Tilak Maharashtra Vidyapeeth
Pune

ENVIRONMENTAL STUDIES

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CHAPTER 1

ENVIRONMENTAL STUDIES : MULTIDISPLINARY NATURE

The term environment means surroundings and is generally used as an abstract concept. The surroundings may be natural, man-made, physical, chemical or biotic. The environment is thus, a complex of many things encompassing an organism that interact not only with the organisms but also among themselves. As a result of this it is difficult to isolate or alter any one of them without affecting the other components. The growth, behaviour and life history of an organism, are therefore, influenced by the environment in which they live. The preferred environment of an organism is usually referred to as habitat. The term, habitat denotes a more specific meaning of the surrounding than environment. On our planet earth, we find two major types of habitats, terrestrial (174 million per square km) and aquatic (40 million per square km) with different environmental complexes. Both of these habitats support innumerable forms of life, the nature and concentration of which vary considerably, although certain forms (amphibians) are dependent on both of them for completing their life cycle.

The 'environment' is defined as *"outer physical and biological system in which man and other organisms live as a whole, albeit a complicated one with many interacting components"*. The wise management of environment depends upon an understanding of those components: namely rock, minerals and water, of its present and potential vegetation, animal life, livestock husbandry and climate. It demands positive and realistic planning that balances human needs against the potential environment.

An Interdisciplinary Science or a Multidisciplinary Studies

It has long been held that environmental science deals with the study of the atmosphere, the land, the oceans and the great chemical cycles that flow through the physical and biological systems. Currently it was noticed that modern environmental science is increasingly becoming interdisciplinary, preparing people for global citizenship and training them to be flexible, competent to analyse and be a good decision makers. Three branches of sciences namely Earth, Life and Social interact.

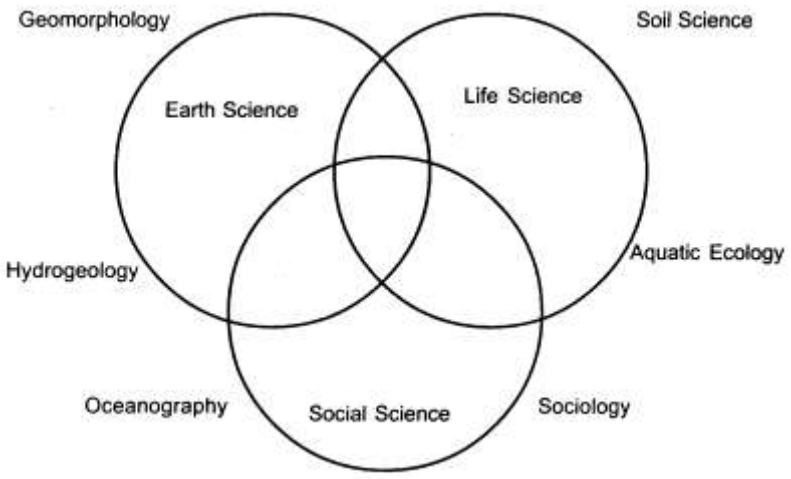

Fig 1: Various Disciplines of Environmental Science

With the advancement in the knowledge of environment, explosive increase in human population, scarcity of space, food problems, deterioration of hygienic conditions, threatening depletion of natural resources and socio-economic problems, one needs extensive and exhaustive study of the environment, particularly in relation to human survival and benefit. The subject is gaining more popularity with its name as "environmental biology". However, the environmental are not a new discipline but simply an extension of ecologies approach which stresses the study of the environment in its totality with special emphasis on the welfare of man and his comfort. Man has been considered the most evolved and an intelligent component of the ecosystem.

Environment is not merely the atmosphere and other physical factors surrounding us, but is the complex of all factors which not only affect "one organism, one time, but all organisms all the time". In a larger sense, environment constitutes the various physical, mental, social, spiritual, educational, economic and intellectual aspects of whole humanity. When kept healthy and inspiring, it promotes the progress and development. It is a boon to mankind.

Dimensions of environmental biology are fact increasing. The understanding of the subject needs an adequate knowledge of geography, climatology, pedology, microbiology, bio-chemistry, physiology, biophysics, biometry, sociology, economics, etc. The environmental problems with which now we are concerned embrace diverse aspects ranging from the economic, social, and psychological problems of human settlements to the management and use of natural habitats. Since time immemorial, man has been, and will always be exploiting nature without taking into consideration of environmental deterioration. In fact, what he considers progress, in reality, is disturbing the environmental balance seriously, leading to breakdown of life-supporting system on the earth. The thoughtless exploitation is mainly on account of ignorance about environment and ecosystem. Also lack of concern amongst planners and ecologists about the side effects of the development projects, gaps in information, data and feed back system. This calls for proper environmental strategy for maintaining the ecological balance and making preservation of nature, an integral part of developmental planning, together with the adoption of alternative means of livelihood. Environmental biology is a growing discipline, which incorporates all these aspects of environment.

