from developing countries. Major polluting developing countries, including **China, India, South Africa, and Brazil,** are now poised to make transparent emissions reductions or

reductions in pollution rates. This is the first time that developing countries have agreed to binding emission reductions in an international agreement. This represents a major shift from the schism between developed and developing countries that blocked progress in the past. The accord also says developed countries will aim to mobilize $100bn per year by 2020, to address the needs of developing countries.

On the other hand, the summit did not result in a legally binding deal or any commitment to reach one in future. The accord calls on countries to state what they will do to curb greenhouse gas emissions, but these will not be legally binding commitments. Furthermore, there is no global target for emissions reductions by 2050 and the accord is vague as to how its goals - such as the $100bn of funds annually for developing countries - will be achieved.

The **leading voices of opposition to the Accord came from Venezuela, Sudan, Bolivia, Nicaragua, and Cuba.** The first three nations are oil-producing states that would lose major revenue if countries reduce their global warming pollution by using less oil. The latter two nations are clients of Venezuela that must carry favour with their patron. The ability of a handful of petro-states to block the Accord from being endorsed by the entire U.N. Framework Convention on Climate Change at Copenhagen suggests the flawed nature of the United Nations process that requires unanimity among 193 nations. Their opposition will not stop those signing onto the Accord from moving forward and carrying out its mandate, but many observers believe that the outcome of this meeting suggests that alternative venues, such as the Major Economies Forum, which includes the world's largest developed and developing nations polluters, **can and should** play a larger role in the design and implementation of future agreements.

BALI ROAD MAP 2007

The Bali Road Map was adopted at the 13th Conference of the Parties and the 3rd Meeting of the Parties in December 2007 in Bali. COP13 and COP/MOP3 succeeded in establishing a framework for negotiations to create an agreement that would replace the Kyoto protocol as of 2012 that is essential to reaching a secure climate future.

The Bali Road Map includes the Bali Action Plan, which charts the course for a new negotiating process designed to tackle climate change. The Bali Action Plan is a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012, in order to reach an agreed outcome and adopt a decision.

The Convention track included the establishment of an Ad Hoc Working Group on Long-Term Cooperative Action which will provide its conclusions on the "full, effective and sustained implementation of the Convention." The Kyoto Protocol track signed the continuation of the work of the AWG which is required to provide recommendations to COP/MOP5 for adoption of new commitments for Annex I Parties.

The Bali Action Plan did not introduce binding commitments to reduce greenhouse gas emissions but included the request for developed countries to contribute to the mitigation of global warming in the context of sustainable development. In addition, the Bali Action Plan envisaged enhanced actions on adaptation, technology development and on the provision financial resources, as well as measures against **deforestation.**

The Bali Action Plan was divided into five main categories: shared vision, mitigation, adaptation, technology and financing. The shared vision refers to a long-term vision for action on climate change, including a long-term goal for emission reductions. The main focus of the negotiations under the KP is to decide what to do when its first commitment period expired.

KYOTO PROTOCOL

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997. Due to a complex ratification process, it entered into force on 16 February 2005.

It commits industrialized countries to stabilize greenhouse gas emissions based on the principles of the Convention.

Kyoto Protocol has set binding emission reduction targets for 37 industrialized countries and the European community. Overall, these targets add up to an average five per cent emissions reduction compared to 1990 levels over the five-year period 2008 to 2012.

It was structured on the principles of the Convention. It only binds developed countries because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere, which are the result of more than 150 years of industrial activity. It placed a heavier burden on developed nations under its central principle: that of "common but differentiated responsibility".

- **Monitoring Emission Targets**

The targets cover emissions of the six main greenhouse gases, namely:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulphur hexafluoride (SF_6)

Country	**Target (1990 - 2008/2012)**
EU-15, Bulgaria, Czech Republic, Estonia, Latvia, Liechtenstein, Lithuania, Monaco, Romania, Slovakia, Slovenia, Switzerland	-8%
US	-7%
Canada, Hungary, Japan, Poland	-6%
Croatia	-5%
New Zealand, Russian Federation, Ukraine	0
Norway	+1%
Australia	+8%
Iceland	+10%

The goals of Kyoto were to see participants collectively reducing emissions of greenhouse gases by 5.2% below the emission levels of 1990 by 2012.

While the 5.2% figure is a collective one, individual countries were assigned higher or lower targets and some countries were permitted increases.

Under the Protocol, countries' actual emissions have to be monitored and precise records have to be kept of the trades carried out. This included:

Registry system tracks and records transactions committed by Parties. The UN Climate Change Secretariat, based in Bonn, Germany, keeps an **international transaction** log to verify that transactions are consistent with the rules of the Protocol.

Reporting is done by Parties by way of submitting annual emission inventories and national reports under the Protocol at regular intervals.

A **compliance** system ensures that Parties are meeting their commitments and helps them to meet their commitments if they have problems doing so.

- **The Kyoto Mechanisms**

Under the Treaty, countries must meet their targets primarily through national measures. However, the Kyoto Protocol offers them an additional means of meeting their targets by way of three market-based **mechanisms.**

The Kyoto Protocol has put in place three flexibility mechanisms to reduce emission of Green House Gases. Although the Protocol places maximum responsibility of reducing emissions on the developed countries by committing them to specific emission targets, the three mechanisms are based on the premise that reduction of emissions in any part of the globe will have the same desired effect on the atmosphere, and also that some developed countries might find it easier and more cost effective to support emissions reductions in other developed or developing countries rather than at home.

The three mechanisms are **Joint implementation, Emissions Trading** and **Clean Development mechanisms**

Joint Implementation

Through the Joint Implementation, any Annex I country can invest in emission reduction projects (referred to as joint implementation project) in any other Annex I country as an alternative to reducing emissions domestically.

Two early examples are change from a wet to dry process at a Ukraine cement works, reducing energy consumption by 53 per cent by 2008-2012; and rehabilitation of a Bulgarian hydropower project, with a 267,000 ton reduction of CO_2 equivalent during 2008-2012.

Emissions Trading

Emissions trading are a market-based approach used to control **pollution** by providing **economic incentives** for achieving reductions in the emissions of **pollutants.**

Under Kyoto protocol a limit or cap on the amount of a pollutant that can be emitted was limited for the countries. The limit or cap is allocated or sold to firms in the form of emissions permits which represent the right to emit or discharge a specific volume of the specified pollutant. The total number of permits cannot exceed the cap. Firms that need to increase their emission permits have to buy permits from those who require fewer permits.

The transfer of permits is referred to as a **trade.** In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions.

Clean Development Mechanism

The Clean Development Mechanism (CDM) allows developed country with an emission reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission reduction project in developing countries as an alternative to more expensive emission reductions in their own countries. In exchange for the amount of reduction in emission thus achieved, the investing gets carbon credits which it can offset against its Kyoto targets. The developing country gains a step towards sustainable development.

To get a CDM project registered and implemented, the investing country' has to first take approval from the designated national authority in the host country, establish. "Additionally", define baselines and get the project validated by a third party agency, called a Designated Operational Entity (DOE). The Executive Body of CDM registers the project and issues credits, called Certified Emission Reductions (CERs) or carbon credits, where each unit is equivalent to the reduction of one metric tonne of CO_2 or its equivalent. There are more than 4200 CDM projects in the pipeline as on 14.3.2010. The expected CERs till the end of 2012 was 2,900,000,000

The "Additionality" clause in a CDM project

The feature of "additionality" is a crucial element of CDM project it means that the industrialized country that is seeding to establish the CDM project in the developing country and earns carbon credit from it has to establish that the planned carbon reductions would not have occurred on its own, in the absence of the CDM project. They have to establish a baseline of the project. Which is the emission level that would have been there in the absence of the project? The difference between this baseline level and the (lower) emission level achieved as a result of the project is the carbon credit due to the investing country i.e. CER units generated under the CDM will only be recognized when the reductions of greenhouse gas emissions are additional to any that would occur in the absence of the certified project activity.

The risk of "false Credits" is a cause for concern with regard to CDM projects i.e. a project does not actually offer an additionality and the reduction in emission would have happened anyway even without the project.

The mechanisms help stimulate green investment and help Parties meet their emission targets in a cost-effective way.

- **Adaptation**

The Kyoto Protocol, like the Convention, is also designed to assist countries in adapting to the adverse effects of climate change. It facilitates the development and deployment of techniques that can help increase resilience to the impacts of climate change.

The **Adaptation Fund** was established to finance adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol. The Fund is financed mainly with a share of proceeds from CDM project activities.

The Kyoto Protocol is generally seen as an important first step towards a truly global emission reduction regime that will stabilize GHG emissions, and provide the essential architecture for any future international agreement on climate change.

By the end of the first commitment period of the Kyoto Protocol in 2012, a new international framework needs to have been negotiated and ratified that can deliver the stringent emission reductions, the **Intergovernmental Panel on Climate Change (IPCC)** has clearly indicated, are needed.

While almost every country in the world has signed the Kyoto Protocol, the signature alone is symbolic; a token gesture of support. Ratification

carries legal obligations and effectively becomes a contractual arrangement.

Australia negotiated hard when the Kyoto Protocol was being developed; in fact it was to be allowed an 8% increase in emissions. The excuse - it will be bad for Australia's economy, the same reasoning the USA uses.

Annex I, Annex II countries and Developing Countries

Parties to UNFCCC are classified as:

Annex I countries - industrialized countries and economies in transition.

Annex II countries - developed countries which pay for costs of developing countries.

Annex I countries which have ratified the Protocol have committed to reduce their emission levels of greenhouse gases to targets that are mainly set below their 1990 levels. They may do this by allocating reduced annual allowances to the major operators within their borders. These operators can only exceed their allocations if they **buy emission allowances,** or offset their excesses through a mechanism that is agreed by all the parties to UNFCCC. Annex II countries are a sub-group of the Annex I countries. They comprise the **OECD** members, excluding those that were **economies in transition** in 1992.

Developing countries are not required to reduce emission levels unless developed countries supply enough funding and technology. Setting no immediate restrictions under UNFCCC serves three purposes:

it avoids restrictions on their development, because emissions are strongly linked to industrial capacity

they can sell emissions credits to nations whose operators have difficulty meeting their emissions targets

they get money and technologies for low-carbon investments from Annex II countries.

Developing countries may volunteer to become Annex I countries when they are sufficiently developed.

RIO EARTH SUMMIT 1992

The United Nations Conference on Environment and Development (UNCED) took place in 1992 in Rio de Janeiro, Brazil. Government officials from 178 countries and between 20,000 and 30,000 individuals from governments, NGOs and the media participated in this event to discuss solutions for global problems such as poverty, war or the growing gap between industrialised and developing countries. It emphasises that economic and social progress depends critically on the preservation of the natural resource base with effective measures to prevent environmental degradation.

The UN summit focused on three broad concepts: An "Earth Charter" covering a number of principles aiming at development and the protection of the environment. Secondly, "**Agenda 21**" was intended to be a global action plan for sustainable development; thirdly, developing countries demanded a substantial increase in new **funding from developed countries** to contribute to sustainable development in the South.

Negotiations attempted to reach agreements at least on the broad outlines of several conventions **covering climate change, biological diversity, forests, etc.** Especially representatives from developing countries emphasised at Rio the importance of their right to economic development, which goes together with growing impacts on the environment, so that industrialised countries have a special responsibility for the realisation of the global environmental goals stated at UNCED.

Outcomes of the Rio Earth Summit

Generally, Rio 1992 gave a good impulse to the further development of international environmental law. Six conventions came out of Rio 1992 some of which have been converted into the next and more decisive phase, namely protocols, from which point they would become ratified in their respective countries.

The Rio Declaration - a set of 27 principles designed to commit government to ensure environmental protection and responsible development and intended to be an Environmental Bill of Rights. It established the "Precautionary principle" and the principle of "common but differentiated responsibilities".

The United Nations Framework Convention on Climate Change (UNFCCC), including the **Kyoto Protocol** from 1997 -- an international agreement aimed at the stabilization of atmospheric concentrations of global greenhouse

gases to prevent dangerous climate change as a result of anthropogenic greenhouse gas emissions.

The United Nations Convention on Biological Diversity, including the **Cartagena Protocol on Bio-safety** -- an international agreement to conserve biological species, genetic resources, habitats and ecosystems; to ensure the sustainable use of biological materials; and to provide for the fair and equitable sharing of benefits derived from genetic resources.

The Rio Forestry Principles - Fifteen non-binding principles for the protection and sustainable use of global forest resources proposed. These principles have often been regarded as a foundation for a process to negotiate and agree an International Forestry Convention.

The United Nations Convention to Combat Desertification - to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification. The convention was actually not a direct result of UNCED but was added after the conference. To date this convention has been ineffective for lack of a financing mechanism. A revitalisation could take place by expanding the thematic coverage of the Global Environmental Facility (GEF)

Agenda 21 - Undoubtedly it was the most important and complete document that came out of the Earth Summit. It has become the blueprint for sustainability and forms the basis for sustainable development strategies. Its recommendations range from news ways to educate, to new ways to care for natural resources and new ways to participate in shaping a sustainable economy. The overall objective of Agenda 21 was very ambitious for it was nothing less than designing a safe and just world with people in the South and North alike would live an equitable life within Earth's capacities.

The institutional result of the UNCED was the **Commission on Sustainable Development (CSD).** Agenda 21 called for the creation of the CSD to ensure effective follow-up of UNCED and further the process of constituting sustainable development. CSD was also meant to be the international body to monitor the implementation of Agenda 21. In addition, many countries set up sustainable development commissions and to develop national strategies for sustainable development.

Also in the wake of the Rio Earth summit processes were:

- **The Convention on Persistant Organic Pollutants (POPs)** which was signed by Germany and the USA on May 23, 2001; the POPs convention takes the lead on the ban of at least 8 of these dangerous organic substances including the insecticide DDT. The implementation of this ban in southern countries is faltering due to lack of financial means.
- The **Convention on Straddling and Highly Migratory Fish Stocks**
- The **Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.**

The Earth Summit succeeded in presenting new perspectives on economic progress. It was lauded as the beginning of a new era and its success would be measured by the implementation - locally, nationally and internationally - of its agreements.

Carbon Credit

A Carbon credit is a generic term meaning that a value has been assigned to a reduction or offset of greenhouse gas emissions. One carbon credit is equal to one ton of carbon dioxide, or in some markets, carbon dioxide equivalent gases. Carbon trading is an application of an **emissions trading** approach.

Carbon Footprint

Carbon footprint is a measure of the impact of our activities on the environment, and in particular on climate change. It relates to the amount of greenhouse gases we are producing in our day-to-day lives through burning fossil fuels for electricity, heating, transportation etc. Our 'carbon footprint' is a measurement of all greenhouse gases we individually produce. It is measured in units of tonnes (or kg) of **carbon dioxide** equivalent. A carbon footprint is the total set of greenhouse gases (GHG) emissions caused by an organization, event or product. For simplicity of reporting, it is often expressed in terms of the amount of carbon dioxide, or its equivalent of other GHGs, emitted.

A carbon footprint is made up of the sum of two parts, the primary foot print and the secondary footprint.

1. The primary footprint is a measure of our direct emissions of CO_2 from the burning of fossil fuels, including domestic energy consumption and transportation (e.g. car and plane). We have direct control of these.
2. The secondary footprint is a measure of the indirect CO_2 emissions from the whole lifecycle of products we use - those associated with their manufacture and eventual breakdown. To put it very simply - the more we buy the more emissions will be caused on our behalf. Our decisions on the following add up to our secondary footprint.

OTHER ENVIRONMENTAL TREATIES

a) Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental agreement on hazardous and other wastes. The Convention has 172 Parties and aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes. The Basel Convention came into force in 1992.

In the late 1980s, a tightening of environmental regulations in industrialized countries led to a dramatic rise in the cost of hazardous waste disposal. Searching for cheaper ways to get rid of the wastes, 'toxic traders' began shipping hazardous waste to developing countries and to Eastern Europe. When this activity was revealed, international outrage led to the drafting and adoption of the Basel Convention.

A central goal of the Basel Convention is 'environmentally sound management' (ESM), the aim of which is to protect human health and the environment by minimizing hazardous waste production whenever possible. ESM means addressing the issue through an integrated life-cycle approach, which involves strong controls from the generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal. Many companies have already demonstrated that cleaner production methods, which eliminate or reduce hazardous outputs, can be both economically and environmentally efficient.

Hazardous wastes comprise solid, liquid, or gas wastes that can cause death, illness or injury to people or destruction of the environment if improperly treated, stored, transported, or discarded.

The Strategic Plan for the implementation of the Basel Convention is the blueprint adopted by Parties in 2002 to give effect to the 1999 Basel Declaration on Environmentally Sound Management. It established priorities in terms of policy and programmes, selected priority waste streams and projects.

b) Stockholm Convention on Persistent Organic Pollutants

Stockholm Convention on Persistent Organic Pollutants is an international **environmental treaty** that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs).

Persistent Organic Pollutants (POPs) are organic chemical substances. They possess a particular combination of physical and chemical properties such that, once released into the environment, they:

remain intact for exceptionally long periods of time (many years);

become widely distributed throughout the environment as a result of natural processes involving soil, water and, most notably, air;

accumulate in the fatty tissue of living organisms, including humans, and are found at higher concentrations at higher levels in the food chain; and are toxic to both humans and wildlife.

POPs concentrate in living organisms through process of bioaccumulation. Though not soluble in water, POPs are readily absorbed in fatty tissue, where concentrations can become magnified up to 70,000 times the background levels. Fish, predatory birds, mammals, and humans are high up the food chain and so absorb the greatest concentrations. Specific effects of POPs can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders, and disruption of the immune system. Some POPs are also considered to be endocrine disrupters, which, by altering the hormonal system, can damage the reproductive and immune systems of exposed individuals as well as their offspring; they can also have developmental and carcinogenic effects.

The Stockholm Convention, which was adopted in 2001 and entered into force on 2004, requires Parties to take measures to eliminate or reduce the release of POPs into the environment. The Convention is administered by the United Nations Environment Programme and based in Geneva, Switzerland.

c) The Ramsar Convention

The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The treaty was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975.

The Convention's mission is being:

- the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.

- uses a broad definition of the types of wetlands covered in its mission, including lakes and rivers, swamps and marshes, wet grasslands and peatlands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans.

The Ramsar List of Wetlands of International Importance now includes 1,869 sites (known as Ramsar Sites) covering around 1,836,000 km², up from 1,021 sites in 2000. The nation with the highest number of sites is the **United Kingdom** at 168; the nation with the greatest area of listed wetlands is **Canada,** with over 130,000 km², including the **Queen Maud Gulf Migratory Bird Sanctuary** at 62,800 km².

What are wetlands?

Wetlands are areas where the water table is at or near the surface of the land, or where the land is covered by water. The Ramsar Convention takes a broad approach in determining the wetlands which come under its aegis.

Five major wetland types are generally recognized:

Marine (coastal wetlands including coastal lagoons, rocky shores, and coral reefs);

Estuarine (including deltas, tidal marshes, and mangrove swamps);

Lacustrine (wetlands associated with lakes);

Riverine (wetlands along rivers and streams); and

Palustrine (meaning "marshy" - marshes, swamps and bogs).

Why to conserve wetlands?

Wetlands are among the world's most productive environments. They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival. They support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. Wetlands are also important storehouses of plant genetic material.

Wetlands provide tremendous economic benefits, for example: water supply (quantity and quality); fisheries (over two thirds of the world's fish harvest is linked to the health of coastal and inland wetland areas); agriculture, through the maintenance of water tables and nutrient retention in floodplains; timber production; energy resources, such as peat and plant matter; wildlife resources; transport; and recreation and tourism opportunities.

d) Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES)

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

A specimen of a CITES-listed species may be imported into or exported (or re-exported) from a State party to the Convention only if the appropriate document has been obtained and presented for clearance at the port of entry or exit. There is some variation of the requirements from one country to another and it is always necessary to check on the national laws that may be stricter.

Roughly 5,000 species of animals and 28,000 species of plants are protected by CITES against over-exploitation through international trade. They include some whole groups, such as primates, cetaceans (whales, dolphins and porpoises), sea turtles, parrots, corals, cacti and orchids.

e) Vienna Convention (adopted in 1985, entered into force in 1988)

The Vienna Conference was the first international conference on ozone layer depletion. It aims at:

1. Protect human health and the environment against adverse effects resulting from human activities: The ultimate objective of the Convention is to protect human health and the environment against adverse effects resulting from human activities which modify or are likely to modify the ozone layer and urges the Parties to take appropriate measures in accordance with the provisions in the Convention and its Protocols which are in force for that Party.
2. Cooperate for better understanding: To achieve the aforementioned objectives, the Parties, within their capabilities, are expected to: cooperate to better understand and assess the effects of human activities on the ozone layer and the effects of the modification of the ozone layer; adopt appropriate measures and cooperate in harmonizing appropriate policies to control the activities that are causing the modification of the ozone layer; cooperate in the formulation of agreed measures for the implementation of this Convention; and cooperate with competent international bodies to implement effectively this Convention and protocols to which they are party.

What is Ozone?

Ozone is a form of oxygen. Oxygen occurs in three different forms in the atmosphere; as oxygen atoms (O), as oxygen molecules (O_2) and as zone (O_3). Ozone's unique physical properties allow the ozone layer to act as our planet's sunscreen, providing an invisible filter to help protect all life forms from the sun's damaging UV (ultraviolet)rays. Most incoming UV radiation is absorbed by ozone and prevented from reaching the Earth's surface. Without the protective effect of ozone, life on Earth would not have evolved the way it has.

What is Ozone Depletion?

Ozone depletion occurs when the natural balance between the production and destruction of stratospheric ozone is tipped in favour of destruction.Although natural phenomenon can cause temporary ozone loss, chlorine and bromine released from synthetic compounds is now accepted as the main cause of a net loss of stratospheric ozone in many parts of the world since 1980.There is strong evidence that global ozone depletion is occuring. The evidence is in the observations of the Antratic ozone "hole"and atmospheric records indicating seasonal declines in global ozone levels.

f) The Montreal Protocol on Substances that Deplete Ozone Layer (adopted, 1987; entered into force, 1989)

The Montreal Protocol on Substances that Deplete Ozone Layer is a protocol under the Vienna Convention. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere--chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform--are to be phased out.