Scope and Importance

Environmental problems are always interrelated. Often solution to one problem actually creates another problem. The major environmental problems can be divided into following categories:

1. Over-population : It amplifies all other environmental problems.
2. Pollution : It makes vital resources less useful and reduces the quality of life.
3. Depletion of resources: It makes things that are vital to human existence more expensive.
4. Global changes : They result from human activities and may permanently alter the Earth in unpredictable ways;

5. War: This causes all other environmental problems. - Modern warfare which threatens the survival of the human species.

At present the world is very crowded, more polluted, ecologically fragile and vulnerable to disruption. Despite greater material output, the World's people will be poorer in many ways than they are today. Regional water shortage will become more severe. Significant losses of world forests will continue over the next 20 years as demand for forest products and fuel wood increases. The world's forests are currently disappearing at the rate of 20 million hectares per year, with most of the loss occurring in the humid tropical forests of Africa, Asia and South America.

Serious deterioration of agricultural soils will occur worldwide, due to erosion, loss of organic matter, desertification, salinization and water logging. Atmospheric concentrations of carbondioxide and ozone depleting chemicals are expected to increase at rates that could alter the world's climate and upper atmosphere significantly by 2050. Acid rain from increased combustion of fossil fuels threatens and causes damage to lakes, soils and crops. Radioactive and other hazardous materials create health and safety problems in increasing numbers of countries. Extinctions of plant and animal species will increase dramatically. More than 20 percent of all species on earth will be irretrievably lost from their habitats and thus vanish, especially from tropical forests.

Necessity for Environmental Awareness and Education

Environmental Science is an inter-disciplinary awareness and education science encompassing the principles of basic sciences like physics, chemistry, biology, geology and applied sciences like engineering, agriculture and other similar disciplines. It also gives input to social sciences such as sociology, economics, law, political science and philosophy. It can be include two main aspects as follows.

i. Theoretical aspects dealing with the identification of environmental problems.

ii. Applied aspects dealing with development of solutions to the environmental problems identified above.

It has now been globally identified that to maintain the quality of life, there is a an urgent need to protect the environment. This is initiated by creating awareness among the people so that it becomes a part of their life style.

As the Earth's natural resources are rapidly dwindling and our environment is being increasingly degraded by human activities, it is evident that something needs to be done. It is the prevention of environmental degradation that must become a part of all our lives. Protecting our environment is economically more viable than cleaning it up once it is damaged. Individually, we can play a major role in environment management. We can reduce wastage of natural resources and we can act as watchdogs that inform the government about sources that lead to pollution and degradation of the environment.

This can only be made possible through public awareness. Mass media such as newspapers, radio and television strongly influence public opinion. If each of us feels strongly about the environment, the press and media will add to our efforts. Politicians in a democracy

always respond positively to a strong publicly-supported movement. We are living on spaceship earth with a limited supply of resources. Each of us is responsible for spreading this message to as many people as possible.

Man and Environment

Man cannot be considered in isolation from his environment. 'All over the world, the needs of people differ enormously, At one time the environmental problems debated in international organizations have been those recognized by the developed countries - the need to control pollution and the desirability of conserving ecological and genetic richness and the natural beauty of the earth. Since the United Nations Conference of the Human Environment, it has been increasingly realized that environmental issues are also of vital concern to developing countries and that the world environmental problems are still those associated with poverty, poor housing, bad .public health, malnutrition and inadequate employment.

Both the creation and the recognition of environmental problems depend on the way society is organized and on its values and objectives. Changes on the relationship between man and his physical environment depend to a large degree on changes in the organization and aims of society. If man is to escape from a situation in which much energy and resources are devoted to correcting past mistakes, his aim must be to build a society, which is intrinsically compatible with its environment.

On the whole, the environmental problems can only be solved through development. But that development, producing more food and drawing on the great resources of the planet, needs to be environmentally wise, and be based upon through evaluation of the potential uses of the different regions of this highly variable earth. Short-term solutions as they have in many countries - lead to long-term losses which a growing world population control affords.

UNESCO's programmes on environment and natural resource management (MAS) aim at providing the scientific basis and trained personnel needed for solving the environmental problems of our times.

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CHAPTER 2

NATURAL RESOURCES

Any material which is required or used to sustain life or livelihood is termed as a resource. In other words the term 'resource' means anything natural or human or cultural, which satisfies human wants.

Natural Resources :

Natural resources are defined as a form of energy or matter which is essential for functioning of organism, population and ecosystems. In other words Natural resources include all natural forces or factors, such as air, water, soils, landforms, minerals, forest etc. which serve human wants.