Further the 'Multilateral Fund for the Implementation of the Montreal Protocol' provides funds to help developing countries to phase out the use of ozone-depleting substances. Funds are used, for example, to finance the conversion of existing manufacturing processes, train personnel, pay royalties and patent rights on new technologies, and establish national ozone offices.

g) Convention On Biological Diversity

The Convention on Biological Diversity (CBD) is an international legally-binding treaty with three main goals: **conservation of biodiversity; sustainable use of biodiversity; fair and equitable sharing of the benefits** arising from the use of genetic resources. Its overall objective is to encourage actions which will lead to sustainable future. The conservation of biodiversity is a common concern of humankind. The Convention on Biological Diversity Covers biodiversity at all levels: **ecosystems, species and genetic resources.**

It consists of two main protocols:

- The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international treaty governing the movements of living modified organisms (LMOs) resulting from modern biotechnology from one country to another. It was adopted on 29 January 2000 as a supplementary agreement to the

Convention on Biological Diversity and entered into force on 11 September 2003.

- The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity is an international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components. It was adopted by the Conference of the Parties to the Convention on Biological Diversity at its tenth meeting on 29 October 2010 in Nagoya, Japan.

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Man's relation with his natural environment is a complex one. While he is subject to certain natural controls and events, he also acts as the dominant force in many of the Earth's physical and biological systems. The relationship has changed with time. For thousands of years, the direction and extent of his progress were to a considerable measure dictated by his physical environment such as adverse climate, frequent disasters, food shortage, etc. Increasingly, man has become capable of altering his physical environment to suit himself. Although the object of these alterations was to improve his living conditions, in some cases they have created major long-term problems, and in still others they have been catastrophic, both for the natural environment and himself.

In some parts of the world, the environment has been so transformed that few elements of its original nature are detectable. Even extreme habitats such as the tundra or hot deserts only sparsely populated by man have not escaped untouched, since they are often the most sensitive to the slightest interference.

MODIFICATION OF LANDFORMS

Mining and quarrying, deforestation, the introduction of exotic plants and animals, the use of agricultural machinery, the building and use of tracks and roads, and the overgrazing of pastures, have all, singly and in combination, profoundly altered landforms and caused accelerated erosion and deposition to occur. Where man excavates or piles up material himself, he can be regarded as a direct agent of change; where he causes natural landform processes, such as wind and water action, to accelerate or diminish, he is acting in an indirect manner. Indirect effects are by far the most widespread. Much of this influence occurs accidentally or secondarily to some other purpose; conscious attempts to influence landform processes—for example, by building coastal groynes or by reforestation—are inevitably expensive and limited in extent.

Alteration of Landforms due to:

a) Mining

Mining, world over, has become an important input in the economic development of a mineral rich country. In addition to the general value-adding benefits of mining, a quality which it shares with many other businesses, mining has some special qualities which enable it to serve as a springboard for countries seeking to industrialise. Mining is at the beginning of the value chain and has a capacity to kick start economic development that few other businesses offer. It does not require a sophisticated supply chain in the country in which it takes place, as manufacturing so often does, and it does not require developed local markets.

The process of mining from discovery of an ore body through extraction of minerals and finally to returning the land to its natural state consists of several distinct steps.

The first is discovery of the ore body, which is carried out through prospecting or exploration to find and then define the extent, location and value of the ore body. This leads to mathematical resource estimation to estimate the size and grade of the deposit. This estimation is used to conduct a pre-feasibility study to determine the theoretical economics of the ore deposit. This identifies, early on, whether further investment in estimation and engineering studies is warranted and identifies key risks and areas for further work.

The next step is to conduct a feasibility study to evaluate the financial viability, technical and financial risks and robustness of the project. This includes mine planning to evaluate the economically recoverable portion of the deposit, the metallurgy and ore recoverability, marketability and pay ability of the ore concentrates, engineering concerns, milling and infrastructure costs, finance and equity requirements and an analysis of the proposed mine from the initial excavation all the way through to reclamation. The proportion of a deposit that is economically recoverable is dependent on the enrichment factor of the ore in the area.

Once the analysis determines a given ore body is worth recovering, development begins to create access to the ore body. The mine buildings and processing plants are built. The operation of the mine to recover the ore begins and continues as long as the company operating the mine finds it economical to do so. Once all the ore that the mine can produce profitably is recovered, reclamation begins to make the land used by the mine suitable for future use.

Each phase of mining is associated with different sets of environmental impacts.

Exploration: Step 1

Information about the location and value of the mineral ore deposit is obtained during the exploration phase. This phase includes surveys, field studies, and drilling test boreholes and other exploratory excavations.

The exploratory phase may involve clearing of wide areas of vegetation (typically in lines), to allow the entry of heavy vehicles mounted with drilling rigs. Many countries require a separate EIA for the exploratory phase of a mining project because the impacts of this phase can be profound and because further phases of mining may not occur if exploration fails to find sufficient quantities of high-grade mineral ore deposits.

Development: Step 2

If the mineral ore exploration phase proves that there is a large enough mineral ore deposit, of sufficient grade, then the development of the mine occurs. This phase of the mining project includes

Construction of roads and houses for employees

The construction of access roads either to provide heavy equipment and supplies to the mine site or to ship out processed metals and ores, can have substantial environmental impacts, especially if access roads cut through ecologically sensitive areas or are near tribal areas.

If a mine site is located in a remote, undeveloped area, the housing project for the settlement of employees will be needed. This will lead to clearing of vast ecological site and thus in return will affect environment.

Active mining: Step 3

Once a mining company has constructed access roads and prepared houses for personnel and equipment, mining may commence. Different mining methods have different environmental impacts.

Open-pit mining is a type of strip mining in which the ore deposit extends very deep in the ground, necessitating the removal of layer upon layer of overburden and ore. The use of heavy machinery, usually bulldozers and dump trucks, is the most common means of removing overburden. Open-pit mining often involves the removal of natively vegetated areas, and is therefore among the most environmentally destructive types of mining, especially within tropical forests.

Placer mining is used when the metal of interest is associated with sediment in a stream bed or floodplain. Bulldozers, dredges, or hydraulic jets of water are used to extract the ore.

In underground mining, a minimal amount of overburden is removed to gain access to the ore deposit. Access to this ore deposit is gained by tunnels or shafts. Tunnels or shafts lead to a more horizontal network of underground tunnels that directly access the ore. Although underground mining is a less environmentally-destructive means of gaining access to an ore deposit, it is often more costly and entails greater safety risks than open-pit mining.

Ore extraction: Step 4

After a mining company has removed overburden, extraction of the mineral ore begins using specialized heavy equipment and machinery, such as loaders, haulers, and dump trucks, which transport the ore to processing facilities using haul roads. This activity creates a unique set of environmental impacts, such as emissions of fugitive dust from haul roads, the production of large quantities of waste, sedimentation etc.

By nature, mining involves the production of large quantities of waste. The amount of waste produced depends on the type of mineral extracted, as well as the size of the mine. Gold and silver are among the most wasteful metals, with more than 99 percent of ore extracted ending up as waste. By contrast, iron mining is less wasteful, with approximately 60 percent of the ore extracted processed as waste.

Disposing of such large quantities of waste poses tremendous challenges for the mining industry and may significantly impact the environment. The impacts are often more pronounced for open-pit mines than for underground mines, which tend to produce less waste. Degradation of aquatic ecosystems and receiving water bodies, often involving substantial reductions in water quality, can be among the most severe potential impacts of metals extraction.

Pollution of water bodies results from three primary factors: sedimentation, acid drainage, and metals deposition. Erosion from waste rock piles or runoff after heavy rainfall often increases the sediment load of nearby water bodies. In addition, mining may modify stream morphology by disrupting a channel, diverting stream flows, and changing the slope or bank stability of a stream channel. These disturbances can significantly change the characteristics of stream sediments, reducing water quality. Higher sediment concentrations increase the turbidity of natural waters, reducing the light available to aquatic plants for photosynthesis. In addition, increased sediment loads can smother benthic organisms in streams and oceans, eliminating important food sources for predators and decreasing available habitat for fish to migrate and spawn. Higher sediment loads can also decrease the depth of streams, resulting in greater risk of flooding during times of high stream flow.

Acid drainage is one of the most serious environmental impacts associated with mining. It occurs when sulfide-bearing minerals, such as pyrite or pyrrhotite, are exposed to oxygen or water, producing sulfuric acid. Acidic water may subsequently leach other metals in the rock, resulting in the contamination of surface and groundwater. Waste rock piles, other exposed waste, mine openings, and pit walls are often the source of acidic effluents from a mine site. The process may occur rapidly and will continue until there are no remaining sulfides. Acid drainage impacts aquatic life when acidic waters are discharged into nearby streams and surface waters. Many fish are highly sensitive to even mildly acidic waters and cannot breed at pH levels below 5. Some may die if the pH level is less than 6.

Most mining operations use metals, reagents, or other compounds to process valuable minerals. Certain reagents or heavy metals, such as cyanide and mercury, are particularly valued for their conductive properties and thus are frequently used. The release of metals into the environment can also be triggered by acid drainage or through accidental releases from mine tailings impoundments. While small amounts of heavy metals are considered essential for the survival of many organisms, large quantities are toxic. Few terrestrial and aquatic species are known to be naturally tolerant of heavy metals, although some have adapted over time. In general, the number of plant and animal species decreases as the aqueous concentration of heavy metals increases.

Few examples

- ***Rainforests: Gold Mining***

Gold, copper, diamonds, and other precious metals and gemstones are important resources that are found in rainforests around the world. Extracting these natural resources is frequently a destructive activity that damages the rainforest ecosystem and causes problems for people living nearby and downstream from mining operations.

In the Amazon rainforest most mining today revolves around alluvial gold deposits. Due to the meandering nature of Amazon Rivers, gold is found both in river channels and on the floodplains where rivers once ran. These deposits are actively mined by large-scale operators and informal, small-scale miners. Both operators rely heavily on hydraulic mining techniques, blasting away at river banks, clearing floodplain forests, and using heavy machinery to expose potential gold-yielding gravel deposits.

Studies have found that small-scale miners are less efficient with their use of mercury than industrial miners, releasing an estimated 2.91 pounds (1.32 kg) of mercury into waterways for every 2.2 pounds (1 kg) of gold produced. Elemental or inorganic mercury can be transformed (methylated) into organic forms by biological systems and enter food chains. Not only are methylated mercury compounds toxic, but highly bio-accumulative, meaning that mercury concentrations increase up the food chain. Top predators, including otters, birds of prey, and humans, will have the highest levels of mercury in their systems. Those who eat large amounts of fish are at the greatest risk.

Other toxic compounds are used and generated in the mining process as well. Mining

exposes previously buried metal sulfides to atmospheric oxygen causing their conversion to strong sulfuric acid and metal oxides, which run off into local waterways. Cyanide, a highly toxic compound, is also often used to separate gold from sediment and rock. While cyanide is supposed to be carefully monitored to prevent its escape into the surround environment, spills do occur—especially when there's no one around to enforce mining regulations. The effects of poisoning can be widespread, especially when a waste-holding pool overflows or breaks, as it did in Guyana in August 1995.

Large-scale mining operations, especially those using open-pit mining techniques, can result in significant deforestation through forest clearing and the construction of roads which open remote forest areas to transient settlers, land speculators, and small-scale miners. These settlers and miners are probably a greater threat to the tropical rainforest environment than industrial mining operations. Wildcat miners enter regions rumored to have gold deposits and clear forest in search of riches. They hunt wildlife, cut trees for building material and fuelwood, and trigger erosion by clearing hillsides and detonating explosives. Miners can also bring diseases to local indigenous populations (where they still exist) and battles over land rights.

While deforestation and chemical pollution from mining can impact the rainforest environment, downstream aquatic habitats fare worse. Increased sediment loads and reduced water flows can seriously affect local fish populations.

- ***Mining in Goa***

Mining has been a very important element in the economic history of modern Goa and a significant foreign exchange earner for the state. Recently, it has been designated as the industry at par with tourism. It has provided the trigger to boost economy of the mining talukas.

Mining in Goa is mostly concentrated in four talukas namely, Bicholim in North Goa district and Salcete, Sanguem and Quepem in South Goa district. Some 400 mining leases had been granted in Goa till 2002-03, covering approximately 30,325 ha – this works out to almost eight per cent of the total geographical of the state.

Number of mines is increasing every year; especially during last one year it has shown significant growth. Assuming that total mining project that came to expert committee since June 2007, gets cleared then another 8.4 per cent and 5.3 per cent geographical area of Sanguem Taluka and Quepem Taluka respectively will get converted into mine. Since June 2007, 120 mining projects came up for clearance with ministry recommending clearance for overwhelming 48 per cent of the projects

Large number of clearance also means that a large areas of fertile agricultural land getting diverted for mining. Since June 2007, the total numbers of mining projects, which have been submitted for clearance, cover a huge area of 9,404 ha. This is only a year's data. No data is available as to how much land was diverted for mining between 2002-03 and 2006-07. Adding this 9,404 ha to the total land under mining in Goa (till 2002-03), it works out to be 10.5 per cent of the total area leased out for mining major minerals in the state.

Therefore, if projects are cleared, it will significantly alter the forest cover in these talukas. Other than the forest, the proposed projects also cover a lot of agricultural land and were one of the major causes of concern.

The commonly used practice of "open cast" mining creates up to 3 tons of waste for each ton of ore produced. This waste pollutes rivers and lakes – many of which run red with ore. Mining practices also pollute the land, disrupting animal life and flowing onto farms and damaging land fertility. Large dumps of earth dislodged by mining litter the landscape.

The environmental impact is exacerbated by the coincidence of India's iron ore belt with the Western Ghats, a fragile eco-system ranked as one of the world's 12 ecological hotspots. Rich in biological diversity of plant and animal life, the highland area stretches 1,600 kilometers, running just inland along the length of India's west coast, through the states of Goa, Maharashtra, Karnataka, Tamil Nadu and Kerala.

The effects of mining in the state go beyond the direct pollution released. The industry is also taking a toll on infrastructure, air quality and public safety. Every day, up to 12,000 trucks race to and from the mines and Goa's main port, Marmugao, spreading dust and exhaust fumes.

Although the maximum legal load is 10 tons per truck, most vehicles are overloaded, carrying 15 or 16 tons, and damaging Goa's narrow roads. With the drivers paid per load, they need to pack in as many trips as they can per day and have little incentive to drive slowly and with care. "There are many accidents because of the trucks," Anthony Da Silva told an anti-mining rally in Goa in February 2009.

Mining has also created a degraded environment and is also a matter of concern. Damage to the environment is mainly done by the reject dumps, pumping out of muddy waters from the working pits including those where the mining operations have gone below the water table, and slimes from the beneficiation plant. The damage is more evidenced during monsoon where the rain water carries the washed out material from the waste dumps to the adjoining low-lying agricultural fields and water streams. It is stated that the slimes and silts, which enter the agricultural field are of such character that they get hardened on drying. The washed out material from the dumps and the flow of slimes from the beneficial plants besides polluting the water causes Siltation of water- ways, especially during monsoon. Such silting of water ways over the years may trigger years even flooding of the adjacent fields and inhabitated areas, especially during monsoon.

EIAs of mining projects often underestimate the potential health risks of mining projects. Hazardous substances and wastes in water, air, and soil can have serious, negative impacts on public health. The World Health Organization (WHO) defines health as a "state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity." The term 'hazardous substances' is broad and includes all substances that can be harmful to people and/or the environment. Because of the quantity, concentration, or physical, chemical or infectious characteristics, hazardous substances may (1) cause or contribute to an increase of mortality or an increase in serious irreversible or incapacitating illness; or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

b) Deforestation and Desertification

Deforestation involves the deliberate removal of vegetation to create new agricultural or urban land, to provide wood for building and manufacturing, for the exploitation of minerals and fossil fuels, to create reservoirs for water supplies and hydroelectric generation, for fuel, or as a result of the use of defoliants during wars. Boreal, temperate and tropical forests have all suffered deforestation at different times and to different degrees. Deforestation gives birth to several problems encompassing environmental degradation through accelerated rate of soil erosion, increase in the sediment load of the rivers, siltation of reservoirs and river beds, increase in the frequency and dimension of floods and droughts, changes in the pattern of distribution of precipitation, intensification of greenhouse effects, increase in the destructive force of the atmospheric storms etc; economic loss through damages of agricultural crops due to increased incidence of floods and drought, decrease in agricultural production because of loss of fertile top soils, decrease in the supply of raw materials to the industries are building materials (timber) to the urban and rural areas, marked decrease in fodder to animals etc. and social problems in the form of economic poverty, crimes and increased legal litigation.Currently the world's annual deforestation rate is estimated to be about 13.7 million hectares a year, that's about the land area of Greece. Roughly half of this area gets reforested to a degree, though new growth forests don't function in the same way, support the same biodiversity, nor do they provide the many benefits that old-growth forests do. In addition to these numbers, forests have been becoming more and more affected by climate change, with increasing drought, forest fires, increased and more powerful storms, diseases, and an explosion in insect numbers.Forests are natural umbrella for ground surface because these protect the ground surface from erosion caused by falling raindrops and control radiation balance of the earth and the atmosphere by consuming increased amount of carbon dioxide released from ever-increasing 'human volcanoes' (chimneys of the factories) and thus prevent the earth from becoming too hot. Removal of forest cover exposes the ground surface to the atmospheric processes. It may be pointed out that forests intercept falling raindrops and thus split them and reduce their (of raindrops) kinetic

energy. Intercepted rainfall reaches the ground surface slowly in the form of '*AERIAL STREAMLETS*' through the leaves, branches and stems of trees. Thick leaf litters on the ground surface alter decomposition provide humus content to the soils and also make the soils friable. Thus the ground surface allows maximum infiltration of rainwater and minimum surface runoff. On the other hand deforestation exposes the ground surface to falling raindrops with full kinetic energy. This results into maximum erosion of soils because the infiltration of rainwater is markedly reduced and surface runoff is increased. Thus deforestation causes a chain of effects which adversely affect the natural environmental conditions as given below.Accelerated rate of soil erosion, through rain splash, rain-wash, sheet wash, rill erosion and gully erosion, consequent upon deforestation, increases sediment load of the rivers. Increased suspended and bed loads of the rivers cause rapid rate of siltation of alluvial rivers which results in gradual rise of the river beds. Thus increased surface run-off and reduced water accommodation capacity of the river valleys due to siltation increase the frequency and dimension of floods of alluvial rivers as flood waters easily overtop the river banks and spread over large areas.Increased rate of soil erosion caused due to deforestation results in colossal loss of fertile topsoil and agricultural land which ultimately causes marked reduction in agricultural production. Rapid rate of rill and gully erosion in the intervening zone between the Ganga plains and the northern foreland of Indian peninsula has resulted into the conversion of thousands of hectares of good land into ravenous land which has displaced the affected inhabitants from their agricultural land. The development of circuitous network of dense mesh of gullies ranging in depth from a few metres to 80 m has rendered vast expanse of agricultural and forest land into waste land on the one hand and has deprived millions of people of their livelihood on the other hand. Thus the increased rate of soil erosion consequent upon deforestation and destruction of grassland has been responsible for social pollution in addition to land degradation. The zigzag network of deep gullies of the riverine tract of the Yamuna, the Chambal, the Betwa rivers etc. (Fatehpur, Etawah, Agra, Banda, Jhansi, Jalaun districts of Uttar Pradesh and Bhind, Morena, Gwalior, Tikamgarh, Chhatarpur districts of Madhya Pradesh, India) offers easy and safe shelter to dacoits and bandits. This has alarmingly increased the rate of crimes including theft, dacoity and murder in the said areas and thus has social atmosphere.Deforestation has also increased the rate of aeolian erosion through deflation and desertification through desert spreads. Many of the tribal areas of the forested land of India have lost the forest stands in their immediate surroundings and thus are facing the acute problem of fuels and fodder. The destruction and alteration of habitats due to deforestation causes ecological imbalance in the region concerned.Whereas Desertification is the process by which fertile land is transformed into desert, usually as a result of deforestation, drought, and agriculture use/practices. Desertification played a significant role in the collapse of many large empires and civilizations; such as the Roman Empire, Carthage, the Harappan civilization, and Greece. Most of the desertification that these civilizations experienced was as a result of agriculture, deforestation, and associated changes in aridity and the climate.The process occurs primarily in dryland ecosystems, which are already very fragile, and simply can't support the pressures that result from significant human populations. Drylands currently occupy about 40% of the world's land area. As these lands are cultivated the limited nutrients that are available in them are quickly depleted. Often times the land is also improperly irrigated, leading to salty soils, and emptied aquifers. The limited natural vegetation that is present is also often overgrazed, leading to large-scale soil erosion and increased runoff/decreased rainfall retention.The Sahara is currently expanding south at a rate of up to 48 kilometers per year.

Case study of Gadchiroli District: Gadchiroli in Central India is one of the most forested districts in India with a predominantly tribal population. In recent years there has been an accelerated process of deforestation in the district of Gadchiroli. As in most cases it is the locals and the tribals who get blamed for the deforestation that is happening here whereas a closer look at the situation reveals that one of the major cause is without doubt policies of the government. In one such village is Mendha.Mendha is a significant case because of the initiatives of the villagers, and their decisions which have contributed immensely in the conservation of the forests of the area. The village has established a very strong community organization of its own. It has various

institutional structures like the Van Suraksha Samiti (VSS) or the Forest Protection Committee which takes the forest related decisions. The village has also been successful in establishing good relations with some sensitive government officials and Non Governmental Organizations and succeeded in facilitating inter-departmental co-operation among the various government agencies working in the area. In the last seven years the villagers have taken up a number of soil and water conservation programs, built a water hole for wild animals, controlled forest fires to an extent and framed regulations for the controlled extraction of biomass from the forest. They have also succeeded in stopping the indiscriminate and destructive extraction by the paper mill. They carry out daily patrolling and with the help of the Forest Department have punished those who have been caught violating the rules. The village has also brought its forests under the Joint Forest Management (JFM) scheme of the state government. This has not only formalized their position as the custodians of the forests but has also opened up the possibilities for negotiating benefits from the official forest related activities. In another significant move the village council has made it mandatory for all government and nongovernmental agencies to seek its permission before carrying out any forest related activity in the village and the surrounding forests and this includes the powerful external commercial forces like the paper industry.

c) Overgrazing and ploughing

Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. Overgrazing reduces the usefulness, productivity, and biodiversity of the land and is one cause of desertification and erosion.

Overgrazing typically increases soil erosion. Reduction in soil depth, soil organic matter and soil fertility impair the land's future natural and agricultural productivity. Soil fertility can sometimes be mitigated by applying the appropriate lime and organic fertilizers. However, the loss of soil depth and organic matter takes centuries to correct. Their loss is critical in determining the soil's water-holding capacity.

The phenomenon of the dustbowl in the Great Plains region of America in the 1930s is a well-known example of man-induced land erosion. The area was former grassland underlain by rich brown and chestnut soils, but both overgrazing and ploughing contributed to the catastrophe which caused the widespread abandonment of farms. A great expansion in wheat cultivation in the early years of the decade was followed by a series of droughts; the soil, largely exhausted of its natural fertility, was subject to deflation and particle drifting of disastrous proportions.

The dustbowl situation is by no means unique. In the marginal areas around today's hot deserts, such as the Thar desert of Pakistan and India, and the Egyptian desert, a great deal of deflation is initiated by grazing animals. In other deserts, as in the central Sahara and the south-west United States, desert pavements (Chapter Eight) normally contribute little coarse dust, but this protective layer is easily destroyed by wheeled vehicles, exposing finer-textured materials.

In Britain, coastal dunes are highly susceptible to deflation when interfered with by man. Constant trampling or vehicular traffic quickly destroys the protective grass vegetation, initiating blowouts or landward migration of the dunes. On the Dutch coast, protection of the dune systems from degradation by man is vital as these give protection to large inland areas lying below sea-level.

d) Salinization and Acidification of Soil

Salinity occurs naturally, even in healthy catchment areas. Salt borne from the sea by wind and rain is deposited across the landscape. Naturally occurring salts are leached downwards into groundwater where they are concentrated by the transpiration of plants. This naturally-occurring salinity is known as primary salinity.

Secondary salinity is the salinisation of land and water resources due to the impacts of human activities. Secondary salinity takes the form of irrigated salinity due to rises in groundwater resulting from irrigation, and dryland salinity caused by the removal of vegetation that otherwise keeps saline groundwater at levels below the root zone.

Of particular concern is the condition of riparian vegetation, which is severely affected as it occupies the lowest parts of the landscape where much of the saline groundwater is released to the surface; but there has been no significant increase in vegetated stream length

since 1989. This is of major concern as riparian vegetation plays a key function in stopping the movement of salt through river systems.

At the farm level, salinity will result in the loss of production and income. Other effects include the decline in capital value of land, damage to infrastructure, salinisation of water storages, loss of farm flora and fauna, and loss of shelter and shade. These effects are magnified at the regional scale. Salinity will have a substantial impact on resources such as biodiversity, water supplies and infrastructure.

Acidic soils are those with a pH less than 5.5 and they are usually found in areas of high rainfall. Acid soils are toxic to plants because they can release toxic levels of aluminium and other mineral elements. Acid soil conditions also restrict the availability of nutrients and trace elements vital to plant growth. The four main causes of soil acidity are:

- removal of product from the farm
- leaching of nitrogen below the plant root zone
- inappropriate use of nitrogenous fertilisers
- build-up in organic matter (NSW Agriculture 1999).

e) Soil Erosion

Soil erosion is the detachment or breaking away of soil particles from a land surface by some erosive agent, most commonly water or wind, and subsequent transportation of the detached particles to another location. Erosion is a natural process and is a critical factor in soil formation from rock parent material. Human activities are responsible for greatly accelerating erosion rates, usually by reducing or eliminating plant and residue cover.

However, once productive agricultural soils have been formed over periods of thousands or millions of years, erosion of the soil material is then usually very low or negligible because of the impacts of protective natural plant and residue cover. This exposes the soil to wind and water erosion forces, weakening the soil cohesive forces by tillage disturbance, and increasing the erosive agents, particularly by activities that increase surface runoff. Soil erosion is a serious problem and major cause for the declining productivity, particularly in the rainfed areas world over.

If we consider the case of India, almost the entire rainfed area in the country, covering an area of about 70 m ha, is affected by severe sheet and rill erosion. Loss of topsoil is one of the major factors for the low and unstable crop yields obtained in the semi-arid and sub-humid subtropics of India Gullies and ravines are also commonly seen in these areas. Wind erosion is dominant in the western regions of the country and to some extent in the coastal areas. It causes loss of topsoil, terrain deformation, over blowing and shifting of sand dunes. It is estimated that more than 45 per cent of India's geographical area is already affected by serious soil erosion and this proportion is increasing year by year.

It is estimated that the soil forming process needs hundreds of years for the formation of few inches of agriculturally productive soils. Under natural condition, undisturbed by man, equilibrium gets established between the climate of a place and the cover of vegetation that protects the soil layer. A certain amount of erosion does take place even under this natural cover, but it is slow and very limited in nature which is balanced by the soil that is formed by continuous weathering and other soil forming processes. When this balance is upset because of the cultural operations followed or any other reason, the removal of soil takes place at a faster rate than its renewal. In sheet erosion, the movement of runoff water and eroded soil occurs in thin sheets continuously. When this moving sheet assumes sufficient velocity, its cutting action on the soil gets increased and results in the formation of rills, trenches or gullies. If the velocity of the runoff water is doubled, its energy increases fourfold and its erosive action on the soil is correspondingly increased and its capacity to carry soil particles is increased by 64 times. The gullies tend to get deeper and wider with every succeeding rain and eventually cut up the agricultural lands into fragments and making it unfit for cultivation. Gully erosion is more evident and spectacular at the surface but sheet erosion is more dangerous as it is insidious and is seldom noticed before it is too late to remedy its destructive effects on heavy soils.

Some examples on Human induced accelerated land degradation

The excessive demand for construction materials like bricks and sand for infrastructure projects in developing countries like India are causing huge soil degradation in peri-urban

environment at an alarming rate. A study conducted at Bangalore, India revealed that sand supply from riverbeds to Bangalore is not able to meet the demand of booming construction sector. Enterprising farmers have taken up extraction of sand by washing surface soils of agricultural fields. Nearly 25 percent of sand supplied is from this source. Study revealed that significant employment and economic gains are realized at an ecological cost. Loss of surface soils, nutrient losses, crop yield losses, siltation of tanks, excessive ground water exploitation and soil erosion are taking place due to sand extraction. Nearly 18000 ha of land which was usually used for growing the staple food of the region, i.e., Finger millet is going out of cultivation for few years to come.

Damage to the environment is mainly done by the reject dumps, pumping out of muddy waters from the working pits including those where the mining operations have gone below the water table, and slimes from the beneficiation plant. The damage is more evidenced during monsoon where the rain water carries the washed out material from the waste dumps to the adjoining low-lying agricultural fields and water streams. It is stated that the slimes and silts, which enter the agricultural field are of such character that they get hardened on drying. The washed out material from the dumps and the flow of slimes from the beneficial plants besides polluting the water causes siltation of water-ways, especially during monsoon. Such silting of water ways over the years may trigger years even flooding of the adjacent fields and inhabitated areas, especially during monsoon.

Desurfacing of farm lands for brick industry is another source of soil degradation. Thousand of ha of lands are losing their productive potential due to unscientific extraction of soils. Recently technology of using fly ash for brick production has been evolved which may help in reducing the soil degradation to some extent.

Purposeful conversion of productive farming lands in to shrimp farming or urban development is taking place at a very large scale on coastal zones. In India, Goa a tiny state is a world famous tourist place. The state has low lying 18000 ha of vary productive paddy farming lands called Kazan lands. Slumping revenues from agriculture in Goa has led to breaching the bunds to allow saline water into the fields to raise fish, as this is far more profitable than cultivating paddy has become rampant. It is reported that khazan lands are extensively inundated for as many as 15 years and used for shrimp farming. The growing density of population poses another threat to the khazan lands. Goa's population is concentrated in the Mandovi-Zuari basin, which is also where the khazan lands are situated and almost all urban expansion has taken place at the expense of these lands. Threats to the khazan lands include those arising from general environmental degradation. Deforestation in the upper river catchment areas and mining activity have added to the silt load of the rivers. The sediment that gets deposited in the estuarine region have resulted in many acres of khazan lands now getting flooded during the monsoon.

The rivers have become heavily polluted near the towns and much of the waste material they carry flows into the khazan lands with the tides. And, this problem is compounded by the petroleum residues from barges, tankers and trawlers in the rivers."The problem is that any expansion that takes place in Goa has to be at the cost of the khazan lands. Comprehensive policy is needed to make these enterprises ecologically tolerable.

Vicious cycle of population, poverty and land degradation

A chain of cause and effect links direct and indirect causes of land degradation. The driving force is an increase in population dependent on limited land resources base. This produces land shortage leading to small farms, low production per person, increasing landlessness and in consequence, poverty. Land shortage and poverty together lead to non-sustainable land management practices, the direct causes of degradation. Poor or landless farmers are led to clear forest, cultivate steep slopes, overgraze village common lands like pastures or make short-term unbalanced fertilizer applications. These non-sustainable management practices lead to land degradation, causing lower productivity and lower responses to inputs.

This has the effect of increasing the land shortage, thus completing the cycle.

Irresponsible rich farmers sometimes exploit the land, but by and large farmers with secure tenure and capital are more likely to conserve natural resources. When natural disasters occur, rich farmers can turn to alternative sources of income, or borrow and repay in better years. These alternatives are not open to the poor.

In the past, rural populations had access to adequate land to meet their needs. When a disaster occurred, whether of natural origin or war, there were spare resources to fall back upon. They could take new land into cultivation, kill livestock, which fed upon natural pastures or go into forest and extract roots or hunt wildlife. Because of land shortage, these options are no longer available. Farmers are surrounded by other farmland, such common rangeland as exists is often degraded, and overlarge areas no forest remains. The options open are to work on the farms of others, non-agricultural occupations, enforced migration to the cities or ultimately dependence on famine relief.

If we consider the case of India, the limited land area which is equal to only 2.5 per cent of the world's geographical area. It supports approximately 17.5 per cent of the world's human population and 20 per cent of the world's livestock population. The population of India has already crossed one billion marks and is still growing at the rate of about two per cent. This exponential growth of population and dependence of more than 60 per cent of the population for their livelihood on agriculture and allied activities exerts tremendous pressure on the limited land resources of the country. At present, the per capita availability of land is only 0.15 ha, which will be further reduced to less than 0.07 ha in 2050 with an expected population of about two billion. Hence the stress on limited land resources is going to increase day by day. Governments need to address the issues with all the seriousness. The link between population, poverty and soil degradation is now widely recognized. FAO reports 'A lack of control over resources, population growth and inequity are all contributing to the degradation of the region's resources. In turn, environmental degradation perpetuates poverty, as the poorest attempt to survive on a diminishing resource base'.

Through force of circumstances, it is the poor who take the major role in the causal nexus between land shortage, population increase and land degradation. Thus rapid population growth can exacerbate the mutually reinforcing effects of poverty and environmental damage of which the poor are both victims and agents. Hence, in such nations population control needs to be taken on top priority to protect the natural resources base besides other socio-economic conflicts.

MODIFICATION OF OCEANS

The ocean absorbs a great amount of carbon dioxide and pollutants, but pollution levels of our whole Earth system are reaching beyond carrying capacity. As human population has increased, so has the deterioration of the world's ocean ecosystems.

Two thirds of the major cities in the world are situated along coasts, and millions of people vacation at shorelines. Pollution from developed areas drains into the ocean killing marine life, threatens human health, causes toxic algae blooms, and forces beach closures. Human pollution is destroying coral reefs and coastal habitat which are vital for breeding, food and shelter for marine species. Vast amounts of pollution are draining into our ocean waters daily from human-related activities. Ocean currents can carry pollutants far from the source of entry, and species consume and absorb them. Pollutants have caused major declines in species, and are threatening the planet's ecological stability; and therefore, our life support system.

Sewage, toxic chemicals, pulp mill and manufacturing wastes, fertilizers, soaps, detergents, litter and refuse disposal, radioactive wastes, plastics, oil spills and leaks, runoff, and insecticides are contaminating our ocean and freshwater sources on a daily basis - far in excess of what the natural filtering and recycling systems can sustain. As some hazardous chemicals are banned worldwide and/or locally, many other new chemicals are developed that continue the harm.

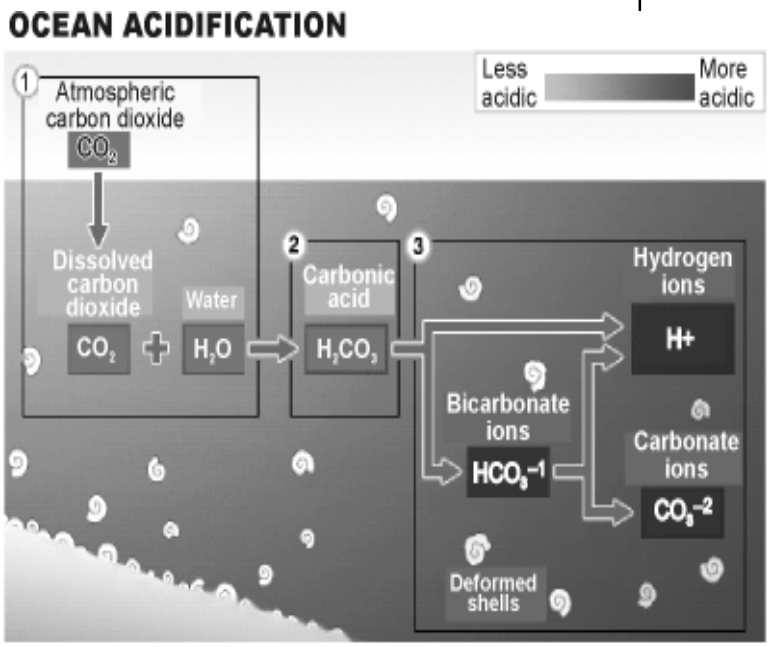
Alteration in oceans due to:

a) Ocean Acidification

When carbon dioxide (CO_2) is absorbed by seawater, chemical reactions occur that reduce seawater pH, carbonate ion concentration, and saturation states of biologically important calcium carbonate minerals. These chemical reactions are termed "ocean acidification". Calcium carbonate minerals are the building blocks for the skeletons and shells of many marine organisms. But excessive carbon in the atmosphere from the burning of fossil fuels over the last two centuries has caused increased acidity in the oceans, which is threatening ecosystems, sea creatures and their food supplies. These rising levels of acidity, along with the effects of global warming, could affect the ability of the oceans to absorb greenhouse gases.

Since the beginning of the Industrial Revolution, the pH of surface ocean waters has fallen by 0.1 pH units.

Ocean acidification is expected to impact ocean species to varying degrees. Photosynthetic algae and seagrasses may benefit from higher CO_2 conditions in the ocean, as they require CO_2 to live just like plants on land. On the other hand, studies have shown that a more acidic environment has a dramatic effect on some calcifying species, including oysters, clams, sea urchins, shallow water corals, deep sea corals, and calcareous plankton.



The Biological Impacts on

Pteropods

The pteropod, or "sea butterfly", is a tiny sea creature about the size of a small pea. Pteropods are eaten by organisms ranging in size from tiny krill to whales and are a major food source for North Pacific juvenile salmon. Pteropod's shell when placed in sea water with low pH the shell slowly dissolves after 45 days.

Shellfish

In recent years, there have been near total failures of developing oysters in both aquaculture facilities and natural ecosystems. These larval oyster failures appear to be correlated with naturally occurring upwelling events that bring low pH waters under-saturated in aragonite as well as other water quality changes to nearshore environments. Lower pH values occur naturally during upwelling events, but recent observations indicate that anthropogenic CO_2 is contributing to seasonal undersaturation.

Coral

Many marine organisms that produce calcium carbonate shells or skeletons are negatively impacted by increasing CO_2 levels and decreasing pH in seawater. For example, increasing ocean acidification has been shown to significantly reduce the ability of reef-building corals to produce their skeletons.

b) Ozone depletion

Continued depletion of the ozone layer in the upper atmosphere (from chemicals released by human actions on Earth) could cause a drastic decline in the world's oceanic plankton. Planktons are tiny organisms floating in vast numbers in the ocean which are the first link in providing food supporting marine/sea life. With less protection provided by the ozone layer, more harmful ultraviolet radiation reaches the Earth. A decrease in plankton would lead to a domino effect throughout the aquatic food chain, and severely impact all aquatic species and marine wildlife.

c) Flow of waste materials in ocean

Wildlife is dying from litter and uncontained trash improperly discarded by humans. The fishes get entangled in the holders of canned drinks, such as sodas and beer. These should be cut up before properly disposing of them. It is best to remove them and not take them out into nature.

Marine animals sometimes mistake debris for food and swallow it or become caught in it and die. Debris and trash can be carried downstream in rivers endangering all aquatic life on its way to the sea where it will drift through the ocean currents for years and years. Plastic floating in the ocean can resemble jellyfish. Many leatherback turtles die from ingesting plastic bags which they mistake for their favorite food, jellyfish. The leatherback is listed on the U.S. Endangered Species List as endangered worldwide.

Of the approximately 7 billion tons of litter that enters the world's oceans each year, about 60 percent is of a plastic composition (Plastics include bags, bottles, strapping bands, sheeting, synthetic ropes, synthetic fishing nets, floats, fibreglass, piping, insulation, paints and adhesives). These items can last for 10-20 years before finally decomposing. It is estimated that 1 million seabirds and 100,000 other marine animals, including endangered species, die as a result of having swallowed plastic litter or been caught in it.

Lost and discarded fishing lines and nets also cause terrible wounds and suffocation to sea animals. Huge "wall of death" driftnets have entrapped mammals as large as whales and cut into them down to the bone, causing a long painful death from wounds and suffocation. Millions of dolphins have drowned in fishing nets that are set out to catch other fish. These huge fishing nets capture, injure and kill an enormous amount of sealife of all varieties which can't be sold for human food, and the bodies are just tossed back into the ocean.

d) Coral bleaching

Coral reefs are found in circum-tropical shallow tropical waters along the shores of islands and continents. The reef substrate is mainly composed of calcium carbonate from living and dead scleractinian corals. Many other invertebrates, vertebrates, and plants live in close association to the scleractinian corals, with tight resource coupling and recycling, allowing coral reefs to have extremely high productivity and biodiversity, such that they are referred to as 'the Tropical Rainforests of the Oceans'.

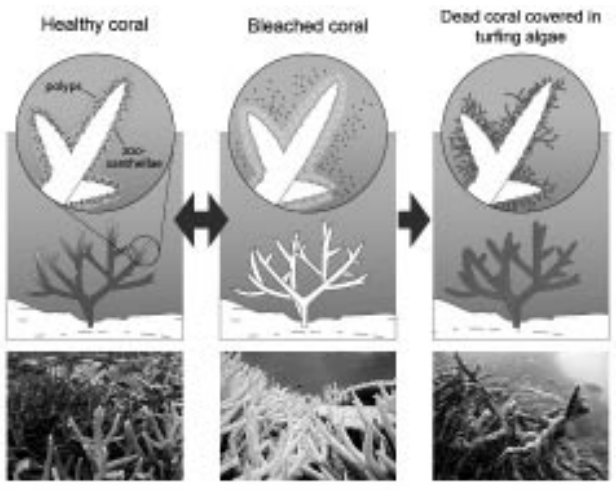
Corals live in very nutrient poor waters and have certain zones of tolerance to water temperature, salinity, UV radiation, opacity, and nutrient quantities.

Zooxanthellae live symbiotically within the coral polyp tissues and assist the coral in nutrient production through its photosynthetic activities. These activities provide the coral with fixed carbon compounds for energy, enhance calcification, and mediate elemental nutrient flux. The host coral polyp in return provides its zooxanthellae with a protected environment to live within, and a steady supply of carbon dioxide for its photosynthetic processes. The symbiotic relationship allows the slow growing corals to compete with the faster growing multicellular algaes because the tight coupling of resources and the fact that the corals can feed by day through photosynthesis and by night through predation.

The tissues of corals themselves are actually not the beautiful colors of the coral reef, but are instead clear. The corals receive their coloration from the zooxanthellae living within their tissues.

Bleaching, or the paling of zooxanthellate invertebrates, occurs when (i) the densities of zooxanthellae decline and / or (ii) the concentration of photosynthetic pigments within the zooxanthellae fall. If the stress-causing bleaching is not too severe and if it decreases in time, the affected corals usually regain their symbiotic algae within several weeks or a few months. If zooxanthellae loss is prolonged, i.e. if the stress continues and depleted zooxanthellae populations do not recover, the coral host eventually dies.

Coral reef ecosystems world-wide have been subject to unprecedented degradation over the past few decades. Disturbances affecting coral reefs include anthropogenic and natural events. Recent accelerated coral reef decline seems to be related mostly to anthropogenic impacts (overexploitation, overfishing, increased sedimentation and nutrient overloading. Natural disturbances which cause damage to coral reefs include violent storms, flooding, high and low temperature extremes, El Nino Southern Oscillation (ENSO) events, subaerial exposures, predatory outbreaks and epizootics. For example 95% of the coral reefs in Galapagos Island were destroyed due to this wave of climate extremity. El Niño events are found to occur every 7 to 8 years, research indicates that they now occur much more frequently at anywhere from



every 3 to 5 years. This increase in frequency is attributable to climate change. Global warming is the cause of an increasing number of cases of coral bleaching all over the world.

e) Oil spill

A major source of ocean pollution is from oil. Oil spills and leaks come from oil tankers, oil wells, runoff from land spills and leaks into rivers and underground watersheds from industry, oil refineries and storage facilities. The recent case has been oil spill in Gulf of Mexico (The total discharge is estimated at 4.9 million barrels). Some oil spills are accidental, but it's not accidental when they come from rusted-out gasoline tanks and inadequate old oil tankers or from careless and uncaring humans.

Oil coats the ocean surface, seabirds, fish, and marine mammals. It washes onshore and destroys shoreline habitat. Vast numbers of plants and animals die, and entire fishing industries have been destroyed. Coastal communities suffer economic damage. Oil damage cleanup costs run into the millions of dollars. Recovery takes years, and some areas will never recover fully. The greatest loss is to the environment and life forms. Since the devastating and widespread Exxon / Valdez spill, improved ship hull designs and additional safety procedures have been implemented for oil-carrying vessels.

MODIFICATION OF THE ATMOSPHERE

Human activities are increasingly altering the Earth's climate. Human impacts on the climate system include increasing concentrations of atmospheric greenhouse gases (e.g., carbon dioxide, chlorofluorocarbons and their substitutes, methane, nitrous oxide, etc.), air pollution, increasing concentrations of airborne particles, and land alteration. A particular concern is that atmospheric levels of carbon dioxide may be rising faster than at any time in Earth's history, except possibly following rare events like impacts from large extraterrestrial objects.