Natural resources can be divided into two main categories –

i. Renewable resources ii. Non-renewable resources

i) Renewable resources: The resources that can be replenished through rapid natural cycles are known as renewable resources, e.g. Water, Air, Soil, Solar energy, Forest.

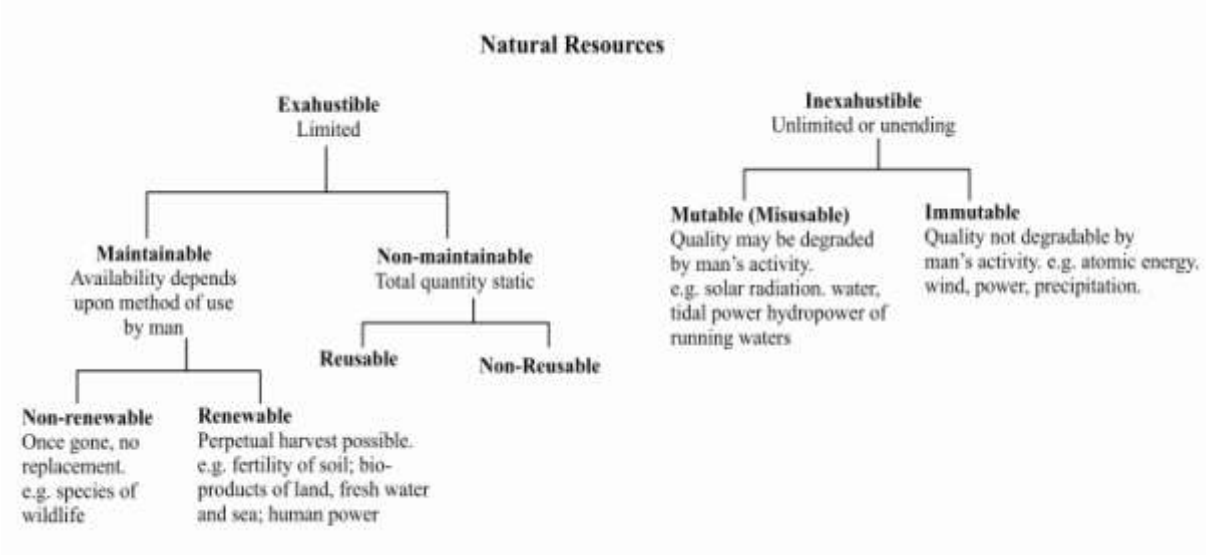
ii) Non-renewable resources: The resources that can't be replenished through natural processes are called non-renewable resources. These are available in limited amount and which once used exhaust for ever. e.g. Fossil, petrol, coal, metals, iron, copper, gold, silver etc.

Non renewable resources can be further divided into two types

a) Recyclable and b) Non-Recyclable.

a) The resources which can be collected after they are used and can be recycled are called recyclable resources, e.g. Copper, Aluminum, Phosphate and Potassium Mineral etc.

b) The resources which can not be collected after they are used and recycled in any way are known as non-recyclable resources, eg. Coal, Petroleum, Uranium etc.



Forest resource: Forest is important resource in two ways i.e. ecologically and economically.

Ecological Uses:

1. Forests help in balancing oxygen and carbon dioxide level in atmosphere, regulating earth temperature and hydrological cycle.
2. Forests check the rain bearing winds and cause rainfall. Further they increase the amount of moisture in the atmosphere , thus preventing drought situation.
3. They minimize the extreme variations in climatic conditions and make the climate bearable.
4. They control floods during heavy rains by impeding the velocity of run-off on soil surface, check soil erosion, silting and landslides.
5. They act as wind breaks and protect the adjoining farmlands against strong winds.
6. They increase the fertility of the soil. The trees and plants collect nitrogen from the atmosphere, fix it into the soil and thereby increase the fertility of the soil. The decomposed leaves and other organic matter help fertility of the soil.
7. They provide shelter to wild animals and birds. They offer hunting grounds.
8. They provide fresh air and beautiful scenery and become recreational centres.

Economic uses:

1. They provide grasses for feeding, thatching, paper industry etc. In Forests provide timber for house building, ship building, railway carriages, log bodies, carts, furniture, tool handles etc.
2. They supply fire wood and charcoal in homes and in industries.
3. Forests provide raw materials for various forest based industries, i.e., pulp and paper, rayon, matches, soaps, paints, rubber etc.
4. Products like bamboos, resins, gums, canes, training materials, dye stuffs, oils (Sandal) fibers, medicine, Kattha, lac etc are also obtained from the forests.
5. They provide honey for food and medicines, bee wax for candles etc.

Over exploitation of forests-

Rapid increase of population, industrialization, urbanization and mining has brought about indiscriminate tailing of trees and denudation of forests. The forest areas at global, regional and local level have so markedly decreased due to our exploitation that several serious environmental problems have been created. Many of the developing countries of the tropical and subtropical regions have lost substantial portions of their forest covers due to conversion of forest land into agricultural land to feed the millions.

Many plant species have been extinct due to irreversible change in forest ecosystem by human interference.

Deforestation :

"The temporary or permanent removal of forests cover from a forest land is known as deforestation." The term deforestation refers to the destruction of indigenous forest and wood lands. It does not include the removal of industrial forests such as plantations. Deforestation is one of the out-come of various developmental activities. Forest clearings were made not only for village settlements but also for cultivation and pastures. As the population increased more forests were cleared for various uses. Apart from this the commercial exploitation of forests is the main cause of deforestation. There was a time when 70% of the land area was covered with forests. Now the total forest cover has reduced to 16% only at global level.

Effect of deforestation:

Deforestation gives rise to several problems, 1) Soil erosion, 2) Increase in the sediment load of the rivers, 3) Siltation of reservoirs and riverbeds, 4) Increase in the frequency and dimension of floods and droughts,. 5) Change in the pattern of distribution of precipitation, 6) Intensification of green house effects, 7) Increase in the destructive force of the storms, 8) Economic loss through damages of agricultural crops and low yield, 9) Decrease in the supply of raw materials and timber, 10) Marked decrease as fodder to animals, 11) Extinction of species, 12) Alteration in the carbon and water cycles, 13) Social problems in the form of economic poverty, crimes and increased legal litigation.

Dams have been constructed for supply of water to cropland and other purposes. In modern days big dams are constructed for multipurpose, e.g. go Provide irrigation, to aid for flood control, generating hydropower, in land navigation, island fishing, for recreation etc.

Such large dams affect the native to a great extent. The forest is being cleared for dam construction, for approach roads, offices, and residential quarters and for storage of construction materials. The processes of filling the reservoirs drown large tracts of forest, displace the tribal and other people and affect wild life.

With the reduction of forest cover and the entry of people the pressure on the remaining forest increases. Their needs for fire wood, lead to further deforestation. Thus, the construction of dams has a very serious effect on forests. Although dams are intended to provide in-expensive electricity, many of the economic failures are due to lack of environmental planning.

Water Resources:

Water is essential to all life. First life was originated in water. Means of obtaining and conserving water have shaped the nature of terrestrial life. Water is one of the main agents in pedogenesis and also the medium for several different ecosystems.

Water is essential not only for the sustenance of human life but also for the 'quality of life as well. It is the essence of life on Earth and totally dominates the chemical composition of all organisms. It provides both food and drink and has been used for recreation, transport, cooling, power generation and waste disposal.

The various forms of water are found in every section of the ecosphere, atmosphere, the lithosphere and the hydrosphere. However, in-spite of enormous quantity of the substance that

exists, only a small proportion of it is actually usable by human beings. The ocean alone constitute 97 percent of the hydrosphere, and the polar ice caps, ice fields and glaciers make up another 2 percent in the form of ice. Inland surface water (lake and rivers) account for barely 0.02, percent.

Only 3 percent of the total global of approximately 1.4 billion cubic meters of water is fresh and suitable for human use. Of this against 77.2 percent is permanently frozen, 22.4 percent occurs as ground water and soil moisture, 0.35 percent is contained in lakes and wetlands, and less than 0.01 percent in rivers and streams. Thus fresh water is a very limited resource.

i) Surface Water Resources

As a rough estimate, the annual rainfall in India would be equivalent to about 3700 billion cubic meters. Of this around 1250 cubic meters is lost by evapotranspiration, and another 790 billion cubic meters by seepage into the soil, thus leaving 1660 cubic meters as surface flow into the rivers. Fourteen major river system share 83 percent of all drainage basins, accounting for 85 percent of the surface flow and serve 80 percent of the total population of the country. There are other 44 medium and 55 minor rivers which are mostly seasonal in nature. However, all the river water flow cannot be utilized because of the numerous limitations imposed by topography, climate, soil conditions etc. It has been estimated that only about 666 billion cubic meters of water can be utilized from various rivers without large inter basin water transfers. Moreover, because of the uneven distribution of rainfall over the years, it becomes necessary to store up the flows in the monsoon period for regulated release during the non-monsoon months.

The area and volume of surface water on Earth has increased because of the impoundments of rivers to form both medium and large reservoirs and the construction of countless small farm ponds and stock tanks. By March 1981, India had constructed about 1554 major dams along with several medium and small ones, with a storage capacity of about 1,60,352 million cubic meters.