Atmospheric carbon dioxide concentrations have increased since the mid-1700s through fossil fuel burning and changes in land use, with more than 80% of this increase occurring since 1900. Moreover, research indicates that increased levels of carbon dioxide will remain in the atmosphere for hundreds to thousands of years. It is virtually certain that increasing atmospheric concentrations of carbon dioxide and other greenhouse gases will cause global surface climate to be warmer.

Atmospheric changes induced by man may be grouped as:

a) Pollutants in the Atmosphere

To city-dwellers the most obvious way in which man has affected the atmosphere is through pollution. Pollutants include particulate matter, both solid and liquid particles, and gaseous substances such as sulphur dioxide (SO_2), oxides of nitrogen (NO, NO_2, NO_3), carbon monoxide (CO) and hydrocarbon compounds. But not all man-made pollution comes from cities. Isolated industrial activities frequently create a footprint of atmospheric pollution in areas of countryside downwind from the industrial site: particularly infamous examples in Britain include smelters and brickworks. Mining and quarrying activities also send large amounts of mineral dust into the air. Even man-induced forest and grass fires as well as bonfires, can greatly add to particulate pollution at certain times of year.

Atmospheric pollutants are conducted upward from the emission sources by rising air currents as part of the normal convective processes. Larger particles settle under gravity and return to the ground as fallout. Smaller suspended particles are brought to the Earth by precipitation as washout. By a combination of the two processes the atmosphere tends to be cleaned of pollutants, and in the long run a balance is achieved between the input and output of pollutants, although there are large fluctuations in the quantities stored in the air at a given time. Pollutants are also eliminated from the air over their source areas by winds which disperse the particles into large volumes of clean air in the downwind direction. Smoke stacks are intended to take as much advantage of this as possible. The passage of a cold front accompanied by strong winds is usually very effective in sweeping away pollutants from an urban area, but during stagnant anticyclonic conditions concentrations may rise to high values, sometimes producing a smog.

Once in the atmosphere, the primary pollutants undergo a number of chemical reactions, generating a secondary group of pollutants. For example, sulphur dioxide combines with oxygen and

suspended water droplets to produce sulphuric acid. This acid is harmful to organic tissues and is also very corrosive. Photochemical reactions are brought about by the action of sunlight: for example, sunlight acting on nitrogen oxides and organic compounds produces ozone. Another toxic chemical produced by photochemical action is ethylene.

The harmful effects of atmospheric pollution on plant and animal life are manifold. For example, there are many technologies or devices burn wood, coal, or oil inside buildings such as woodstoves, boilers, furnaces, ovens and heaters. When these devices are used, they must be probably vented to the outside because the gases that result from combustion can have a serious impact on the ability of humans to breathe.

Carbon monoxide is one such gas that often results from combustion and it is becoming more common for carbon monoxide monitors or alarms to be installed within homes and buildings. Carbon monoxide, or CO, is a colorless, odorless gas that results from incomplete combustion or burning of fuel. Normally, the atmosphere contains a very small amount of carbon monoxide, about 200 parts per billion (ppb), or .02 parts per million (ppm). If the concentration of carbon monoxide in the air a person breathe increases slightly to 9 parts per million, the person may begin to have difficulty breathing. A healthy person may be just barely affected by CO exposure of 9 ppm, but older individuals and asthmatics, whose lung function may be already compromised, are likely to feel a greater level of effect. Carbon monoxide reduces the ability of the body's blood to absorb oxygen. It is also colorless and odorless making detection difficult. Inhaling low levels of carbon monoxide can result in fatigue and chest pain, particularly in individuals with chronic heart disease. Increased exposure to CO can result in headaches, dizziness, sleepiness, nausea, vomiting, and disorientation. At very high levels, inhalation of carbon monoxide can cause loss of consciousness and death. An increase from .02 to 9 ppm in carbon monoxide may seem like a large relative increase, but a change of this magnitude is a change of only 0.000088% in the total concentration of gases in the air we breathe.

In addition to carbon monoxide, there are many other chemicals, substances, and gases which can be harmful to human health. These chemicals, substances, or gases as a group are called indoor air pollutants. Indoor pollutants are not as easily dispersed or diluted as outdoor pollutants are. As a result, concentrations can often be many times higher than outdoors. Indoor pollution occurs in a wide range of indoor environments including homes, schools, factories, office buildings, and commercial workplaces. Excessive noise, dust, odors and fumes can all serve to lower worker productivity and adversely affect human health. Pollutants found indoor include asbestos, biological contaminants, formaldehyde, fumes from household products, lead, nitrogen dioxide, particulates, pesticides, radon, and tobacco smoke.

Environmental Tobacco Smoke (ETS) is a major source of indoor air pollution because it contains carbon monoxide, formaldehyde and many other harmful gases. ETS is often referred to as '*second hand smoke*' and the exposure to ETS is called '*passive smoking*'. Some building materials like asbestos, furnishings and household products like aerosol sprays, adhesives, paints etc. release volatile organic pollutants continuously which cause diseases ranging from scamming of lung tissues to visual disorder, abdominal cancer and memory impairment. Other sources includes, use of unvented stoves or space heater, solvents for cleaning products and housekeeping also release pollutants intermittently.

Further the number of automobiles is increasing day by day and has become a cause of air pollution and degradation of the environment. The automobile, with its internal combustion engine, emits poisonous gases that are harmful to human health and is the most serious pollution of the technological age. Exhaust emissions from diesel engines include carbon monoxide, hydrocarbon oxides, organic acids etc. The two primary pollutants are carbon monoxide and nitrogen dioxide, both of which are extremely poisonous gases. Lead is a toxic compound and its main source in the environment is believed to be from leaded gasoline used as fuel for internal combustion engines. The presence of lead in the atmosphere is a threat to the environment as well as for all living organisms.

The rapid rate of industrialization has resulted in more and more air pollution. Various industrial processes release almost all types of pollutants into the air. Some industries like cement, iron and steel, fertilizer, petrochemical, etc. are of great concern because of the difficulty in controlling the emission of pollutants from them. Acid rain has become a great threat to the

environment. The use of solvents is increasing with the growing use of paints, spray, polish, etc. Due to presence of hydrocarbons in these materials, air pollution is caused which is dangerous for health. Similarly, spray of pesticides in agriculture is also responsible for air pollution even in rural areas.

b) Changes in Atmospheric Gas Levels

Of the main natural constituent gases in the atmosphere, carbon dioxide (CO_2) and oxygen (O_2) are the most critical from an environmental viewpoint; both are inextricably involved in the biochemical cycles between atmosphere and the surface of the Earth. Although nitrogen comprises four fifths of the atmosphere, its inert chemical nature relegates it to a minor role in this respect. Oxygen and carbon dioxide are naturally added to the atmosphere by 'outgassing' from the Earth's interior. The work of plants has been essential in removing carbon dioxide from the atmosphere and storing it as coal and other fossil organic substances. Before the Industrial Revolution, carbon dioxide levels appear to have been about 290 parts per million (p.p.m.) in the atmosphere. But in the last hundred years or so, this amount has increased by about ten per cent, largely because of man's use of fossil fuels. It has been suggested that, in contrast to the effect of solid particles, an increased level in carbon dioxide content will increase the temperature of the atmosphere, since the gas is an absorber of long-wave radiation and will lead to global warming.

It has been pointed out also that man's large-scale combustion of hydrocarbon fuels requires a large quantity of oxygen to be withdrawn from the atmosphere and converted into carbon dioxide and water vapour. There is therefore the possibility of a lowering of the oxygen content of the atmosphere to levels which might have a detrimental effect on animal life.

Changes in water vapour levels brought about by man through combustion and alterations to the vegetation cover could in theory markedly affect global radiation and heat balances in the same manner as changes in carbon dioxide levels. But water vapour content varies greatly from place to place and it is difficult to measure global changes. It seems unlikely that there would be a general build-up of excess atmosphere water vapour through combustion, as it would rapidly return to the oceans as precipitation. A special case, however, is the emission of water vapour and various other substances by jet aircraft. These emissions occur in the stratosphere, where the water vapour content is normally very small. The condensation trails (contrails) of aircraft can often be observed to spread laterally and develop into cirrus clouds. These clouds are highly reflective and can have an effect on the Earth's albedo.

Gases that contribute to the greenhouse effect include:

- **Water vapour:** The most abundant greenhouse gas, but importantly, it acts as a feedback to the climate. Water vapour increases as the Earth's atmosphere warms, but so does the possibility of clouds and precipitation, making these some of the most important feedback mechanisms to the greenhouse effect.
- **Carbon dioxide (CO_2):** A minor but very important component of the atmosphere, carbon dioxide is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels. Humans have increased atmospheric CO_2 concentration by a third since the Industrial Revolution began. This is the most important long-lived "forcing" of climate change.
- **Methane:** A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture, and especially rice cultivation, as well as ruminant digestion and manure management associated with domestic livestock. On a molecule-for-molecule basis, methane is a far more active greenhouse gas than carbon dioxide, but also one which is much less abundant in the atmosphere.
- **Nitrous oxide:** A powerful greenhouse gas produced by soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.
- **Chlorofluorocarbons (CFCs):** Synthetic compounds of entirely of industrial origin used in a number of applications, but now

largely regulated in production and release to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer. They are also greenhouse gases.

c) Ozone Depletion

Ozone is formed in the stratosphere when oxygen molecules photo-dissociate after absorbing an ultraviolet photon whose wavelength is shorter than 240 nm. This converts a single O_2 into two atomic oxygen ions. The atomic oxygen ions then combine with separate O_2 molecules to create two O_3 molecules. Further these ozone molecules absorb UV light between 310 and 200 nm, following which ozone splits into a molecule of O_2 and an oxygen atom. The oxygen atom then joins up with an oxygen molecule to regenerate ozone. This is a continuing process which terminates when an oxygen atom "recombines" with an ozone molecule to make two O_2 molecules.

$$O + O_3 \rightarrow 2O_2 \text{ chemical equation}$$

The overall amount of ozone in the stratosphere is determined by a balance between photochemical production and recombination.

But because of increasing man-made pollution and the release of gases like CFCs (chlorofluorocarbons) the natural balance is broken and the amount of ozone destroyed is far higher than the amount naturally formed.

The average amount of ozone in the atmosphere is about 300 Dobson Units, ozone holes are the areas where the concentration drops to an average of about 100 Dobson Units.

The Antarctic ozone hole is an area of the Antarctic stratosphere in which the ozone levels drops to as low as 33% of their pre-1975 values. The ozone hole occurs during the Antarctic spring, from September to early December, as strong westerly winds start to circulate around the continent and create an atmospheric container.

Before the initiation of Antarctica Spring season the Polar winters are dark, consisting of three months without solar radiation (sunlight). The lack of sunlight decreases the temperature around or below "80 °C. These low temperatures form cloud particles polar stratospheric clouds (PSCs).

There are three types of PSC clouds — nitric acid trihydrate clouds, slowly cooling water-ice clouds, and rapid cooling water-ice (nacerous) clouds — that provide surfaces for chemical reactions that lead to ozone destruction.

Usually most of the chlorine in the stratosphere resides in stable "reservoir" compounds, primarily hydrochloric acid (HCl) and chlorine nitrate ($ClONO_2$). But during the Antarctic winter and spring, reactions on the surface of the polar stratospheric cloud particles convert these "reservoir" compounds into reactive free radicals (Cl and ClO). However the reactions are slow due to absence of sunlight during winters.

During the spring season, the sun energy drives photochemical reactions and melts the polar stratospheric clouds, releasing the trapped compounds which lead to ozone depletion at its maximum.

Whereas as the temperature increases with time the polar stratospheric clouds (PSCs) are destroyed, the ozone depletion process shuts down, and the ozone hole closes.

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EIA & ENVIRONMENTAL AUDIT

CONCEPT OF EIA

Environmental Impact Assessment (EIA) means a formalised procedure for examination, analysis and assessent of planned activities with a view to ensuring environmentally sound and sustainable development. The principal goals of EIA practices are:

- To establish that before decisions are taken by the competent authority to undertake some project, the environmental effects of those activities should be taken fully into account.
- To promote the implementation of appropriate procedures in all countries consistent with national laws and decision-making processes.
- To encourage the development of reciprocal procedures for information exchange, notification and consultation between states when proposed activities are likely to have significant transboundary effects on the environment of those states.

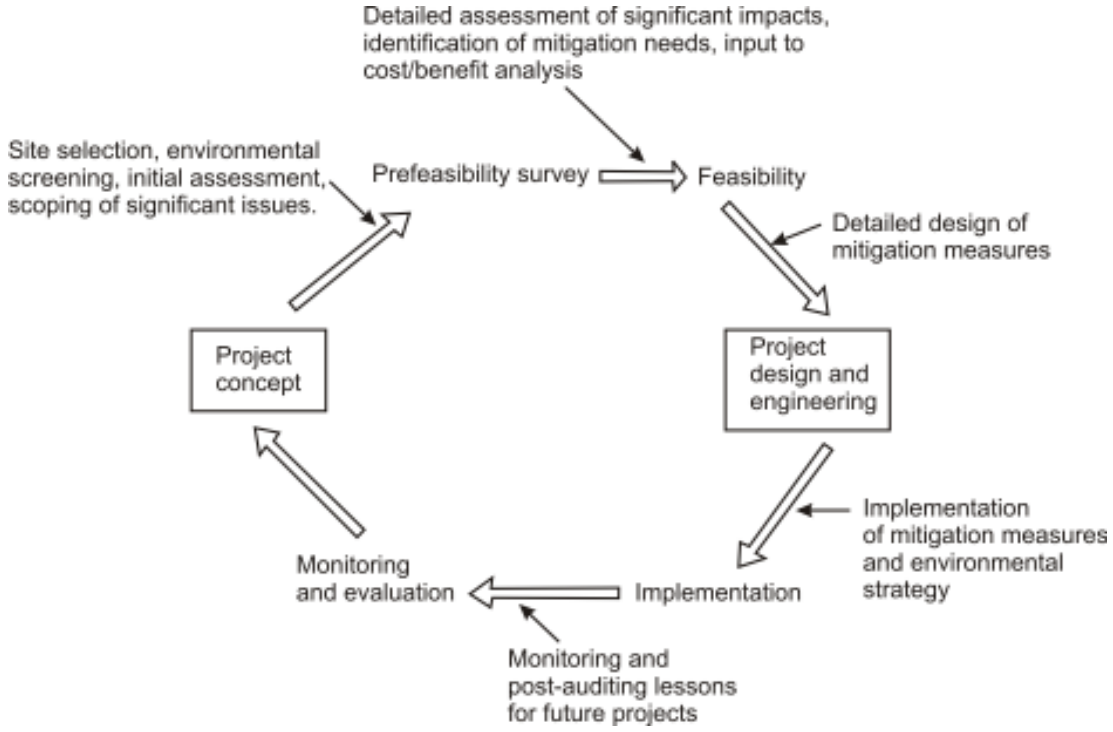
PROCESS OF EIA

There are nine major stages of EIA process—Screening, Preliminary assessment, Orga-nisation, Scoring, Identification, Prediction, Evaluation, Mitigation and Documentation in the form of Environment Impact Statement (EIS).

In the process of environmental impact statement (EIS) preparation, there are four areas which need to be reviewed properly. These are:

1. Description of the development, the local environment and the baseline conditions.
2. Identification and evaluation of key impacts.
3. Formulation of alternatives and mitigatory measures.
4. Impact interpretation and communication of results.

The purpose(s) of the development should be described as should the physical characteristics, scale and design. Quantities of



UN ENVIRONMENT PROGRAMME (UNEP)

Principles of EIA

1. States (countries, including their competent authorities) should not undertake or authorise activities without prior consideration, at an early stage, of their environmental effects. Where the extent, nature or location of a proposed activity is such that it is likely to significantly affect the environment, a comprehensive environmental impact assessment (EIA) should be undertaken in accordance with the following principles.
2. The criteria and procedure for determining whether an activity is likely to significantly affect the environment and is therefore subject to an EIA should be defined clearly by legislation, regulation, or other means, so that subject activities can be quickly and surely identified and EIA can be applied to the activity as it is being planned.
3. In the EIA process, the relevant significant environmental issues should be identified and studied. Where appropriate, all efforts should be made to identify these issues at an early stage in the process.
4. An EIA should include, at a minimum :

   (a) A description of the proposed activity;

   (b) A description of the potentially affected environment, including specific information necessary for identifying and assessing the environmental effects of the proposed activity;

   (c) A description of practical alternatives, as appropriate;

   (d) An assessment of the likely or potential environmental impacts of the proposed activity and alternatives, including the direct, indirect, cumulative, short-term and long-term effects;

   (e) An identification and description of measures available to mitigate adverse environmental impacts of the proposed activity and alternatives and an assessment of those measures;

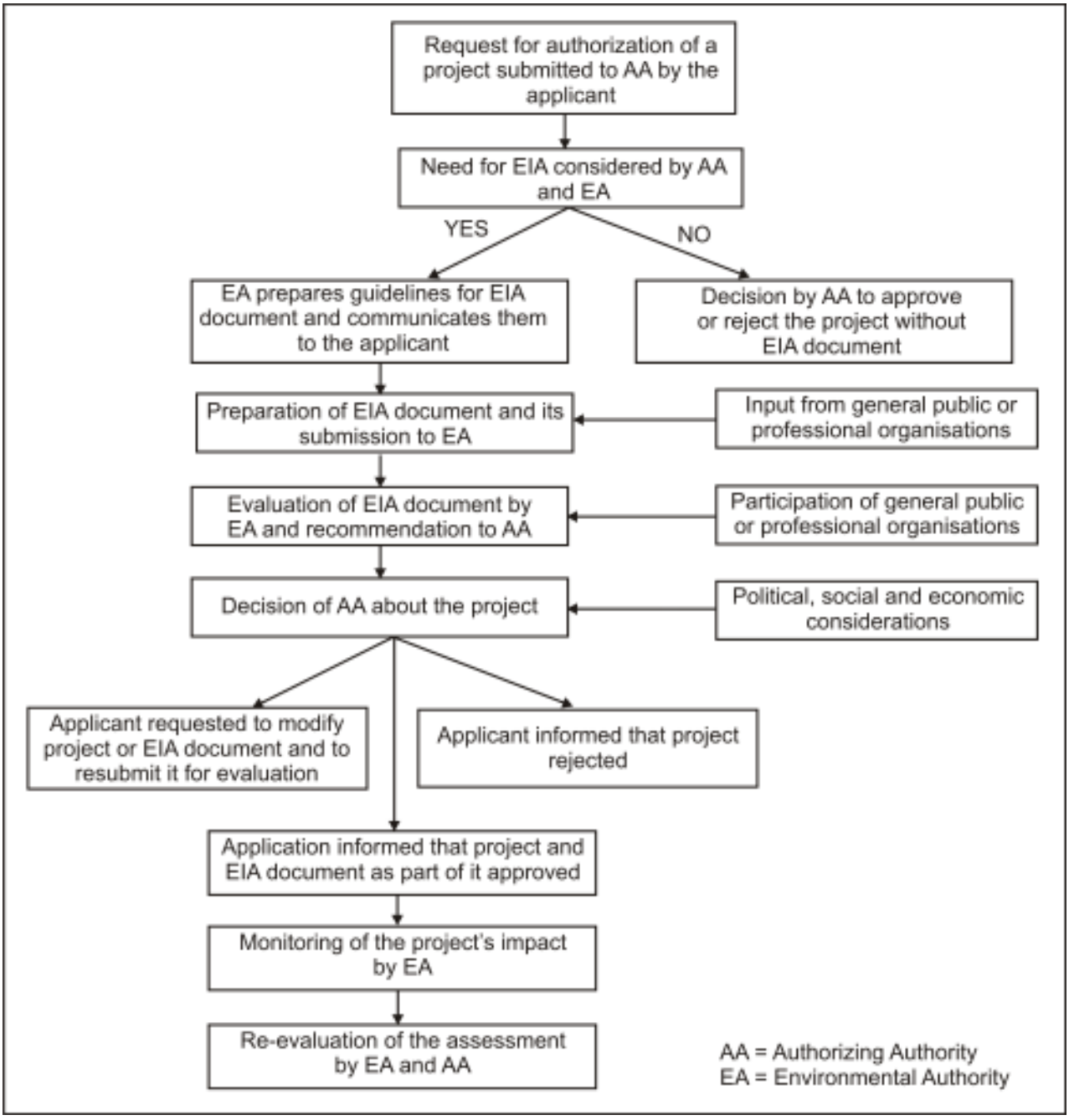
   (f) An indication of the gaps in knowledge and uncertainties which may be encountered in compiling the required information;

   (g) An indication of whether the environment of any other State or areas beyond national jurisdiction is likely to be affected by the proposed activity or alternatives;

   (h) A brief, non-technical summary of the information provided under the above headings.
5. The environmental effects in an EIA should be assessed with a degree of details commensurate with their likely environmental significance.
6. The information provided as part of an EIA should be examined impartially prior to the decision.
7. Before a decision is made on an activity, government agencies, members of the public, experts in relevant disciplines and interested groups should be allowed appropriate opportunity to comment on the EIA.
8. A decision as to whether a proposed activity should be authorised or undertaken should not be taken until an appropriate period has elapsed to consider comments pursuant to principles seven and twelve.
9. The decision on any proposed activity subject to an EIA should be in writing, state the reasons therefore and include the provisions, if any, to prevent, reduce or mitigate damage to the environment. This decision should be made available to interested persons and groups.
10. Where it is justified, following a decision on an activity which has been subject to an EIA, the activity and its effects on the environment or the provisions (pursuant to principle nine) of the decision on this activity should be subject to appropriate supervision.
11. States should endeavour to conclude bilateral, regional or multilateral arrangements, as appropriate, so as to provide, on the basis of reciprocity, notification, exchange of information and agreed-upon consultation on the potential environmental effects of activities under their control or jurisdiction which are likely to significantly affect other States or areas beyond national jurisdiction.
12. When information provided as part of an EIA indicates that the environment within another State is likely to be significantly affected by a proposed activity, the State in which the activity is being planned should, to the extent possible:

    (a) Notify the potentially affected State of the proposed activity;

    (b) Transmit to the potentially affected State any relevant information from the EIA, the transmission of which is not prohibited by national laws or regulations.



materials needed during construction and operation should be included and where appropriate, a description of the production processes. In addition, the site land requirements of the development should be described and the duration of each land use. As and where practicable, specific mitigation measures should be put forward. Mitigation methods considered should include modification of the project, compensation and provision of alternative facilities as well as pollution control. Clear details of how the mitigation measures will be implemented and function over the time span for which they are necessary should be described in depth.