B. Ground Water Resources

It has been estimated that out of about 790 billion cubic meters of water that seeps into the soil, about 430 billion cubic meters remain in the top soil layers and produces soil moisture which is essential for growth of vegetation. The remaining 360 billion cubic meters percolates into the porous strata and represents the actual enrichment of underground water. Out of this water that can be extracted economically is only about 225 billion cubic meters (Murthy, 1975)

Hydro Electric Energy: Although energy generation for hydroelectric stations avoids polluting effects of fossil fuel or nuclear plants, it has a number of indirect effects, many of which are undesirable. Ahuja (1986) has sub-divided these impacts into physico-chemical, biological and social. Similarly, we can differentiate the effects on the area surrounding the reservoir from those that affect downstream areas all the way up to estuaries and deltas. Siltation decreases the capacity of reservoirs and greatly reduces their lifetime. The observed rates are always greater than expected. It is feared that Bhakra Nangal Dam may loose its entire storage -capacity in the next 35 years.

Mineral Recourses:

"A naturally occurring element or compound formed by inorganic processes is called mineral. It has a definite chemical composition or range of compositions, properties and atomic structure".

Minerals are derived from the earth. "The extraction of minerals from the earth is called mining". Like agriculture mining is a primary occupation of man. Man is using mineral from the beginning of civilization. There are more than 3,000 mineral types.

Mineral resources are fixed in quantity and they are exhaustible. For this reason, mining is said to be 'robbery industry and extractive industry. Therefore mining economy is temporary in nature.

Energy Resources:

Energy resources are found on our planet in a variety of forms or source. Firewood and fossil fuel are being used for supply of energy since time immemorial and are known as conventional energy sources. Wind, hydropower, solar energy and atomic energy are the new and non-conventional sources of energy. Fossil fuels being limited in supply may be termed as exhaustible source while others like solar, hydel, wind and atomic energy that would be available to man for infinite period are regarded as inexhaustible sources.

Non Conventional Energy Sources:

Solar Energy: Sun is the primary energy source in our lives. Solar energy can be directly used through various natural processes that provides us with food, water, fuel and shelter. Sun rays induce the growth of plants, which form our food material and help in breathing. Energy from the sun evaporates water from river to form clouds that turn into rain.

Electrical energy comes from hydel power based on the cycle that is powered by the sun energy that supports evaporation or from thermal power stations powered by fossil fules. Nuclear energy is held in the nucleus of an atom and is now harnessed to develop electrical energy.

Energy is used for household, agriculture, and production of goods and for running transport. Modern agriculture uses chemical fertilizers, which require large amount of energy during their manufacture. Industry uses energy to power manufacturing units and the urban complexes that supports it.

At present almost 2 billion people worldwide have no access to electricity at all. People who have the access they continue to increase their individual requirements. A large proportion of energy from electricity is wasted during transmission as well as at the user level.

When the energy is used wastefully, it always contributes to a major environmental disaster.

Energy has always been closely linked to man's economic growth and development between 1950 and 1990. The world's energy needs increased four fold, In the last few years, the worlds demand for electricity has increased considerably. Electricity is at present the fastest growing form of energy worldwide. The Asia Pacific zone is expected to consume some 40% more energy than North America, in near future.

Among the commercial energy sources used in India, coal is the predominant source accounting for 55% of energy consumption, followed by oil (31%), Natural gas (8%), hydro (5%) and Nuclear (1%).

In India, biomass (mainly, wood and dung) accounts for almost 40% of primary energy supply.

Non Renewable Energy: This consist of the mineral based hydrocarbon fuels, coal, oil and natural gas that were formed from ancient forests. These are called fuels and are formed after plant life is fossilized. When the fossil fuels are burnt, they produce waste products which are released, into the atmosphere as gases such as CO2, oxides of sulphur, nitrogen and carbon monoxide. All of these cause air pollution. These have led to a grave problem to number of people all over the world. It has also affected buildings like Taj Mahal. These gases also act like a green house letting the long wavelength radiations in and trapping the heat inside. This has led to global warming. It has also increased global temperature causing, drought in some areas, floods in other regions, melting of ice caps, and rise in sea levels which is slowly submerging coastal belts all over the world. Warming of seas also leads to the death of sensitive organisms such as corals.

Renewable Energy

Renewable energy systems use resources that are constantly replaced and are usually less polluting. Examples include hydropower, solar, wind and geothermal (energy from the heat inside the earth). Renewable energy is also obtained from bio-fuels Renewable energy technologies will improve the efficiency and cost of energy systems.

Bio Energy

Plants and trees depend on sunlight for growth and hence biomass energy is a form of stored solar energy. Although wood is the largest source of biomass energy, agricultural waste, sugarcane wastes and other farm byproducts are also used for getting energy. Biomass can be burnt to produce heat and electricity, changed to gas such as methane changed to a liquid fuel. Liquid fuels called bio-fuels include two forms of alcohol, ethanol and methanol. Some day biomass can supply much of our transportation fuel needed for cars, truck, buses, airplanes with diesel fuel replaced by 'bio-diesel' made from vegetable oils. Researches are also developing algae that will produce oil. New ways have been found to produce ethanol from greases, trees, bark, sawdust, paper and farming wastes.

Organic solid waste includes paper, food waste and other organic non fossil and derived materials such as textiles, natural rubber and leather that are found in the waste of the urban areas. These waste materials can be converted into electricity by combustion boilers or steam turbines.

Biogas is produced from plant material, animal waste, garbage, waste from households and some other types of wastes, such as fish processing, dairies and sewage treatment plants. It is a mixture of gases which includes methane, CO, H_2S and water vapour. Biogas plants have become increasingly popular in India in the rural sector. The Biogas plants use cow dung,

which is converted into a gas which reduces smoke, and dung usage have increased in thousands of homes.

Solar Energy

Ideally, solar energy could be trapped on the unutilized surfaces of house roofs. According to one estimate, in which the developing countries are not included, roof surfaces on buildings of all types throughout the world represent about 20 sq. m. of space per person. Solar energy imparted to this area amounts to about 24,000 kwh per person per year. This corresponds to the sum raised to the power of ten of all the energy consumed per person in the world today in the form of oil and nuclear energy. The same roof area could give off into the atmosphere at night between 3.5 and 8.5 million kilo calories of heat per year without warming up the air in outer space.

Solar heating has rapidly gained popularity in the United States. In 1979 there were 40,000 solar installations, compared with 24 in 1970. Such growth suggests that as much as 15% of the population by 2015 may live in home with solar space or water heating.

Solar heating buildings vary widely in size and cost, and they are found in all kinds of climate. Some use passive systems, in which sunlight commonly is admitted by south facing glazing, stored in walls and floors and distributed by convective airflow. Other buildings use active systems in which mechanical means move the heat from sunlight collectors to storage and from storage to the rooms of the houses. The most practical strategy for a house in specific and can be quite different from that for a house in other area.

Many houses use both active and passive collectors to take best advantage of the sun. The first solar heated home in Maine, for instance, built in 1974, used 190 square feet of double glazed windows for passive heat collection and a 520 square foot "trickle collector" for the active collection The trickle collector is one of the simplest heat transfer devices. Water trickles down the valleys of corrugated aluminum that is heated by the sun. In the Maine house, the heated water flows into a 1600 gallon tank surrounded by 20 tons of small rocks. A fan blows air across the heated rocks, and the warm air rises into the living areas of the house. The solar system meets about 70% of the house's heating needs. The rest of the heat is supplied by a fireplace and wood furnace. The house owners estimate that their solar system saves them $600 a year in heating expenses. As the periods of energy production and energy consumption do not usually coincide, storage of the energy is essential in solar heated buildings. Owing to the high temperature differentials between storage container and the environment, normal heat storage suffers from the disadvantage that, even when well insulated, the heat slowly escapes in course of time. But by the use of what are known as latent energy stores, this can be avoided. Here heat energy applied is used only to a minor extent for raising the temperature, and is used in the for changing the storage medium consisting of specific salt mixtures which are transformed by heating from a solid phase to a liquid condition In the liquefaction process, a large part of the thermal energy is established in the form of fusion heat, and can be recovered later in the form of useful heat.

Another scheme for the utilization of solar energy for heating and air conditioning uses, roof plates, adjustable systems with a heat rectifying effect. In this case solar energy

temperature corresponds to the room temperature. The solar energy taken in is passed into a thin latent storage layer which can be compressed so that its constantly corresponds to the room temperature. In this way the solar energy absorbed by day is stored in the latent storer and is given off again into the space of the room at night. If during the summer the room temperature rises too much, the rectifier effect of the roof plates can be reversed for cooling purposes. The overheated room air now imparts energy to the latent storer, which gives off energy into the atmosphere at night in the form of infrared radiation.

Hydroelectric power : This uses water, flowing down a natural gradient to turn turbines to generate electricity known as hydroelectric power by constructing dams across rivers. Hydel power is considered to be the cheapest source of electricity and maintenance free.

Biogas or Gobar Gas

Cow dung when subjected to the action of a kind of micro organism in closed tanks under anaerobic condition undergoes a type of fermentation. As a result dung is converted into gobar gas which is a mixture of methane, carbon dioxide and minute quantities of other gases. In addition, slurry rich in combined nitrogen is also obtained which is used as manure for the fertility of agricultural lands. The gas is highly flammable and very useful as a fuel, under the name Biogas or Gobar Gas.

Wind energy: Wind was the earliest energy source used in transportation by sailing ships. In Tamil Nadu, there are large wind farms producing 550 Mega watts of electricity. At present, India is the third largest wind energy producer in the world.

Wind power has little environmental impact, as there are virtually no air or water emissions, radiation or solid waste production. The principal problems are bird kills, noise, and effects on TV reception and aesthetic issues.

Wind depends on the geographic distributors of wind. Wind therefore cannot be used as the sole resource for electricity and requires some other back up or stand by electricity sources.