Each EIS should have an executive summary. The summary should be comprehensive, containing, at least, a brief description of the project and the environment, an account of the main mitigation measures to be undertaken by the developer and a description of any remaining or residual impacts. A brief explanation of the methods by which these data were obtained and an indication of the confidence which can be placed in them, should also be included.

In every project formulation, EIA preparation is one of the mandatory aspects as it forms an integral part of the project cycle (Fig. 1). On the whole the purpose of EIA is to give the environment its due weightage of the decision making process by clearly evaluating the environmental consequences of a proposed

CURRENTLY USED IMPACT EVALUATION METHODS

Types		Detailed Methodologies
I	Ad hoc	These methodologies provide minimal guidance for impact assessment beyond suggesting broad areas of possible impacts (e.g., impacts upon flora and fauna, lakes and forests), rather than defining the specific parameters within the impact area which should be investigated.
II	Simple check-lists	These methodologies present a specific list of environmental parameters to be investigated for possible impacts, or a list of agency activities known to have caused environmental concern. They may have considerable value when many repetitive actions are carried out under similar circumstances. They do not, in themselves, establish a direct cause-effect link, but merely suggest lines of examination.
III	Overlays	These methodologies rely upon a set of maps of project area's environmental characteristics (physical, social, ecological, aesthetic). These maps are overlaid to produce a composite characterisation of the regional environment. Impacts are identified by noting the congruence of inherently antagonistic environmental characteristics within the project boundaries. The Geographic Information System (GIS), is a modern development of this method.
IV	Matrices	The matrix methodologies incorporate both a list of project activities and a checklist of potentially impacted environmental characteristics. In a way, the matrix presents both alternatives from the check-list approach (i.e., both attributes and activities) to be considered simultaneously. The two lists are then related in a matrix which identifies cause and effect relationships between specific activities and impacts. Matrix methodologies may either specify which actions impact which environmental characteristics or may simply list the range of possible actions and characteristics in an open matrix to be completed by the analyst.
V	Networks	These methodologies work from a list of project activities to establish cause condition-effect relationships. They are an attempt to recognise that a series of impacts may be triggered by a project action. Their approaches generally define a set of possible networks and allow the user to identify impacts by selecting and tracing out the appropriate project actions.
VI	Combination computer-aided	These methodologies use a combination of matrices, networks, analytical models and a computer-aided systematic approach: – Identify activities associated with implementing major federal programmes; – Identify potential environmental impacts at different user levels; – Provide guidance for abatement and mitigation techniques; – Provid analytical models to establish cause-effect relationships to quantitatively determine potential environmental impacts; – Provide a methodology and a procedure to utilise this comprehensive information in responding to requirements of EIS preparation.

activity. A simplified flow chart for the procedure of EIA is given in Fig. 2.

EVALUATION METHODOLOGY

Different methods currently used for EIA evaluation are summarised below with respect to their criteria suitability in Table 1.

Among these, four methods are often used for their various criteria suitability. Quite considerable number of matrix system application were known in recent years. Among these, Leopold and Lohani and Thanh's procedure is often applicable in most cases.

In recent years, however, a new type of 'Environmental evaluation system' is often implemented, this is called "Battelle Environmental Evaluation System" (BEES). This process involves identification of environmental parameters likely to be affected by project implementation, estimation of resulting changes in the selected parameters and aggregating the changes in determining resultant environmental quality.

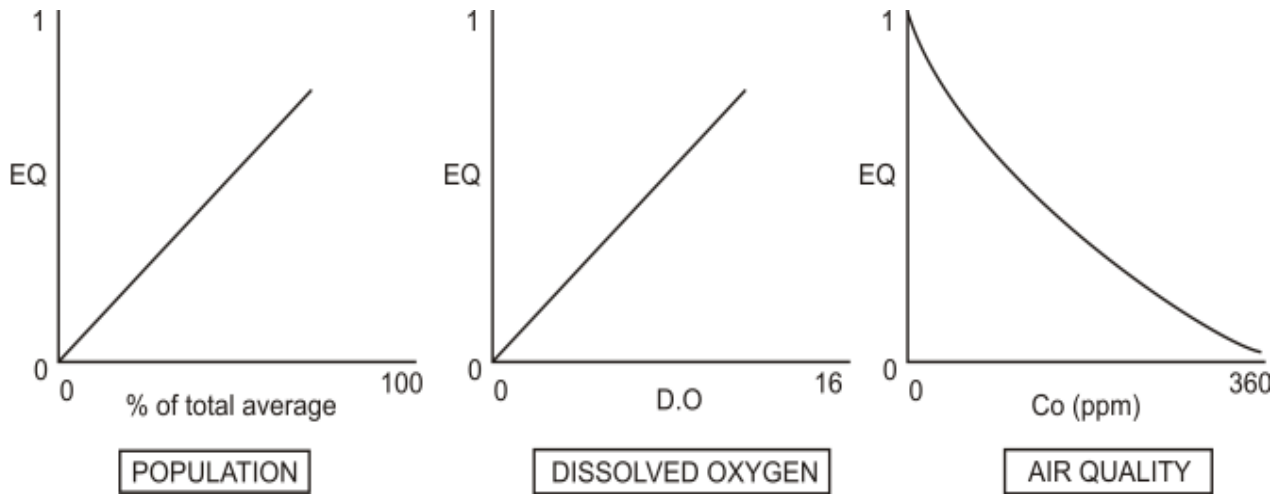
Thus this process necessitates trans-formation of parameter estimates into Environmental Quality (EQ) on a scale ranging from zero to one. Such a transformation is achieved through value function graphs which provide functional relationships between the parameter estimates and environmental quality scale. In addition as each of the selected parameter represents only a part of the total environment, weights are assigned to the parameters to reflect their relative importance for ascertaining impact of the project on natural and socio-economic environment. These weights are derived by an interdisciplinary expert team using ranked pair-wise comparision technique and expressed as Parameter Importance Units (PIU). A total of 1,000 'PIU's are allocated amongst the selected parameters.

For evaluation of impact of project on environment, an index expressed as Environmental Impact Units (EIU) has been estimated for three alternative environmental conditions, viz., the baseline without project, without environmental management plan (EMP) and project with EMP.

The impact scaling in this process has been, accomplished through the use of value functional relationships of identified 45 typical parameters. Functional relationships refer to transforming parameter measurements (baseline or predicted values) into subjective evaluations through graphical means. The typical functional relationships of some selected parameters are depicted in Fig. 3. Objective measurements are transformed into subjective interpretation of environmental quality (EQ) on a scale representing, a value of 1.0 for good quality and 0.0 for poor quality.

It is observed that the estimated change in EIU from baseline, due to the project without EMP is – 111. The recommended EMP for the project charges the EIU value is + 131. The overall change in EIU due to project over the baseline is + 20.

Though Battelle Environmental Evaluation System (BEES) has been considered to be the best aavailable evaluation technique in EIA evaluation, yet it suffers from inherent uncertainty in assigning relative weights, or PIU to different environmental parameters and subjectivity in formulation of Value Function Graphs (VFG).



THE ROLE OF EIA IN SOCIETY

1. Provides a procedure for the full consideration of the possible adverse environmental impacts of policies, programmes, activities and projects before any decision to proceed; it precludes 'behind closed doors' decision making in the public and private sectors;
2. There is an opportunity to present recommendations to the decision-maker on the suitability of the policy, programme (groups of projects, either sequential or concurrent), activity, or project, to proceed or not, on environmental grounds;
3. For proposals which proceed, there is the opportunity to present the incorporation of conditions of consent that should mitigate some of the adverse environmental effects;
4. It is an avenue for the public to contribute to the decision-making process, through written and oral contributions to the decision-maker(s) appearances at public inquiries and hearings and possible participation in mediation processes;
5. The whole process of development is open to scrutiny for the benefit of all the key players : proponent (applicant), government and public, resulting in better projects more carefully thought-out.
6. Basically unsatisfactory projects (including otherwise satisfactory projects on the wrong site) tend to weed themselves out before advancing far into the EIA process and certainly before reaching a public enquiry stage;
7. Conditions of approval may ensure monitoring, annual reporting by the proponent, post-project analyses (PPA) and independent auditing;
8. Alternative approaches, mixes of technology, and sites, can be thoroughly examined;
9. EIA is seen, however, as the servant of development: promoting better developments, at best, but basically supporting economic growth;
10. The process endorses waste discharges, the emission of greenhouse gases in many cases and the profligate use, mining, extraction, and processing of natural resources;
11. The whole process as a creature of government, is subject to political pressures; key players within government have no security of employment whatever;
12. Officers of integrity have little chance when confronted by a combination of hostile interests at a political level;
13. On the other had, a vigilant public, skilled objectors and organisations with a range of legal rights to object, access to the courts, and a supportive media with some political sympathy, can exercise countervailing power and influence.

ENVIRONMENTAL AUDIT

1. CONCEPT

Environmental auditing is a management tool designed to provide information on environmental performance to the right people at the right time.

An environmental audit is a systematic means of providing environmental management information:

(a) to all levels of management;

(b) for a variety of purposes.

The term 'environmental audit' is, therefore, used to refer to a number of different information and assessment activities. These can be categorised as :

(a) ***A technical review :*** Such an audit will involve the systematic collection of information about the existing and potential impact of the organisation's activities on the environment; it will normally cover compliance with pollution control and waste management legislation. It will not cover management practices.

(b) ***A management review*** **:** This will focus more on the management procedures and record keeping and will also gather information on compliance with legislation. It may also review procedures in the context of company policies, programmes and other requirements. It will not examine the existing or likely impact of the operation on the surrounding environment from a technical standpoint.

(c) ***Due diligence review*** **:** This will examine the likely cost of implementing pollution control and site remediation actions and will take account of existing and future legislation. Such liability reviews are normally carried out in the context of mergers, acquisitions and long range company planning.

An environmental audit thus represent a management tool comprising a systematic, documented, periodic and objective evaluation of the performance of the organisation, management system and processes designed to protect the environment with the aim of:

(i) facilitating management control of practices which may have an impact on the environment;

(ii) assessing compliance with company environmental policies.

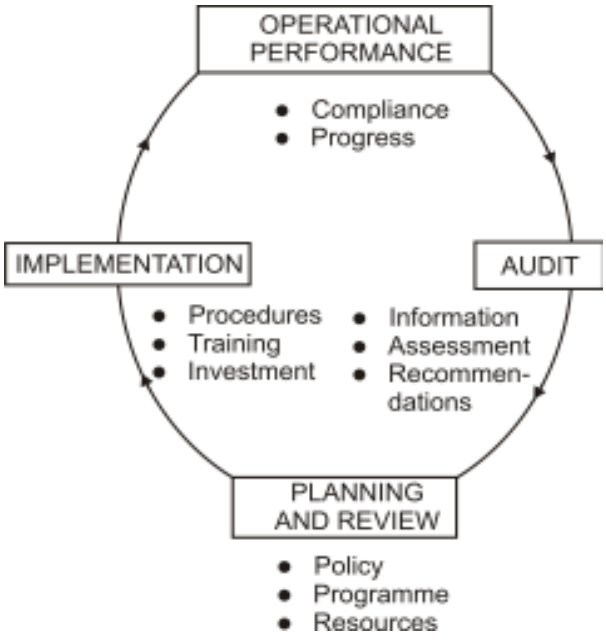


Fig. 1: Environmental management cycle

The Regulation specifies that an audit should include at least the following steps :

– Planning of the audit activities, including definition of responsibilities for the audit;

– Review of the environmental protection policy of the company;

– Assessment of the organisation, management and equipment;

– Gathering of data and of all relevant information;

– Evaluation of the overall performance;

– Identification of areas for improvement;

– Internal reporting to the top management;

An outline of environmental management cycle is shown in Fig. 1.

SETTING UP AN AUDIT PROGRAMME

Developing an audit programme requires decisions to be taken on :

– the scope of the audit : what information is to be collected;

– the frequency with which each site (or issue) is to be audited;

– who is to carry out the audit;

– what, if any, information is to be made available to the public.

It is also necessary to develop an audit protocol : that is, the detailed plan to be used by each auditor when carrying out the audit.

SCOPE AND FREQUENCY OF THE AUDIT

The scope of the audit will depend on the information that is required by management to monitor environmental performance. A full environmental audit will cover:

(i) compliance with environmental regulations,

(ii) implementation of company's environmental policies and procedures,

(iii) good environmental management practice and

(iv) past activities.

In so far as it provides the information to determine an organisation's environmental performance it may be expected to cover not ony waste streams from plants but also wider management and operational issues.

The Eco-Management and Audit Regulation suggests that the following should be covered within the framework of the wider environmental protection system:

- assessment, control and prevention of the impact of the activity concerned on the various sectors of the environment;
- energy management, savings and choice;
- raw materials, management, savings, choice and transportation; water management and savings;
- waste avoidance, recycling, reuse, transportation and disposal;
- selection of production processes;
- production planning (design, packaging, transportation, use and disposal);
- prevention and limitation of accidents;
- staff information, training and participation in environmental issues;
- external information, public participation and handling of public complaints.

In their guidance on environmental auditing the CBI (Confederation of British Industries) includes a similar listing, amplified into more detailed questions (CBI, June 1990). So, for example, on wastes and transport the detailed questions include the following:

Wastes **:** How and where is waste of all types generated? Can it be minimised / eliminated / recycled? Where production of waste is unavoidable, would it provide a suitable raw material for another organisation, either business or voluntary group? Are you losing recycling opportunities or increasing disposal costs by not segregating different types of waste? Who removes your waste—is it carried and disposed of responsibly.

Transport **:** Are you using the most efficient and environmentally sound systems for transporting your goods and materials? Would alternative systems make less demands on the environment? Do staff traveling on business use the most efficient system or merely the most 'convenient'? Would use of public transport bring about cost savings without significant increase in traveling times? Do you encourage staff to travel to work by public transport and could you increase availability of communal transport by providing additional company funded services?

WHO SHOULD CARRY OUT THE ENVIRONMENTAL AUDIT?

To be of maximum value an environmental audit should be objective and the environmental auditor should be free from pressure from within the organisation; in other words it is important that the audit report should be objective and the auditor should be able to make critical comments without fear of the effect of such comments on his future career within the organisation.

A number of major companies have establihsed audit teams within their corporate environmental health and safety department. In some cases, the staffing of these teams relies on secondment from different departments within the company. In so far as individuals are then auditing different parts of the company this has a benefit that they understand the business but have no internal line of responsibility to the activity being audited.

Some organisations have used external consultants to carry out some or all of the audits; in this case it is often valuable for the external auditor to work with the company's team.

Environmental auditing requires an understanding of the activity to be audited (this may be a plant, an abandoned site or a corporate headquarters); an understanding of management systems, environmental regulations and permitting procedures; and also a broad understanding of environmental impacts. A qualified auditor will, in addition, need to be systematic, able to deal in a constructive way with a range of management and technical staff.

THE AUDIT PROTOCOL

The protocol represents the plan to be used by auditors in conducting an audit. It establishes what information is to be collected, it provides a systematic basis to the audit; and it also gives a step-by-step guide to the environmental auditor on how evidence is to be collected. The protocol is an important tool in so far as it not only serves as the auditor's guide to conducting the audit but also acts as a record of the audit procedures and the notes completed by the team. In addition, a completed audit protocol provides a record for the rationable for any changes in audit

ITEMS TO BE ADDRESSED IN AUDITS

Environment	Safety	Occupational health	Product safety
Site history	Safety policy / procedures	Employee exposure to air contaminants	Product safety programme
Process materials used	Accident reporting Accident investigation	Exposure to physical agents e.g. noise, radiation, heat etc.	Product quality control
Storage of materials above ground below ground	Accident recording	Measurements of employee exposure	Product packaging, storage and shipping
Air emissions	Permit to work systems	Exposure records	Product recall withdrawal procedures
Water discharges	Special procedures for:	Ventilation engineering controls	Customer information on product handling and quality
Solid wastes Liquid hazardous wastes Asbestos, PCBs	confined space entry work on electrical equipment breaking into pipelines, etc.	Personal protective equipment Information and training on health hazards	Regulatory compliance Labelling
Waste disposal on site off site	Emergency response Fire fighting	Medical surveillance programme	Specifications for purchased materials products packaging
Oil / chemical spill prevention Permits, licences	Job safety analysis Safety training	Hearing conversation First aid	Material safety data Vendor qualification Programme
Pollution control Contractors on site	Safety communications promotion	Regulatory requirements	QA testing and inspections
	Housekeeping		Record keeping
Past incidents	Regulations compliance		Product literature Process control

procedures or deviations from plan if these prove necessary during the audit.

SPECIFICALLY THE PROTOCOL

(a) contains a basic questionnaire covering each environmental topic;

(b) provides the hard copy record to assist the auditors as the work progresses and provides a basis for referencing working papers and copies of documentation collected during the audit;

(c) the completed protocols with the supporting documents are the record of the audit and form the basis for the formal audit report.

The protocol is therefore the key step in establishing the audit programme in so far as it informs managers and others about the scope of the audit and provides the opportunity to request that the changes are made either to collect additional information or to delete information that will not be used.

TYPICAL AUDIT PROCESS

The following typical audit process reviews the work required prior to the audit; activities at a site; and post-audit activities. It is specifically applicable to a manufacturing site rather than, for example, a corporate headquarters. The issues that are likely to be addressed in the audit are shown in Table 1.

PRE-AUDIT ACTIVITIES

(a) Select and schedule facility to audit based on :

- selection criteria
- priorities assigned.

(b) Select audit team members

- confirm their availability
- make travel and lodging arrangements
- assign audit responsibilities.

(c) Contact facility and plan audit

- discuss audit programme
- obtain background information
- administer questionnaire (if necessary)
- define scope
- determine applicable requirements
- note priority topics
- modify or adapt protocols
- determine resource needs
- identify facility staff to be interviewed, confirm availability.

ACTIVITIES AT SITE

Step 1: Identify and understand management control systems

- review background information
- opening meeting
- orientation tour of facility
- review audit plan
- confirm understanding of internal controls.

Step 2: Assess management control systems

- identify strengths and weaknesses of internal controls
- adapt audit plan and resource allocation
- define testing and verification strategies.

Step 3: Gather audit evidence

- apply testing and verification strategies
- collect data
- ensure protocol steps are completed
- review all findings and observations
- ensure that all findings are factual
- conduct further testing if required
- liaise with regulatory authorities.

Step 4: Evaluate audit findings

- develop complete list of findings
- assemble working papers and documents
- integrate and summarise findings
- prepare report for closing meeting.

Step 5: Verbal report of findings to facility

- present initial findings at closing meeting
- discuss findings with plant personnel.

POST-AUDIT ACTIVITIES

(a) Issue draft report

- corrected closing report
- determine distribution list
- distribute draft report
- allow time for corrections

(b) Issue final report

- corrected draft report
- distribute final report
- highlight requirement for action plan
- determine action plan preparation deadline.

(c) Action plan and preparation and implementation

- based on audit findings in final report.

(d) Follow-up in action plan.

CARRYING OUT THE AUDIT

COLLECTING INFORMATION

Environmental auditing requires the auditor to develop a full understanding of the controls, procedures and practices; that are in place or are thought to be in place. They are likely to include formal procedures and practices; all forms of records (including monitoring); existing inspection and maintenance programmes; physical controls and other measures to contain spills and other incidents, etc. The auditor will need to understand how responsibilities are defined; how personnel are trained and how competent those on the site appear to be; how procedures are carried out and other standard management issues. In addition to the use of the detailed questionnaire (forming part of the protocol) the auditor will gain information through observation, interviewing individual staff, reviewing specific documentation and speaking to the appropriate regulatory authorities.

AUDIT INTERVIEWS

Since interviewing is one of the primary techniques used in gathering audit information, good interviewing skills are essential to the successful completion of the audit. Attention to the following elements of interviewing skills during the audit process will assist in establishing a good rapport with the facility personnel as well as obtaining the information required.

Take notes during the interview and record the name, title and job description of the person interviewed; be alert and responsive to the interviewee when asking questions and listening to responses; control the interview, but ensure that you appear relaxed and that your interviewee feels relaxed; go to the interviewee's workplace/office where possible; plan the interview so that you introduce yourself, explain the purpose of the interview and gather the appropriate information; know when to end the interview and thank the interviewee; end the interview on a positive note.

DOCUMENTATION

It is a central principle that the audit should be fully documented; there should, therefore, be a clear, written, audit trail. The working papers from an audit will include completed protocols, associated questionnaires, auditor notes and copies of documents collected during the audit itself. It is important that each auditor ends the audit with a complete set of field notes and papers for each protocl step assigned to that auditor; that there is documentaiton (1) to ensure that an adequate audit was conducted and, (2) to substantiate compliance and non-compliance issues, both with respect to regulatory requirements and company procedures; that there is a record of reference copies of documents collected during the audit; and there is the data to support the audit report, which may be helpful in subsequent follow-up.

The working paper should, contain all the information that the auditor believes management and control sysems—including flow charts, diagrams, copies of documents, etc.; a description of the action taken to complete each step of the audit protocol; details of answers to questions in the protocol and other questionnaries used; details of any 'tests' conducted during the audit (e.g., checking that consignments of hazardous waste had the relevant documentation for each disposal).

PUBLIC DISCLOSURE

Unlike financial audits, environmental audits are not carried out for the purposes of providing information to the regulatory authorities or the public at large. They are intended to assist management understand the impact their operations are having upon the environment and to provide a basis for taking action to remedy any problems. To this extent companies are likely to be unwilling to make the results of their environmental audits public; or, if the audit is carried out with this objective, it is likely that it will be a far less valuable management tool. The ICC (Indian Chamber of Commerce) has noted that if environmental audits are to be successfully used as part of company policy 'it is essential that the procedure should be seen as the responsibility of the company itself, should be voluntary and for company use only'.

The Eco-Audit proposal does however propose that certain information should be made available to the public on the environmental performance of the company. This would be an 'environmental statement' specific to each site audited and prepared with the same frequency as the environmental audits.

Such a statement would :

— describe the company's activities at the site;

— provide a detailed assessment of all the significant environmental issues of relevance;

— summarise the figures on pollutant emissions, waste generation, raw material, energy and water consumption and other significant environmental aspects;

— include the company's environmental policy programme as well as the specific objectives for the site considered;

— include an evaluation of the environmental performance of the environmental management system and note the date for the submission of the next statement;

– publish the name of the accredited environmenta l verifier for the Statement: this requirement for external, independent evaluation is a crucial component of the Regulation.