Tidal and Wave energy: Tidal power is generated by forcing the tidal flow to pass through turbines. Tidal power stations bring about major ecological changes in the sensitive ecosystem of coastal regions and can destroy the habitats and nesting places of water birds and interfere with fish rise.

Wave power converts the motion of waves into electrical or mechanical energy. Here an energy extraction device is used to drive turbo generators.

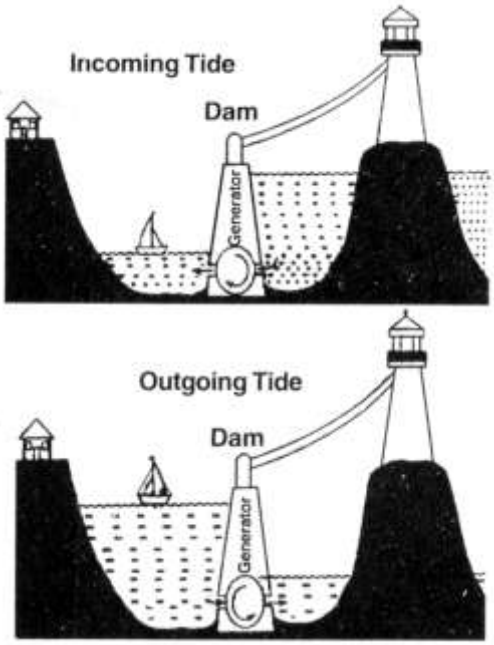


Fig. 2: Diagrammatic representation of Tidal Power Station

Geothermal Energy: It is the energy stored within the earth. Geothermal energy starts with hot molen rock (Magma) deep inside the earth, which surfaces at some parts of the earth's crust. In the 20th century geothermal energy was harnessed on a large scale for heating. It is used for electricity production especially in Iceland, Japan and New Zealand. Geothermal energy is nearly as cheap as hydropower and will thus be utilized in future. Geothermal fluids are a problem, which must be treated before disposal.

Nuclear Power: When the nucleus of the uranium atom is split, some mass gets converted to energy. India has 10 nuclear reactors at 5 nuclear power stations that produce 2% of India's electricity. These are located in Maharashtra, Rajasthan, Uttar Pradesh, Gujarat and Tamil Nadu.

The heat energy produced in the chain reaction of $Uranium_{235}$ (U_{235}) is used to heat turbines that produce steam, which drives turbines that produce electricity. The reaction releases very hot wastewater that damages aquatic ecosystems even though it is cooled by water system before it is released.

The disposal of nuclear waste is becoming an increasingly serious issue. Nuclear accidents can be devastating and the effects can last for long periods of time. A single accident can kill thousands of people, make many others seriously ill and destroy an area for decades by its radioactivity leading to cancer and genetic deformities.

Food Resources

Food may be defined as anything which is able to satisfy appetite and to meet physiological needs for growth, to maintain all body processes and to supply essential energy required for maintaining body temperature and activity. Food is a mixture of many different chemical components. The six major components of food are carbohydrates, proteins, fats,

minerals, vitamins and water. To maintain good health, ingesting a diet containing these nutrients in correct amounts is essential.

In ancient times, human beings were hunt gatherers of food. This type of food provided essential nutrients but limited the number of people that could be adequately supported on a given land area.

Problems of agriculture Overgrazing:

One hundred years ago, most of the semiarid range lands bordering the Sahara Desert were populated by nomadic herders. For centuries these people survived by adapting to their harsh environment. They moved across the continent with little regard for national boundaries, traveling with the seasons and abandoning an area after it had been grazed. This constant movement allowed rejuvenation of affected areas and prevented overgrazing, in addition, population levels of these nomadic tribes were stable and relatively low. In recent years, however, their life style has changed. The demographic transition has been accompanied by decreased infant mortality and a rapidly rising population. In addition, enforcement of national borders and frequent hostilities in some areas has led to the demise of nomadism. As people have become settled and populations have grown, land has been overgrazed, plant systems that normally conserve the sparse rainfall have been destroyed, and desert has grown. This process has been repeated in many other regions of the world as well. Even in the United States, where food is relatively abundant, overgrazing and desertification is a problem in the Southwest. In a wealthy nation such as the United States, it is feasible to initiate a program to halt the spread of deserts on public lands.

Water Logging

This is takes place both by natural and man-made conditions. The natural conditions responsible for water logging are as follows:

1) Deep percolation after rain.

2) The land remaining submerged under floods.

3) Poor natural drainage of the subsoil under unfavourable geology like existence of hard pan or rock outcrops near the soil surface.