Simplified statements must be drawn up for the intervening years in the audit cycle. These must draw attention to significant changes from the previous statement and include details of pollutant emissions.

Where no significant changes have occurred, no further statement is required until the completion of the next audit.

It will be appreciated that for many plants and processes within the UK information on emissios, wastes and environmental effects is already on the public register (through the provisions of the *Environmental Protection Act, 1990)* and increasingly the larger companies are providing a clear statement of their environmental policies and programmes in order to make it clear to the public that they are aware of their environmental responsibilities.

So while the environmental audit remains the internal document (like management accounts) companies may wish to provide a general summary in order to demonstrate to the public that they are carrying out audits and are happly to make some of the information more widely available. It should perhaps be noted that such internal systematic reviews may also become public that, should there be a serious pollution incident at the plant or a civil action with the result that the documents are placed before an inquiry or any other form of legal hearing.

BENEFITS OF ENVIRONMENTAL AUDITING

A properly implemented environmental audtit plan provides a range of benefits for an organisation. These are:

(i) It provides a framework for measuring (and therefore managing) environ-mental performance.

(ii) It reinforces accountability for the environmental dimension of the business: the audit process requires managers to be clear about their responsibilities and how these are being implemented.

(iii) It raises awareness of the importance of professional environment management throughout the organisation.

(iv) To the extent that external reporting will be required, it provides a sound basis that enables companies to feel sure that what is included in the reports is an accurate record.

(v) It provides valuable information for future planning. This includes the future design of processes and products as well as inputs into future financial plans where pollution control and other investments are to be made.

(vi) It allows senior managers to feel secure that all environmental aspects of their business are being professionally managed: it will not remove all possibility of environmental incidents but will at least reduce their likelihood.

ENVIRONMENTAL AUDIT PROGRAMME IN INDIA

The concept of environmental auditing in industrial facilities in India, appears to have first got into meaningful discussions in the beginning of the nineties. Efforts were initiated to see the practicability of this programme before it could be mandatory. This process finally resulted in the issuing of a gazette notification on 13th March 1992 through which submission of the environmental audit reports has been made mandatory. The industries are now required to

submit their audit reports to the concerned state pollution control boards on or before 15th day of May every year beginning 1993.

A good number of polluting industries were identified for submission of regular environmental audit report. These are :

1. Cement factories (above 200 tonnes per day production capacity)
2. Thermal power plants
3. Fermentation / Distillery factories
4. Sugar factories
5. Fertiliser and sulphuric acid plants
6. Integrated iron and steel plants
7. Pulp & paper Industries (above 30 tonnes per day production)
8. Oil refineries
9. Caustic soda plants
10. Petrochemicals plants
11. Pesticide formulation and manufacturing plants
12. Leather processing industries, including tanneries
13. Basic drugs and pharmaceuticals manufacturing plants
14. Dye and Dye intermediates
15. Zinc smelting industries
16. Copper smelting industries
17. Aluminium smelting industries
18. Lead smelting industries.

On the whole, the environmental audit studies were not intended for completing any regulatory requirements, but with the basic philosophy that at least those industries which need priority attention in the sense of pollution control, should know what it is, as well as why and how it is to be done, before the industries actually arrange to set it done on their own as a mandatory requirement, as per the GOI's notification of 13th March 1992.

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ENVIRONMENTAL CONSERVATION

A. BIODIVERSITY CONSERVATION

The term "Biodiversity" is defined as the variability among living organisms and the ecological complexes of which they are part. It includes diversity within and between species and ecosystems.

Need for Bio-diversity Preservation

Though human being is a major component of the eco-system, it cannot overlook the importance of biodiversity at species, genetic and eco-system levels. It has direct consumptive value in food, agriculture, medicine, industry apart from aesthetic and recreative value. Biodiversity maintains ecological balance and continues evolutionary processes. The indirect ecosystem services provided through biodiversity are photosynthesis, pollination, transpiration, chemical cycling, nutrient cycling, soil maintenance, climate regulation, air, water system management, waste treatment and pest control. Bio-diversity regulates the eco-system in the following ways:

(1) Bio-diversity plays an important role in protecting the water resources. The natural vegetation cover in water catchment helps in maintaining hydrological cycles, regulating and stabilising water runoff and acts as buffer against extreme events like floods and drought. It also helps to regulate underground water table. Recently, in many parts of the world due to degradation of habitats groundwater level is depleting. For instance, in eastern coastal region of India the last 25 years have seen a decline of water level by 30 feet.

(2) In the process of soil formation and its protection the bio-diversity also plays a major role. It maintains the soil structure and increases the soils moisture retention capacity as well as nutrient level of soils. Trees help in soil formation, their root system enables deep penetration of water and transport mineral nutrients to surface. Litter formation by the organic matter enhances the microbial activity.

(3) In order to maintain the eco-system biological diversity plays an important role in nutrient recycling. Microorganisms in the soil decompose the dead and decayed wastes which ultimately replenish the soil's nutrients. Hence, the diversity of microorganism is very essential.

(4) The diverse components of the ecosystem, the decomposers, breakdown and absorb pollutants, reduce BOD and also destroy harmful microorganisms. Many pollutants, including sewage, garbage, oil-spills etc. often pollute sites even far away from their actual source. For instance, deleterious DDT levels have been reported in seals and other aquatic inhabitants of the Arctic and the Antarctic regions.

(5) Vegetation influences climate both at the micro and macro levels. Forests maintain rainfall by recycling water vapour stability into atmospheric turbulence. Only trees can absorb CO_2 and maintain the stable CO_2-O_2 balance.

(6) In order to maintain balance between living things and the needful resources the animal-plant relationship should be healthy. The web of life is so intricate that removal or disturbance of one part of the ecosystem could affect the smooth functioning of many of its other components. For sustainable availability of biological resources, a healthy bio-diversity of the ecosystem should be maintained. Since heterotrophs depend on autotrophs, only through conservation of floral biodiversity the global food security could be maintained. The nutritional value is different for different groups. Further diversity of food crops increase opportunities for enhancing agricultural productivity.

(7) The social benefits of the biodiversity also cannot be neglected. Nature serves as the best laboratory for studies. The research, education and extension works can progress only with the help of nature and its inherent bio-diversity. Unaltered habitats help us to evolve indexes to formulate different management levels. There are ample evidences to prove that human culture has co-evolved with the environment. For this reason itself, conservation of biodiversity is important for his cultural identity. It is a fact that nature has always provided inspirational, aesthetic and educational need of the people. Nature also contributes to our emotional and spiritual well being.

Methods for Biodiversity Conservation

1. Wetlands

Wetlands refer to complex ecosystems encompassing a wide range of inland, coastal and marine habitats such as floods plains, swamps, marshes, tidal marshes, etc. They have the characteristics of both dry and wet environments and show wide diversity based on their genesis, location, hydrological regimes and substrate factors.

Wetlands provide suitable habitats for endangered and rare species of birds and animals, endemic plants, insects and invertebrates, besides sustaining migratory birds and waders.

The scheme on conservation and management of wetlands was started in 1986-87 with the objective of undertaking a comprehensive study of important wetlands representing different ecosystems. A National Committee on Wetlands, Mangroves and Coral Reefs has been constituted to lay down broad policy guidelines for implementing the programme and identifying wetlands for intensive conservation, management and research. Based on the recommendations of this committee, 22 wetlands were originally identified for intensive action. Out of these, 18 remain within the wetlands scheme. The rest four namely Bhoj, Sukhna, East Kolkata Wetlands and Pichola are being dealt with under the National Lake Conservation Plan as they fall within urban areas and require special treatment.

National Wetland Conservaton Programme: National Wetland Conservaton Programme has been extended to 115 wetlands all over the Country involving 24 States and Union Territories. 22 new Wetlands have been added to the list after visiting these areas and approving field report in the National Committee for identification of new sites.

The Cabinet Committee on Economic Affairs on February 7, 2013, approved the proposal for the merger of National Lake Conservation Plan (NLCP) and National Wetlands Conservation Programme (NWCP) into a new scheme called the 'National Plan for Conservation of Aquatic Eco-systems' (NPCA). The merged scheme shall be operational during the XII Plan Period at an estimated cost of Rs.900 crore on 70:30 cost sharing between the Central Government and respective State Governments (90:10 for North-East States).

For conservation of lakes and wetlands, the Ministry of Environment and Forests is presently, implementing two separate Centrally Sponsored Schemes (CSS), namely the NWCP and the NLCP. To avoid overlap, promote better synergies and to ensure conservation and management works, an integrated scheme, NPCA is proposed, with the objective of conserving aquatic ecosystems (lakes and wetlands), through implementation of sustainable conservation plans and governed with application of uniform policy and guidelines.

2. Mangroves

Mangroves refer to those forest ecosystems whose vegetation tolerates both high water salinity and regular floods. They are reservoirs of large number of plant and animal species associated together over a long evolutionary time and are tolerant of the same environmental conditions.

Some of the best mangroves in the world occur in the alluvial deltas of Ganga, Godavari, Krishna and Cauvery and in the islands of Andaman and Nicobar. Mangroves occur all along the Indian coastline in sheltered estuary, tidal creeks, backwaters, salt marches and mudflats covering about 6700 sq km which is about 7 per cent of the world's total mangrove areas. Fifteen areas have been selected, on the basis of the recommendations of the National Committee on Wetlands, Mangroves and Coral Reef for intensive conservation and management purposes. These are: northern Andaman and Nicobar, Sunderbans, Bhitarkanika in Orissa, Coringa, Krishna Estuary and Godavari Delta in Andhra Pradesh, Mahanadi Delta in Odisha, Pichavaram and Point Calimere in Tamil Nadu, Goa, Gulf of Kutch, Coondapur in Karnataka, Ratnagiri in Maharashtra and Vembanad in Kerala.

3. Coral Reefs

A particular class of animal belonging to phylum coelenterata is known as coral. It is a soft-bodied radially symmetrical marine invertebrate which secrets a calcareous skeleton. The reef is formed by the cementing together of millions of these calcareous skeletons over a long period of time.

The major reef formations in India are restricted to Gulf of Mannar, Palk Bay, Gulf of Kutch, Andaman and Nicobar and Lakshadweep Island. With the exception of Lakshadweep reefs, which are atolls, others are of fringing type.

The National Committee constituted for conservation and management of wetlands and mangroves also oversees the formulation and implementation of programmes of conservation, management and research of coral reefs. State level steering committees have also been constituted for the formulation and implementation of the management action plan for the identified coral reefs, namely Andaman and Nicobar, Lakshadweep, the Gulf of Mannar and the Gulf of Kutch.

On the recommendation of the National Committee on Mangroves and Coral Reefs, the existing centre of the Zoological Survey of India at Port Blair has been designated as the National Institute of Coral Reef Research.

The Ministry of Environment and Forests has been identified as the national focal point of the International coral reef initiative and the Global Coral Reef Monitoring Network.

4. Coastal Regulation Zone Notification 2011

On January 07, 2011 the Ministry of Environment and Forests (MoEF) released Coastal Regulation Zone (CRZ) Notification 2011 to replace CRZ Notification of 1991. Also for the first time, an Island Protection Zone Notification (IPZ), 2011 was released to cover Andaman & Nicobar Islands, Lakshadweep. The new notification has taken into account the fact that 250 million people live in the coastal areas (roughly 25 per cent of the population).

The Ministry had issued the Coastal Regulation Zone (CRZ) Notification on 19.2.1991 under the Environment (Protection) Act, 1986, with the aim to provide comprehensive measures for the protection and conservation of our coastal environment.

The main objectives of the CRZ Notification, 2011 are:

a) To ensure livelihood security to the fishing communities and other local communities living in the coastal areas;

b) To conserve and protect coastal stretches and;

c) To promote development in a sustainable manner based on scientific principles, taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming.

B. WILDLIFE CONSERVATION

India is one of the few countries of the world, whose Constitution makes specific references to the need for conserving the rich wild heritage of the country. Article 48 (A) of the Constitution enjoins upon the state, the responsibility of protecting and improving Environment and to safeguard forests and the wildlife of the country.

Strategy for conservation: In a country like India, where population pressures and the demand for forest usufructs for the sustenance of the lives of the rural people are rather high, the concept of wildlife protected areas i.e., establishment of National Parks, Sanctuaries representing various bio-geographic regions in the country has been one of the main thrust areas for conservation of wildlife. National parks are the areas of highest biodiversity value, where no human activity is permitted. Sanctuaries enjoy slightly lower status and exercise of certain rights by local residents, including grazing of livestock is allowed. Declaration of any area as a National Park or Sanctuary requires that the rights of the local people in the protected areas are duly recognised and settled. At present, we have extensive network of about 500 National parks and sanctuaries, covering some 4.3% of our territory.

International Union of Conservation of Nature (IUCN) has been involved in developing scientific criteria for identification of sites for protected areas, shape and size of the protected areas and the management strategies to be followed in this regard. A Regional conservation forum- Asia has also been formed for helping development of National Parks and Sanctuaries for effective conservation of wildlife.

It is estimated that about 1000 species of wildlife face extinction. The present probable rate

of extinction of species is about one per year in comparison to nearly one per ten years during AD 1600-1950. If the current pattern of land use continues and if sound conservation measures are not practiced a substantial part of its biological heritage and genetic resources will be lost.

Most wild animals inhabit the forest. Any change in the forest environment in terms of food supply and other details would have a corresponding effect on the animal population. Deforestation leads to destruction of wildlife.

Our main task in conservation is to set aside representatives of biotic communities and protect wild plants and animals. The biosphere reserves concept of UNESCO is an outcome of this need. In the UNESCO programme, representative natural ecosystems such as the deciduous forest, the conifer forest, the tropical forest, etc. are to be set apart as natural reserves. It is hoped that effective practical enforcement of the concept will significantly check the sharply dwindling wildlife populations and also preserve some of our present ecosystems.

In order to conserve the fauna-diversity various activities have been carried out at the government level. The Wildlife (Protection) Act, 1972, the provisions of the Convention on International Trade in Endangered Species (CITES) and Export and Import Policy of India is continued to be enforced. For controlling the poaching and illegal trade in wildlife 17 states/ UTs have set up state level coordination committees.

Schemes for wildlife conservation: As the wildlife conservation involves an extensive policing for protection of wild animals and their habitats as well as maintaining goodwill and seeking cooperation of the local communities, it requires substantial financial inputs. One of the most important schemes is "Development of National Parks and Sanctuaries'. Under this scheme, assistance is provided mainly for the improvement of the wildlife habitat through plantation of suitable species, fire control measures as well as strengthening the protection infrastructure.

The new National Wildlife Action Plan (2002-16), a revised form of the first National Wildlife Action Plan (NWAP) of 1983, has been adopted which outlines the strategies, action points and the priority projects for conservation of wild fauna and flora in the country. In the context of increasing threats due to biotic pressure and change in consumption pattern the NWAP has outlined the following strategies:

A. Strengthening and enhancing the Protected Area Network and their effective management.

B. Conservation of wild and endangered species and their habitats.

C. Restoration of degraded habitats outside Protected Areas.

D. Control of poaching and illegal trade in wild animals and plants.

E. Human research development and personnel planning.

F. Conservation awareness and education.

G. Development of wildlife tourism.

H. Integration of National Wildlife Action Plan with other sectoral programmes.

"Beneficiary/Oriented Scheme for Tribal Development Objectives and Components" has been launched to re-habilitate the tribal and other families proposed to be shifted from inside the protected areas to outside areas under relocation plan. The main objectives of this scheme are to identify the villages to be relocated, to identify the sites for relocation and to prepare rehabilitation projects.

The **"Eco-development Scheme** in and around National Parks and Sanctuaries" has been launched to provide alternate sources of sustenance to the communities living at the fringes. It aims to improve the ecological productivity of the buffer zones of protected areas through the involvement of these communities. The various activities undertaken in the scheme include biomass regeneration, soil and water conservation measures, alternative source of energy, human and livestock health, etc.

Wildlife Institute of India (WII), as an autonomous institute of the Ministry of Environment and Forest, trains the government and non-govt. personnel to carry out research and advise on matters of conservation and management of wildlife resources. The mission of the National Zoological Park (NZP), set up in 1959 at New Delhi, is to maximise the visitors satisfaction by maintaining a healthy collection of a variety of endangered as well as common fauna.

The Indian Board for Wildlife (IBWL) is the apex advisory body in the field of wildlife conservation, headed by the Prime Minister. In its 21st meeting at New Delhi the following resolutions were adopted:

(1) Wildlife and forest shall be declared priority sector at the national level for which funds should be earmarked.

(2) We should fully tap the potential in wildlife tourism and at the same time take care that it does not have adverse impact in wildlife and protected areas.

(3) Protecting interests of the poor and tribals living around the protected areas should be handled with sensitivity and with maximum participation of the affected people.

(4) We should also respond to newer threats to bio-diversity such as toxic chemicals and pesticides.

(5) Different forms of media should support the conservation.

(6) No diversion of forest land for non-forest purposes from critical and ecologically fragile wildlife habitat shall be allowed.

(7) Land falling within 10 km. of the boundaries of National Parks and Sanctuaries should be notified as eco-fragile zones.

(8) No commercial mono-culture to replace natural forests.

Concept of 'Threatened Species'

The rare species of plants and animals have been categorized for conservation purposes by the International Union of Conservation of Nature and Natural Resources (IUCN). The following categories have been identified:

Endangered: The species which are in danger of extinction and whose survival is unlikely if the causal factors continue to be operating. Their number has been reduced to a critical level or their habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

Vulnerable: The species likely to move into the endangered category in the near future if the causal factors continue to operate.

Rare: These are species with small populations in the world. These are not at present endangered and vulnerable, but are at risk.

IUCN Red List of Threatened Species

According to the 2012 World Conservation Union (IUCN) Red List of Threatened Species, life on earth is disappearing fast and will continue to do so unless urgent action is taken. There are now 63,837 species on the IUCN Red List and 19,817 of them are threatened with extinction. The total number of extinct species has reached 905. One in four mammals, one in eight birds, one third of all amphibians and 70 per cent of the world's assessed plants on the IUCN Red List are in jeopardy.

With 3,947 described as "critically endangered" and 5,766 as "endangered", while more than 10,000 species are listed as "vulnerable". At threat are 41 per cent of amphibian species, 33 per cent of reef-building corals, 30 per cent of conifers, 25 per cent of mammals, and 13 per cent of birds. The IUCN Red List has listed 132 species of plants and animals from India as "Critically Endangered".

Highlights of Red List: The population of great apes has declined by more than 60 per cent over the last 20-25 years. Corals have been assessed and added to the IUCN Red List for the very first time. In addition, 74 seaweeds have been added to the IUCN Red List from the Galápagos Islands. Ten species are listed as Critically Endangered, with six of those highlighted as Possibly Extinct. India's and Nepal's crocodile, the Ghariyal (Gavialis gangeticus) is also facing threats from habitat degradation and has moved from Endangered to Critically Endangered. Vultures in Africa and Asia have declined, with five species reclassified on the IUCN Red List. In Asia, the Red-headed Vulture moved from Near Threatened to Critically Endangered while the Egyptian Vulture moved from Least Concern to Endangered.

International Agreements to Conserve Birds

- **Ramsar Convention on Wetlands (1971):** Nearly 2,131 wetland sites in 168 countries, covering around 205,490,520 hectares, have been designated for protection and monitoring under this international agreement to conserve wetland and use them sustainably. The convention was developed and adopted by participating nations at a meeting in Ramsar, Iran on February 2, 1971 and came into force on December 21, 1975.

- **Programme on Man and the Biosphere and World Heritage Convention (1972) under UNESCO:** These initiatives set a framework for designating, protecting and monitoring some of the world's most important biodiversity and cultural hotspots.
- **Convention on International Trade in Endangered Species of Wild Fauna and Flora (1975):** It is an international agreement by 178 countries to monitor international trade in wild animals and plants and ensure that trade does not put wildlife in jeopardy.

Biosphere Reserves

The idea of biosphere reserve was initiated by UNESCO under the aegis of its Man and Biosphere (MAB) programme, to provide a global network of protected areas for conserving natural communities. It was a new concept which "was elaborated by a workshop convened by UNESCO in 1973, which highlighted the need to conserve diversity of living organisms essential for economic, scientific, educational and cultural needs of the present and future generations. Following are the objectives of biosphere reserves:

(i) To conserve representative samples of ecosystem of the world as opposed to species or habitat conservation.

(ii) To promote and facilitate ecological and environmental research.

(iii) Provide opportunities for education and training to local people regarding biosphere and its conservation.

(iv) Promote appropriate sustainable managements of the living resources.

(v) Promote international co-operation.

In brief, we may say that special feature of biosphere reserve is that it combines four major objectives- (i) conservation (ii) research (iii) education, and (iv) local involvement.

They include a wide range of ecosystems, ranging from undisturbed communities to degraded areas. In a biosphere reserve, multiple land use is permitted by designating various zones, the Core Zone (where no human activity is permitted), the Buffer Zone (where limited human activity is allowed), and the Manipulation Zone (where a large number of human activities would go on).

The core area of biosphere reserve should be kept completely free from tourism or any other activity. The buffer zone can be used in a limited way for wildlife educational tourism and related (non-destructive), social, cultural and economic activities by the local population.

Man and Biosphere Programme (MAB)

MAB is an interdisciplinary research programme which emphasizes an ecological approach to the study of interrelationship between man and environment. It is to be implemented in close cooperation with different organizations of the United Nations and suitable non-governmental organizations at global level. Through this programme, attention is to be focused on the structure and systematic data about the changes brought about by man in the biosphere and its resources, overall effects of these changes on humans itself and the education and information to be provided on these aspects.

Objectives of MAB

The general objective is to develop the basis within the natural and social science for the rational use and conservation of the resources of the biosphere and for the improvement of the global relationship between man and the environment to predict the consequences of today's activities on future world and thus to increase man's consciousness to manage efficiently the natural resources of the biosphere. There is a two-fold scientific approach of the programme:

(i) Analysis of the ecosystems: Study of the structure and function of natural as well as crop ecosystems and comparison of natural, man-managed and urban systems to evaluate actual net primary production and studies on biogeochemical cycles.

(ii) Impact of man on the environment and of the environment on man: Man's impact may be due to factors such as population increase, demands of urban conglomerates for recreational space and consequences of waste disposal and engineering works. Other activities include, grazing pressures of large herbivores, application of biocides, irrigation, and different cultural practices.

Modifications in biosphere done by man, in turn have strong influence on man himself. This requires the conservation of nature, which implies man's respect and responsibility for all other forms of life on earth. Thus in shaping his environment man is in fact shaping his own future. An important aspect of MAB is therefore to study how man perceives his environment and acts upon it in natural managed and urban systems and how these environments act upon him.

Biosphere Reserve Network Programme

Biosphere Reserve network Programme was launched in 1971 by UNESCO under the aegis of its Man and Biosphere (MAB) Programme, to provide a global network of protected areas for conserving natural communities. Following are the objectives of Biosphere Reserves:

- To conserve representative samples of ecosystem of the world as opposed to species or habitat conservation.
- To promote and facilitate ecological and environmental research.
- Provide opportunities for education and training to local people regarding biosphere and its conservation.
- Promote appropriate sustainable managements of the living resources.
- Promote international co-operation.

They include a wide range of ecosystems, ranging from undisturbed communities to degraded areas. In a biosphere reserve, multiple land use is permitted by designating various zones, the Core Zone (where no human activity is permitted), the Buffer Zone (where limited human activity is allowed), and the Manipulation Zone (where a large number of human activities would go on).

C. WATER CONSERVATION

With per capita availability of water depleting at a faster pace, the Union government on May 9, 2013 approved a proposal to declare 2013 as Water Conservation Year under which awareness programmes will be launched for conservation of the scarce natural resource. Under the proposal, the Water Resources Ministry will launch a series of programmes among masses, especially children, on water conservation. While India has more than 18 per cent of the world's population, it has only 4 per cent of the world's renewable water resources. With growing population and rising needs, per capita availability of water is likely to go down from 1545 cubic meter per annum in 2011 to 1341 cubic meter per annum in 2025. The increasing demand of water for various purposes will further strain (resources) with the possibility of deepening water conflicts among different user groups as drinking water needs will rise by 44 per cent, irrigation needs by 10 per cent and industry needs by 81 per cent respectively by 2025.

Water Conservation is the key objective of the National Water Mission which is one of the eight National Missions under the National Action Plan for Climate Change. This envisages conservation, minimising wastage and ensuring more equitable distribution of water resources both across and within states through integrated water resources development and management.

A report published by Tata Energy Research Institute (TERI) on July 4, 2001 presents a dismal water scenario. According to it, by 2050 a severe water shortage will hit many parts of the country and 20 to 30 per cent of the population in Gujarat, Rajasthan, the Gangetic plains, West Bengal and the North eastern areas will have practically no water. Though the population will double by 2047, availability of water will remain at 1086 billion cubic meters per year. A further worrying aspect revealed in the report was that 95 per cent of the water was used for agriculture and that 60 per cent of it is wasted.

Hence when we talk about conservation of water, we have to look into both the quantitative and qualitative aspects. The reasons, both natural and man-made, are:

1. **Vagaries of Monsoon**: Monsoon is unpredictable, varies in persistence and "has regional variations insofar as precipitation is concerned. The rainy months are short followed by a generally dry period.
2. **Ground water depletion**: Free or subsidized electricity means a larger number of boring wells with no backup system for recharging ground water. The result is depletion of ground water and deterioration in its quality.
3. **Misuse of water:** In India 95 per cent of our water is used for agriculture and 60 per cent of it is wasted. Also, we are growing more cash crops like sugarcane which require more water hence bulk of the water is diverted to these crops leaving others high and dry.

4. **Lack of effective conservation strategy:** Most of the people have developed a feeling that water is plenty and is easily available. The government too has failed to evolve a sound strategy through measures like water harvesting, community participation, etc.
5. **Water quality deterioration:** Both ground and surface water are polluted from industrial effluents, poorly treated sewage and runoff of agricultural chemicals combined with unsatisfactory household and community sanitary conditions. Traces of metallic oxides, arsenic, etc. have been reported from many monitoring stations. These are highly toxic.

Ganga Action Plan

The Ganga basin is the largest river basin of the country, supporting around 40 per cent of its population. The Ganga action plan was launched on January 14, 1986 with the main objective of pollution abatement, to improve the water quality by Interception, Diversion and Treatment of domestic sewage and present toxic and industrial chemical wastes from identified grossly polluting units, entering into the river.

The first stage of Ganga Action Plan (GAP-1) was scheduled to be completed in March 1990, but was later extended progressively to March 2000. The project area extended over three states of Uttar Pradesh, Bihar and West Bengal, including 6 class-I towns of Uttar Pradesh, 4 of Bihar and 15 of West Bengal. In this first phase, out of nearly 1400 million liters per day (MLD) of sewage generated in 25 class-I towns along the rivers, 870 MLD was proposed to be intercepted, diverted and treated.

GAP-Schemes: In order to implement the works under Ganga Action Plan 261 different schemes have been sanctioned, out of which 173 schemes have been completed so far. The remaining schemes are at various stages of completion.

A) Thirty-Two sewage treatment plants (STP) out of a total of 35 STPs to be established, have become operational.

B) The schemes for sewage interception and diversion have been accorded priority under the Ganga Action Plan. As a result 405 mld of waste water flowing into the river has been diverted out of which 116 mld is being taken to sewage treatment plant for treatment.

C) Under the low cost sanitation programme 43 schemes have been taken up in the GAP-I and 15 schemes in GAP-II.

D) Construction of electric crematoria is a major part of Ganga Action Plan. 44 electric crematories have been constructed in different states.

E) Programme for construction or re-development of ghats, renovation of ponds, improvement of lanes/bye-lanes leading to ghats, traffic regulation and reallocation of dhobi ghats have been taken up under Ganga Action Plan.

F) Based on an Expert Committee report total of 732 (56 in Haryana, 96 in West Bengal, 117 in UP, 428 in Delhi and 35 in Bihar) industrial units have been identified as grossly polluting in GAP.

G) The Ganga Action Plan has introduced new technologies for sewage treatment. The upflow "Anaerobic Sludge Blanket Technology" has been developed in collaboration with the Dutch Government.

H) A new method for afforestation with raw sewage, developed by Central Soil Salinity Research Institute (CSSRI), Karnal is inexpensive but requires more land.

I) Automatic Water Quality Monitoring Stations (AWQMS) have been proposed to be installed at nine locations out of which 5 are functional in Uttar Pradesh and Bihar.

Benefits of GAP

I. Non-User benefits for urban and non-urban users:

- **(i)** General aesthetic benefit
- **(ii)** Less polluted river for ritual bathing
- **(iii)** Improved bio-diversity
- **(iv)** Recreational benefits

II. User benefits:

- **(i)** Pilgrims
- **(ii)** Tourists
- **(iii)** Inhabitants living near the river.

III. Health benefits: Reduction in the diarrhoea causes and skin disorders.

IV. Agricultural benefits: The sludge that remains after sewage treatment may be used as fertilizers.

V. Other benefits:

(i) Benefits of biodiversity, effective conservation, bio monitoring and eco restoration brought about an increase in population of turtle, otters, fish and dolphins.

(ii) Benefits of fisheries and fishermen with increase catch in cleaner waters.

(iii) Benefits from reduction of toxicants.

(iv) Benefits of employment from GAP project.

Yamuna Action Plan I and II:

The Yamuna Action Plan (YAP) is a bilateral project between the Government of India and Japan. It is one of the largest river restoration projects in India. The government of Japan, via the Japanese Bank for International Cooperation (JBIC), has provided financial aid of 17.7 billion yen to carry out the project, which is being executed by the National River Conservation Directorate, the Ministry of Environment and Forests, and the Government of India.

Yamuna Action Plan-I was implemented in April 1993 with the aim of pollution abatement and water quality improvement of river Yamuna by the National River Conservation Directorate (NRCD), Ministry of Environment and forests. Under YAP-I, 15 class-I towns, 6 in Haryana State, 8 in Uttar Pradesh State and Delhi were covered.

Yamuna Action Plan II is one of the important projects, being implemented by U.P Jal Nigam through its Project offices at Ghaziabad and Agra. It is being implemented in 3 States of the country (Haryana, Delhi and Uttar Pradesh) and within UP, 8 towns viz Agra, Mathura Vrindavana, Etawah (all under Agra region) Muzaffarnagar, Saharanpur, Noida, Ghaziabad (under Ghaziabad region) have been selected where river Yamuna passes through. During the first phase of the programme it came out that the river water pollution cannot be lowered down without the active participation of the citizens. Therefore in YAP phase II a special component named as Public Participation & Awareness component has been brought in wherein NGOs are partnering to work at the community level on different themes as:

a) Socio–economic upgradation of the Community Toilet Complexes neighbourhood: As the name suggests, the NGOs involved have to improve the lives and environment of the community residing in the neighborhood of the community toilets.

b) School health and hygiene programme: Wherein school going children have been targeted to sensitise upon the need for maintaining personal hygiene and sanitation.

c) Town Specific innovation programme: Wherein NGOs are given a flexibility to design and develop a programme specific to the town requirements and could be one of the most innovative approaches and not necessarily duplicating the target groups.

d) Clean Yamuna Manch: It is forum of NGOs working in Agra city, to work exclusively at the stakeholders level, bring the issue into mainstream of media and academia and hold continuous dialogue. It is one of the pilot programmes to subs-tantiate the efforts of other programmes of the Agra region.

Yamuna Action Plan III: The Cabinet Committee on Economic Affairs in December 2011 approved the proposal of "Japan International Cooperation Agency (JICA) assisted Yamuna Action Plan (YAP) Phase - III project at Delhi", under the Centrally Sponsored Scheme of National River Conservation Plan at an estimated cost of Rs 1656 crore. The project will be implemented on 85:15 cost sharing basis between the Government of India and the Government of NCT of Delhi for a period of 7 years. Under the YAP-III, it is proposed to rehabilitate the damaged trunk sewers to maximize the utilization of available treatment capacity and modernize the Sewage Treatment Plants (STPs) in three catchment areas of Delhi namely Okhla, Kondli and Rithala.

Watershed Management

Watershed can be defined as the catchment area feeding a de-markable drainage system. In a simpler way it can be defined as a region of land that is crisscrossed by smaller waterways that drain into a larger body of water. This entire area of flowing surface water and ground water together is considered a watershed. Watershed management anywhere possesses some common orientations.

1. To assess the nature and status of the watershed ecosystem;

2. To define the short-term and long-term goals for the system;

3. To determine the objectives and actions needed to achieve selected goals;

4. To assess both benefits and costs of each action;

5. To evaluate the effects, actions and progress towards goals; and

6. To re-evaluate goals and objectives as part of an interactive process.

The idea of watershed management in India was effectively designed by the DVC (Damodar Valley Corporation). Many of micro level integrated development projects were started in 1970s and early 1980s by ICAR (Indian Council of Agricultural Research), Ministry of Environment and Forests, Ministry of Rural Development and so on. There have also been several aided projects funded by World Bank, SDC, ODA, etc. In the 1990s, at a number of experimental sites, micro-watershed management has been installed to enhance resource productivity. The new guidelines introduced by the Government of India in 1994 for micro-watershed development envisaged a high degree of participation in the design and implementation of rehabilitation. The guidelines introduced a framework that emphasized on the village level watershed rehabilitation and management projects.

Watershed management covers a wide range of activities to do with land and water management. However, in India watershed management is largely focused on local level micro-watershed management for improved soil and water management where mainly ground water resources are affected. Much of the benefit gained from this is mainly in the form of increased crop yields. In India micro watersheds are generally defined as falling in the range of 500-1000 ha. In other countries such as South Africa and Zimbabwe catchment management is largely focused on river basin level initiatives to ensure that water is used in the most economical manner possible, and that allocation decisions are taken in a transparent and objective manner mainly by the large scale agricultural and industrial users. In India the entire theme of watershed management has been designed in such a way that to achieve its targeted success it has to become a people's movement. The constitutional frame of India in this regard provides the opportunity of reciprocative clubbing up of grassroot democracy and the utilization of regional natural resources. The theme of Watershed development has been included in the schedule of subjects, handled by the panchayats after the 73rd Constitutional Amendment.

There are a number of issues of concerns about the current approaches to watershed management. While watershed development has benefited many through increased rainfed crop yields, and increased use of irrigation, the results are often poorly distributed. In particular the landless agricultural labourers were hardly able to enjoy the potential gains. On the other hand watershed management approaches may be over reliant on the assumption of an idealised peaceful 'community' neglecting the reality of conflicts between various social groups and class. Thus, while making a plan for watershed management one has to keep the following issues in mind:

a) High demand-pressure on scarce areas.

b) Land tenure system and common property features.

c) Institutional authority (support, capacity and control).

d) Willingness of participants to contribute in labour / money / other investment.

e) Technical resources and support readily available to the community (cost effective and simple).

f) Caste and religious complexity in the project area, etc.

Effective watershed management is the need of the hour as it is feared that within a few decades availability of water in the country will be about 1700 to 2000 cubic meters per person as against the world average of 5000 to 9000 cubic meters per person. Already, in one-third of India's agro-climatic regions, there is water scarcity in terms of per capita demand and supply of water. For the coming decades water shed management should take an innovative course-a course that recognizes water as both a basic need and a scarce resource and therefore seek to address the issues of availability, quality and access through integrated management involving mass participation.

D. FOREST CONSERVATION

Conservation can be defined as "the rational use of the earth's resources to achieve the highest possible quality of life for mankind".

In view of the growing energy crisis, water pollution and deforestation, and increasing human population, man needs to change his outlook towards nature from one of irrigational and reckless exploitation to conservation.

The only way to reverse the trend of environmental deterioration involves rational use "of our valuable resources such as energy, water, forests, etc. Conservation or "preservation of natural resources makes it possible to balance the material and aesthetic needs of man.

The conservation of forests is simple and obvious. To begin with, as little forest as possible should be cut down. We do need timber, but we must take care that there is no wastage of wood in the process of making timber. As things are, it has been calculated that two-thirds of a tree is wasted between the time it is cut and the time it is converted into a finished product. Sometimes the better part of the tree is cut into logs, leaving the rest to decay. In saw mills the logs are carelessly cut without getting the maximum quantity of timber out of them. It is obvious that these are extremely wasteful methods and they result in many more trees being cut than is necessary, such practices should be stopped immediately.

Another practice in our country which ravages the forests is 'shifting cultivation'. This means that peasants clear an area of forest and use the land for agriculture, and when the soil is exhausted, they abandon the land and clear another piece of forest. Large tracts of forest have been whittled away in this way. Instead of this practice, farmers should continue to cultivate the same piece of land, but they should use better farming methods which will ensure that the soil remains fertile and can be used again and again.

Very often, forests are destroyed simply for short-term convenience to locate a various reasons a factory wants to be located in a particular area where the only obstacle is a forest. In such cases the forest is usually cut down at once, so that the factory can be set up. But what should really happen is that the owners of the factory should recognize that the forest is precious and irreplaceable, and they should locate the factory on a different site, even though it may cause some inconvenience.

Forest Management

The introduction of forest management methods was necessitated mainly by the wasteful approach of the industrial man for obtaining forest produce. Block cutting, reforestation, and pest & fire control are some methods practised in a forest management programme. The sustained yield approach advocates a continuous supply of modest timber crop through a method in which the amount of timber harvested annually is replaced by an equal amount of timber crop growth.

The method of block cutting is generally used in forests having even-aged trees, consisting of only very few species. This method is mostly applicable in the case of coniferous forests. A known area of forest is deforested by cutting down the entire tree population of that area, and the lost forest area is replaced by reforestation of an adjacent area of the same size. The net result is a sustained supply of forest products without adversely affecting the original size of the forest. In this way, the net deforestation is followed by net reforestation of the deforested areas. In this way the forest is conserved and at the same time its yield is sustained.

Forest management has multiple uses. Forests are effective in controlling floods and soil erosion. The rising trend of river floods in India is primarily due to loss of some forest areas as a result of indiscriminate and excessive tree felling.

Forests constitute the best habitat for wildlife and conservation of forest and wildlife are inter-related. For example, the Vindhya range forest in the Varanasi division, once an ideal habitat for game animals, including lions, no longer harbour any tigers or lions.

The trunks of forest trees constitute the main source of timber. Lumbermen take away the stem logs but leave behind the stumps, leaves, barks and twigs as debris. Additional wastage of forest produce occurs in the saw mills where round logs are cut into squarish or rectangular logs. Recent technological advances have made it possible to use sawdust, the bark and pieces of wood for industrial and commercial purposes.

The world's future timber demand requires extensive and intensive utilization and management of forests. Some feasible approaches include-

1. Intensification of afforestation or reforestation rates to nearly three times of the present rate.

2. Further improvement of timber quality through genetic breeding.

3. Avoiding wasteful cutting and encouraging sustained yield harvesting.

4. Breeding for disease and pest resistant varieties of forest trees.

5. Control of diseases of important forest trees through judicious application of fungicides and pesticides.

Today there is no need to mention the role of forest in our eco-system. Realising this fact the Indian government has always been aware about the conservation of forest. The "National Forest Action Programme (NFAP)" is a comprehensive strategic long term plan for the next twenty years to address the issues underlying the major problems of the forestry sector in line with National Forest Policy, 1988. The objective of NFAP is to bring one third of the areas of the country under forest/ tree cover and to arrest deforestation for achieving sustainable development of forests.

The centrally sponsored scheme "Introduction of Modern Forest Fire Control Methods" has been renamed as "Forest Fire Control and Management". This scheme is being presently implemented in all the states.

The concept of "Joint Forest Management" has been accordingly initiated by developing appropriate mechanism. A committee has also been constituted by the Ministry for preparing a JFM scheme in order to ensure long term success.

Programmes of Ministry of Environment & Forests

National Mission on Bamboo Technology and Trade Development: Bamboo plays an important role in the rural economy. The National Mission on Bamboo Technology and Trade Development should be implemented for value added high volume products, which will benefit income generation in the rural base and substitute wood products. The programme would facilitate setting up of primary and secondary processing units for value addition of bamboo through adoption of appropriate technology.

National Bio-Diesel Mission: Production of bio-diesel from non-edible oil can help in reclaiming large areas of waste land, create rural employment opportunities, substitute imported petroleum diesel and create greeneries entitled for carbon trading under Kyoto Protocol. Efforts should be made for early implementation of the National Mission on Bio-diesel mooted by Planning Commission and be expanded the same to cover 20 per cent of the diesel requirement of the country.

Afforestation through Panchayats: To achieve the target of 33 per cent coverage by 2012, greening of 28.87 million hectares area outside govt. forests, public lands, private lands, community lands and farm lands need to be targeted. In this context, it is proposed to revive the social forestry movement for development of common property resources at the village level. It is proposed to take up afforestation of 50 ha in each of the 2,34,676 village panchayats in 31 States and UTs in addition to the traditional Councils of Meghalaya, through social forestry wings of the State. A suitable project will be developed and launched involving resources for employment generation and development of land resources.

Gregarious Flowering of Muli Bamboo in North East: The Ministry of Environment & Forests has proposed an action plan of Rs. 105 crore to deal with the problem of gregarious flowering of Muli Bamboo in the North East. The amount is to be utilized for extraction of bamboo before flowering, regeneration of flowered areas, rodent control and arrangements for strengthening Public Distribution System in view of expected rodent menace. Considering that the imminent decay of flowered bamboo has its impact in the forest areas, the action plan should be implemented in the forestry sector. Therefore, an additional allocation of Rs. 84.8 crore had been made for the activities envisaged in the Action Plan during the Tenth Plan period.

TARGETS FOR TWELFTH PLAN

After an in-depth analysis of the policies and programmes in the Environment, Forestry, Biodiversity, Wildlife and Animal Welfare sectors, 13 monitorable targets have been set for the Twelfth Plan.

Monitorable Targets for 12th Plan

Environment and Climate Change

1. Assess and remediate 12 identified contaminated sites (hazardous chemicals and wastes) with potential for ground water contamination by 2017.

2. Clean 80 per cent of critically polluted stretches in rivers by 2017 and 100 per cent by 2020.

3. States to meet NAAQS in urban areas by 2017.

4. To reduce emission intensity of our GDP in line with the target of 20 to 25 per cent reduction over 2005 levels by 2020.

Forests and Livelihood

5. Greening 5 million ha under Green India Mission, including 1.5 million ha of degraded lands, afforestation and ecorestoration of 0.9 million ha of ecologically sensitive areas.

6. Technology-based monitoring of forest cover, biodiversity and growing stock including change-monitoring on periodical basis through dedicated satellite by 2017 and establishment of open web-based National Forestry and Environmental Information system for research and public accessibility by 2015.

7. Engagement of Village Green Guards/ Community Foresters for every Joint Forest Management (JFM) village by 2016.

8. Establish forestry seed bank in forest circles and Model Nursery in every district with information on public portal by 2014.

Wildlife, Ecotourism and Animal Welfare

9. Twenty per cent of veterinary professionals in the country will be trained in treating wildlife.

10. Integrated Ecotourism District Plans covering 10 per cent of all potential Protected Areas (PAs) by 2017.

11. Promoting participation of private sector, civil societies, NGOs and philanthropists in animal welfare.

Ecosystem and Biodiversity

12. Restoring 0.1 million ha of wetlands/inland lakes/water bodies by 2017.

13. Mapping and preparation of biodiversity management plans for deserts (both cold and arid), coastal areas, important coral zones, wetlands, mangroves and so on to be completed by 2017.

Environment in 11th Plan

1. Increasing forest and tree cover by 5 percentage points.

2. Attaining WHO standards of air quality in all major cities by 2011-12.

3. Treating all urban waste water by 2011-12 to clean river waters.

4. Increasing energy efficiency by 20 percentage points by 2016-17.

Major Policy Developments during 11th Plan

- The National Environment Policy was unveiled in 2006 to help realise sustainable development goals by mainstreaming environmental concerns in all development activities.
- The Environmental Impact Assessment (EIA) process has been made more efficient, decentralized and transparent, based on a comprehensive review of the existing environmental process and its re-engineering through the EIA Notification, 2006, and its amendments thereafter. A system of mandatory accreditation of EIA/ Environmental Management Plan (EMP) consultants has also been introduced to improve the quality of impact assessment reports submitted by project proponents.
- Re-engineering of Coastal Regulation Zone (CRZ) Notification 2011 was done to ensure livelihood security to fishing and other local communities, to conserve and protect coastal stretches and to promote development based on scientific principles. Another Notification on Island Protection Zone was issued for similar purposes for the islands of Andaman & Nicobar and the Lakshadweep.
- An NAPCC was released in June 2008 to outline India's strategy to meet the challenge of climate change. The Indian Network for Climate Change Assessment (INCCA), a network-based programme to make science the essence of our policymaking in the climate change space, was also launched.

- Towards conservation of biodiversity, a National Biodiversity Action Plan was released in November 2008.
- A National Ganga River Basin Authority (NGRBA) has been set up to ensure effective abatement of pollution and conservation of the river Ganga by adopting a holistic approach with the river basin as the unit of planning.
- The NAAQS have been revised and limits for 12 pollutants notified.
- National Green Tribunal (NGT) was set up on 18 October 2010 for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources.
- Towards further environmental regulatory reforms and improving environmental governance, an exercise has been initiated to conceptualise and constitute a National Environment Assessment & Monitoring Authority (NEAMA).
- To resolve the deadlock of Compensatory Afforestation Fund Management and Planning Authority (CAMPA), State Level CAMPAs have been created, providing an integrated framework for utilisation of multiple sources of funding and activities relating to afforestation, regeneration, conservation and protection of forests.
- Interventions have been undertaken to increase forest cover. The Green India Mission under NAPCC to be operationalised in 2012–13.
- Wildlife (Protection) Act, 1972 was amended to enable constitution of the National Tiger Conservation Authority and the Tiger and other Endangered Species Crime Control Bureau.

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ECOLOGY SAMPLE QUESTIONS

Civil Services CHRONICLE

1. Consider the following statements:
   1. Carbon credits are certificates awarded to the countries that successfully reduce the emissions that cause global warming and are measured in units of Certified Emission Reductions (CERs).
   2. A carbon footprint is a measure of the impact, our activities have on the environment and in particular climate change and it relates to the amount of green house gases produced in our day-to-day lives through burning of fossil fuels.
   3. A Green Test is a test to determine whether a product is as efficient as possible in term of energy consumption.
   4. Green taxes are meant to reduce environmental burden by increasing prices, and by shifting the basis of taxation from labour and capital to energy and natural resources.

   Which of the following statements is/are correct?

   (a) Only 1 and 3 (b) Only 2 and 3
   (c) Only 2 and 4 (d) All are correct

2. Which of the following components of Green Revolution can lead to dynamic pressure on the ecological setup?
   1. Use of chemical fertilizers
   2. Use of pesticides
   3. Intensive and accurate irrigation, mostly made possible by building of dams
   4. Use of High Yielding Varieties (HYV)

   (a) 1 only (b) 1 and 2 only
   (c) 1, 2 and 3 only (d) 1, 2, 3 and 4

3. An Environmental impact Assessment audit evaluates the performance of an EIA by comparing actual impacts to those that were predicted. The mathematical models for prediction of environmental impact attempt to:
   1. To provide the basic management tool which consists of systematic, documented, periodic and objective evaluation of, how well organization, management systems and equipment are performing.
   2. To describe qualitatively and quantitatively the cause and effect relationship between the various system variables
   3. To check the accuracy of predictions and explain errors of any anthropogenic act done on environment.
   4. The study of impact of environment of proposed action like policy, plan or project.

   Select code:

   (a) 1, 2 and 3 (b) 1 and 2 only
   (c) 1, 2 and 4 d) 1, 2, 3 and 4

4. Consider the following statements:
   1. A large gene pool indicates extensive genetic diversity.
   2. Low genetic diversity can increase chances of extinction.
   3. Genetic drift can help, if population is small, to save from extinction.

   Codes:

   (a) Only 1 & 2 are correct
   (b) Only 2 & 3 are correct
   (c) Only 1 & 3 are correct
   (d) All are correct

5. Consider the following statement and select the correct answer.
   (i) The Stockholm Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs).
   (ii) POPs are chemicals that remain persistent in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife.
   (iii) Saudi Arabia ratified the Stockholm Convention on 25 July 2012, becoming its 178th Party.

   Codes.

   (a) i, ii, Only.

(b) i, iii, Only.

(c) ii, iii, only.

(d) all

6. India believes that 'Common but differentiated responsibility' for countering the menace of environmental degradation at the international level, to which the developed countries do not subscribe to.Which of the following statements is a part of action in line with the above principle?

1. Polluter must pay.
2. Differential contribution to the Global Environment Facility (GEF)
3. Differential reduction in the green house gases emissions.
4. Different prices for carbon credits for the developed and the developing countries.

Codes:

(a) 1, 2 and 3

(b) 2, 3 and 4

(c) 1, 3 and 4

(d) 1, 2 and 4

7. Various facts for ozone depletion are:

i: The jet engines of supersonic aircraft flying at high altitude release sulphur oxides which catalytically destroy ozone molecules.

ii: CFC gets, accumulated in greater amounts at high altitude and in troposphere these compounds release chlorine atoms under influence of UV radiations which finally convert ozone into oxygen.

iii: When the concentration of ozone falls below 200 dobson unit, it is called as ozone depletion.

(a) i,ii,iii (b) ii,iii

(c) iii only (d) none

8. Match the following lists:

List1 (GHG)	**List2 (Source)**
(A) Carbon Dioxide	(1) Burning of fossil fuels
(B) Methane	(2) Aerosol industries
(C) Nitrous oxide	(3) Combustion of carbon in the absence of oxygen
(D) CFCs	(4) Biological processes in soil and water

Codes:

	A	**B**	**C**	**D**
(a)	1	2	4	3
(b)	1	4	3	2
(c)	1	3	4	2
(d)	3	4	1	2

9. Consider the following statements about the Green India Mission:

I. The Prime Minister's Council on Climate Change recently approved 46000 crore rupees for National Mission for Green India.

II. The Green India mission is aimed at increasing forest cover in the country by five million hectares by 2020.

III. The mission is to be implemented by the Union Environment Ministry of India under the National Action Plan on Climate Change announced in 2009.

Which of the above statements is/are correct?

(a) Only I and II are correct

(b) Only II and III are correct

(c) Only I and III are correct

(d) All I, II and III are correct

10. Energy flow in an ecosystem is:

(a) Bidirectional and cyclic

(b) Bidirectional and non-cyclic

(c) Unidirectional and cyclic

(d) Unidirectional and non-cyclic

11. Match the following definitions:

List1 (Ecosystem terms)	**List2** (Definitions)
(A) Biotic Succession	(1) Vegetation community developed at the end of succession
(B) Sere	(2) Sequence of development of vegetation community
(C) Climax	(3) The relational position of a species or population in an ecosystem
(D) Niche	(4) Replacement of one vegetation community by other vegetation community

Choose the correct codes:

	A	B	C	D
(a)	4	2	1	3
(b)	4	2	3	1
(c)	2	4	1	3
(d)	2	4	3	1

12. Consider the following statement and select the correct answer.

(i) Mangroves constitute a homogeneous group of plants with similar adaptations to a particular environment.

(ii) Mangroves are salt tolerant forest ecosystems, found mainly in the tropical and subtropical regions of the world.

(iii) Mangroves trees develop aerial or air-breathing roots to avoid suffocation in the oxygen poor mud.

(iv) A distinctive feature of mangroves is their large fruit, the seeds of which germinate and grow into sturdy seedlings before they leave the parent plant.

Codes:

(a) (i), (ii) & (iii)

(b) (i), (ii) & (iv)

(c) (ii), (iii) & (iv)

(d) (i), (ii), (iii) & (iv)

13. An ecological pyramid is a graphical representation designed to show the biomass at each trophic level in a given ecosystem. A geographical representation of an ecological parameter like number of individuals or amount of biomass or amount of energy present in various trophic levels of a food chain with producer forming the base and top carnivores at the top.

An ecological pyramid may be upright or inverted or spindle shaped. Which of the following pyramid is always upright?

(a) Pyramid of Numbers

(b) Pyramid of Biomass

(c) Pyramid of Energy

(d) None of these

14. Match the following

List I (National Parks/ Sanctuaries)	**List II (State)**
(A) Kanger Ghati National Park	(1) Chattisgarh
(B) Nagerhole National park	(2) Haryana
(C) Kugti Wildlife Sanctuary	(3) Himachal Pradesh.
(D) Sultanpur Bird Sanctuary	(4) Karnataka

Select the codes:

	A	B	C	D
(a)	3	2	1	4
(b)	1	4	3	2
(c)	3	4	1	2
(d)	1	2	3	4

15. Coral bleaching is the whitening of coral that results from the loss of zooxanthellae or the degradation of the algae's photosynthetic pigment. The factors that lead to coral bleaching are:

i. Global climate change

ii. Destructive fishing methods

iii. Mixing of river water

iv. Deposition of sediments in water

v. Prevalence of invasive species

Which of the above listed threats are correct?

(a) ii, iii, iv and v

(b) i, ii, iv and v

(c) i, ii, iii and iv

(d) All of the above

16. Consider the following statements regarding "Bio-fertilizers":

1. Biofertilizers add nutrients through the natural processes of Nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances.

2. Biofertilizers can be expected to reduce the use of chemical fertilizers and pesticides. The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter.

3. Biofertilizers are Eco-friendly organic agro-inputs but less cost effective than chemical fertilizers.

4. Bio fertilizers are crop specific.

Which of the above statements are correct?

(a) 1, 2, 4 only (b) 2, 3 only

(c) 1, 2, 3 only (d) 1, 2, 3, 4

17. Vermicomposting is a simple biotechnological process in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. The benefits of vermicompost are:

I. Helps to open the "metabolic gap" through on-site waste recycling.

II. Enhances germination, plant growth, and crop yield.

III. Reduces greenhouse gas emissions such as methane and nitric oxide.

(a) I only (b) I and II

(c) II and III (d) All of the above

18. Consider the following statement regarding the National Green Tribunal of India:

i. It has been established by an act of parliament in 2010.

ii. The chairperson of the tribunal is justice L.S. Panta, former justice of Supreme Court.

iii. The tribunal has been empowered to issue directions for the compensation and restitution of damage caused from actions of environment negligence applying the polluter pays principal.

Code:

(a) Only I and ii

(b) Only ii and iii

(c) Only I and iii

(d) All are correct

19. Which one of the following statements is correct about Social Forestry?

a. It is the form of forest management prevalent in socialist countries.

b. It is one of the conventional methods of forest management.

c. It is a form of forest management imposed by the State.

d. It helps in rebuilding of forest wealth by the participation of local community.

20. The main effects caused by eutrophication can be summarized as follows:

1. Species diversity decreases
2. Biomass increases
3. Turbidity increases
4. Rate of sedimentation decreases
5. Lifespan of the lake is shortened

Codes:

(a) 1, 2, 3 and 5

(b) 1, 2, 3 and 4

(c) 2, 3, 4 and 5

(d) 1, 2, 3, 4 and 5

21. Consider the following facts regarding e-waste -

1) Rapid changes in technology and falling prices have resulted in a fast growth of e-waste around the world.

2) Basel Action Network attempts to combat the waste trade.

3) Almost all electronic items contain lead and tin (as solder) and copper.

4) Mercury, which is found in fluorescent tubes, affects health of people involved in recycling causing dermatitis, memory loss, and muscle weakness.

Which of the above statements are correct?

(a) Only 1, 3 and 4 (b) Only 1, 2 and 3

(c) Only 1, 2 and 4 (d) All are correct

22. Match the following:

Environmental Principle		**Implication**
A. "Polluter Pays"	1.	Ethical responsibility while caring for infectious/ hazardous waste.
B. "Duty of Care"	2.	Magnitude of a particular risk is uncertain; it should be assumed that the risk is significant.
C. "Proximity Principle"	3.	All producers of waste are legally and financially responsible for safe and environmentally sound disposal of waste they produce.
D. "Precautionary	4.	Treatment and disposal

Principle"		of hazardous waste should take place at the closest possible location to the source.

Codes:

	A	B	C	D
(a)	1	3	4	2
(b)	1	3	2	4
(c)	3	1	2	4
(d)	3	1	4	2

23. Select the correct decreasing order of the global consumption of energy from different fuel types.
   (a) Coal - Oil - Natural Gas - Hydroelectricity
   (b) Coal - Oil - Hydroelectricity - Natural Gas
   (c) Oil - Coal - Hydroelectricity - Natural Gas
   (d) Oil - Coal - Natural Gas - Hydroelectricity

24.
   i. Synbiotics refers to nutritional supplements combining probiotics and prebiotics in a form of synergism.
   ii. Probiotics are nondigestible food ingredients that selectively stimulate the growth of beneficial microorganisms already present in people's colon.
   iii. Prebiotics are food material that contain live microorganisms which are beneficial and also called friendly bacteria.
   iv. Dahi, yoghurt, milk are some forms by which probiotics can be introduced in someone's body.

   Select the right choice.

   (a) i, ii, iii (b) ii, iii
   (c) i, iv (d) i, ii, iii, iv

25. Consider the following statement regarding Noise pollution:
   1. The loudest sound that a person can stand without discomfort is about 90 decibels.
   2. Most of the big cities of India have noise pollution much higher than the permissible limit of 60-70 dB.
   3. Noise pollution results in mental tension blood pressure heart disease and stomach trouble.
   4. Tree plantation along the road side reduces the noise by 10 to 15 dB.

   Which of the above statements are correct?

   (a) Only 1, 2 and 4 (b) Only 2, 3 and 4
   (c) Only 1, 2 and 3 (d) All are correct

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ECOLOGY (SAMPLE QUESTIONS) (ANSWERS)

CHRONICLE IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

1 (d)
2 (d)
3 (a)
4 (d)
5 (d)
6 (a)
7 (c)
8 (b)
9 (d)
10 (d)
11 (c)
12 (c)
13 (b)
14 (b)
15 (d)
16 (c)
17 (d)
18 (c)
19 (d)
20 (a)
21 (d)
22 (d)
23 (d)
24 (c)
25 (b)

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ECOLOGY (UPSC QUESTIONS)

1. Consider the following

1. Star tortoise
2. Monitor lizard
3. Pygmy hog
4. Spider monkey

Which of the above found in India?

(a) 1, 2 and 3 only

(b) 2 and 3 only

(c) 1 and 4 only

(d) 1, 2, 3 and 4

2. Which of the following can be found as pollutants in the drinking water in some parts of India?

1. Arsenic
2. Sorbitol
3. Fluoride
4. Formaldehyde
5. Uranium

Select the correct answer using the codes given below.

(a) 1 and 3 only

(b) 2, 4 and 5 only

(c) 1, 3 and 5 only

(d) 1, 2, 3, 4 and 5

3. Consider the following pairs:

1. Nokrek Bio-sphere Reserve : Garo Hills
2. Logtak (Loktak)Lake : Barail Range
3. NamdaphaNational Park : Dafla Hills

Which of the above pairs is/are correctly matched?

(a) 1 only

(b) 2 and 3 only

(c) 1, 2 and 3

(d) None

4. In the grasslands, trees do not replace the grasses as a part of an ecological succession because of

(a) insects and fungi

(b) limited sunlight and paucity of nutrients

(c) water limits and fire

(d) None of the above

5. Which one of the following is the correct sequence of ecosystems in the order of decreasing productivity?

(a) Oceans, lakes, grasslands, mangroves

(b) Mangroves, oceans, grasslands, lakes

(c) Mangroves, grasslands, lakes, oceans

(d) Oceans, mangroves, lakes, grasslands

6. With reference to food chains in ecosystems, consider the following statements :

1. A food chain illustrates the order in which a chain of organisms feed upon each other.
2. Food chains are found within the populations of a species.
3. A food chain illustrates the numbers of each organism which are eaten by others.

Which of the statements given above is / are correct?

(a) 1 only

(b) 1 and 2 only

(c) 1, 2 and 3

(d) None

7. In which one among the following categories of protected areas in India are local people not allowed to collect and use the biomass?

(a) Biosphere Reserves

(b) National Parks

(c) Wetlands declared under Ramsar Convention

(d) Wildlife Sanctuaries

8. The Millennium Ecosystem Assessment describes the following major categories of eco-

system services-provisioning, supporting, regulating, preserving and cultural. Which one of the following is supporting service?

(a) Production of food and water

(b) Control of climate and disease

(c) Nutrient cycling and crop pollination

(d) Maintenance of diversity

9. What is the difference between the antelopes Oryx and Chiru?

(a) Oryx is adapted to live in hot and arid areas whereas Chiru is adapted to live in steppes and semi-desert areas of cold high mountains

(b) Oryx is poached for its antlers whereas Chiru is poached for its musk

(c) Oryx exists in western India only whereas Chiru exists in north-east India only

(d) None of the statements (a), (b) and (c) given above is correct.

10. Which of the following can be threats to the biodiversity of a geographical area?

1. Global warming
2. Fragmentation of habitat
3. Invasion of alien species
4. Promotion of vegetarianism

Select the correct answer using the codes given below:

(a) 1, 2 and 3 only (b) 2 and 3 only

(c) 1 and 4 only (d) 1, 2, 3 and 4

11. What would happen if phytoplankton of an ocean is completely destroyed for some reason?

1. The ocean as a carbon sink would be adversely affected.
2. The food chains in the ocean would be adversely affected.
3. The density of ocean water would drastically decrease.

Select the correct answer using the codes given below:

(a) 1 and 2 only (b) 2 only

(c) 3 only (d) 1, 2 and 3

12. Vultures which used to be very common in Indian countryside some years ago are rarely seen nowadays. This is attributed to

(a) The destruction of their nesting sites by new invasive species

(b) A drug used by cattle owners for treating their diseased cattle

(c) Scarcity of food available to them

(d) a widespread, persistent and fatal disease among them

13. How does National Biodiversity Authority (NBA) help in protecting the Indian agriculture?

1. NBA checks the biopiracy and protects the indigenous and traditional genetic resources.
2. NBA directly monitors and supervises the scientific research on genetic modification of crop plants.
3. Application for Intellectual Property Rights related to genetic/biological resources cannot be made without the approval of NBA.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

14. Consider the following statements:

Chlorofluorocarbons, known as ozone-depleting substances, are used

1. in the production of plastic foams
2. in the production of tubeless tyres
3. in cleaning certain electronic components
4. as pressurizing agents in aerosol cans

Which of the statements given above is/are correct?

(a) 1, 2 and 3 only (b) 4 only

(c) 1, 3 and 4 only (d) 1, 2, 3 and 4

15. Government of India encourages the cultivation of 'sea buckthorn'. What is the importance of this plant?

1. It helps in controlling soil erosion and in preventing desertification
2. It is a rich source of biodiesel
3. It has nutritional value and is well-adapted

to live in cold areas of high altitudes.

4. Its timber is of great commercial value.

Which of the statements given above is/ are correct?

(a) 1 only (b) 2, 3 and 4 only

(c) 1 and 3 only (d) 1, 2, 3 and 4

16. The acidification of oceans is increasing. Why is this phenomenon a cause of concern?

1. The growth and survival of calcareous phytoplankton will be adversely affected.
2. The growth and survival of coral reefs will be adversely affected.
3. The survival of some animals that have phytoplanktonic larvae will be adversely affected.
4. The cloud seeding and formation of clouds will be adversely affected.

Which of the statements given above is/are correct?

(a) 1, 2 and 3 only (b) 2 only

(c) 1 and 3 only (d) 1, 2, 3 and 4

17. The increasing amount of carbon dioxide in the air is slowly raising the temperature of the atmosphere, because it absorbs:

(a) The water vapours of the air and retains its heat

(b) The ultraviolet part of the solar radiation

(c) All the solar radiations

(d) The infrared part of the solar radiation

18. Biodiversity forms the basis for human existence in the following ways :

1. Soil formation
2. Prevention of soil erosion
3. Recycling of waste
4. Pollination of crops

Select the correct answer using the codes given below:

(a) 1, 2 and 3 only

(b) 2, 3 and 4 only

(c) 1 and 4 only

(d) 1, 2, 3 and 4

19. Recently, "oilzapper" was in the news. What is it?

(a) It is an eco-friendly technology for the remediation of oily sludge and oil spills

(b) It is the latest technology developed for under-sea oil exploration

(c) It is a genetically engineered high biofuel-yielding maize variety

(d) It is the latest technology to control the accidentally caused flames from oil wells

20. The formation of ozone hole in the Antarctic region has been a cause of concern. What could be the reason for the formation of this hole?

(a) Presence of prominent tropo-spheric turbulence; and inflow of chlorofluorocarbons

(b) Presence of prominent polar front and stratospheric' clouds; and inflow of chlorofluorocarbons

(c) Absence of polar front and stratospheric clouds; and inflow of methane and chlorofluorocarbons

(d) Increased temperature at polar region due to global warming

21. Regarding "carbon, credits", which one of the following statements is not correct?

(a) The carbon credit system was ratified in conjunction with the Kyoto Protocol

(b) Carbon credits are awarded to countries or groups that have reduced greenhouse gases below their emission quota

(c) The goal of the carbon credit system is to limit the increase of carbon dioxide emission

(d) Carbon credits are- traded at a price fixed from time to time by the United Nations Environment Programme

22. Consider the following:

1. Photosynthesis
2. Respiration
3. Decay of organic matter
4. Volcanic action

Which of the above add carbon dioxide to the carbon cycle on Earth?

(a) 1 and 4 only

(b) 2 and 3 only

(c) 2, 3 and 4 only

(d) 1, 2, 3 and 4

23. The "Red Data Books" published by the International Union for Conservation of Nature and Natural Resources (IUCN) contain lists of

1. Endemic plant and animal species present in the biodiversity hotspots,
2. Threatened plant and animal species.
3. Protected sites for conservation of nature and natural resources in various countries.

Select the correct answer using the codes given below:

(a) 1 and 3

(b) 2 only

(c) 2 and 3

(d) 3 only

24. Human activities in the recent past have caused the increased concentration of carbon dioxide in the atmosphere, but a lot of it does not remain in the lower atmosphere because of

1. its escape into the outer stratosphere.
2. the photosynthesis by phyto-plankton in the oceans.
3. the trapping of air in the polar ice caps.

Which of the statements given above is/are correct?

(a) 1 and 2

(b) 2 only

(c) 2 and 3

(d) 3 only

25. In the context of ecosystem productivity, marine upwelling zones are important as they increase the marine productivity by bringing the

1. decomposer microorganisms to the surface.
2. nutrients to the surface.
3. bottom-dwelling organisms to- the surface.

Which of the statements given above is/are correct?

(a) 1 and 2

(b) 2 only

(c) 2 and 3

(d) 3 only

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ECOLOGY (UPSC QUESTIONS) (ANSWERS)

CHRONICLE IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

1 (a)
2 (a)
3 (a)
4 (d)
5 (c)
6 (a)
7 (b)
8 (c)
9 (a)
10 (a)
11 (a)
12 (b)
13 (d)
14 (c)
15 (c)
16 (a)
17 (d)
18 (d)
19 (a)
20 (b)
21 (b)
22 (c)
23 (b)
24 (b)
25 (b)

❖❖❖