The artificial conditions responsible for water logging are as Follows:

1. No maintenance of natural drainages.

2. Blocking of natural drainage channels by roads and railways.

3. Irrigated fields enclosed with embankments choking up natural drainage.

4. Heavy seepage from unlined canals.

5. High intensity of irrigated agriculture irrespective of the soil and subsoil.

Salinity

The term "Salinity" refers to the amount of dissolved salt that is present in water. Sodium and chloride are predominant ions in seawater, and the concentrations of magnesium, calcium, and sulfate ions are also substantial. Naturally occurring waters vary in salinity from

the almost pure water, devoid of salts, to the saturated solutions in salt lakes such as the Dead Sea. Salinity in the oceans is constant but is more variable along the coast where seawater is diluted with freshwater from runoff of rivers. This brackish water forms a barrier separating marine and freshwater organisms.

Land Resources

Land is regarded as a natural resource because it is essential for the functioning of organisms, populations and ecosystems. Along with sunlight, air and water, land supports all living beings i.e. plants and animals. All terrestrial plants have their roots in soil from which they absorb water and nutrients. Man and all land animals, in turn, depend on these plants for food, directly or indirectly.

Although land appears to be an unlimited resource, its exploitation would limit its availability. Thus, land is not a limitless commodity. Increasing population and industrial expansion has generated urban sprawl, with thousands of square Km of open space being taken over annually for housing and business. As a result congestion and wide spread pollution, along with depletion of water and mineral resources and destruction of wilderness and wild habitats, has become increasingly severe.

Soils:

Soil is one of the most significant ecological factors, which is derived from the transformation of surface rocks. Plants depend for their nutrients, water and supply and anchorage on soils. It constitutes an important medium wherein numerous animals live. In fact, soil of a nation is its most valuable material heritage. The soil provides home and ideal environmental conditions for living beings.

The soil is the thin cover on the solid crust of the earth. Soil is made up of weathered rock material of varying degree of fineness and in varying degrees from the parent rocks by the action of different agencies. Soil is derived from the latin word solum, which means floor or ground.

Soil is a natural body, a biochemically weathered and synthesised product of nature. Pedology considers soil as a natural entity, a biologically weathered and synthesized product of nature. Pedologists study soils, which includes the study of origin of the soil, its classification and its description.

b) Soil is also considered to be a natural habitat for plants and other living organisms and justifies soil studies primarily on that basis. Edaphology considers the soil as a natural habitat for plant. Edaphology is the study of soil from the standpoint of Plants. It considers the various properties of soils as they relate to growth and production. The edaphologist considers the soil in relation to growth, nutrition and yield of crops.

Land Degradation

The area of land surface that is potentially available for agricultural use declines from year to year. Vast cultivated areas have already become practically unusable by erosion. In the tropical and subtropical zones in particular, agricultural production has been jeopardized

by erosion and impoverishment of the soil. One of the main causes of deterioration of the land is deforestation by fires. The burning of forests removes practically the entire nitrogen supply for vegetation. The other nutrients (calcium, potassium, phosphorus, etc) are still available in soluble form within the resulting ash and so can still be used by the plants. In the early years following clearance by fire, the land could be used for agricultural purposes. But as absorptive clay minerals will be missing from the soil, the nutrients cannot be retained. Since they are soluble they will be removed to lower levels where they are no longer accessible to growing plants. There will thus be a rapid loss of quality of the soil and consequent decline in the vegetation.

Apart from the loss of nutrients there will also be a drop in the water supply and a change in the microclimate. The absorptive effect of the forest land, which previously served to even out the fluctuations between the dry season and periods of rainfall, will no longer exist. Consequently, in periods of rainfall there will be flooding and in the dry season, drought. With heavy rains the ground surface will be eadden with fine particles caught up in the rainwater, so that on drying out a hard crust will form. In this way the oxygen supply required to promote the root activities of plants will be cut off. For most plants this will cause a sharp drop in growth, but will give a competitive advantage to resistant grasses. In this way a prairie is formed, which cannot be used for agricultural purposes.

The second main cause of deterioration of the land is wind erosion. This, mostly takes place in dry regions with strong winds, It is normally held in check by the fact that the land is protected by a thick covering of plants and is consolidated by the root growth. In this way the removal by wind (and water) of the valuable upper humus layer is prevented. When the land is used for agriculture this covering of plants is removed and replaced by cultivated plants. As these are regularly harvested and replanted, the ground is exposed periodically (as after ploughing and while the newly planted cultivated plants are still small) to the unfavourable effects of wind and water. The wind erosion can be kept within limits when the cultivated plants are sown in mixed cultivations or when the fields are small and the ground is also covered with organic material. On the other hand, the weathering process can be accelerated by alternating effects once the wind erosion has already begun. The more the ground is eroded, the less fruitful will it be for plant growth. With a lower rate of growth the wind erosion is intensified. Similar to the causes of wind erosion are the causes of water erosion. Water erosion arises especially in areas of high precipitation. Water erosion takes place in particular when the protective plant covering on the ground is destroyed on steep slopes (as by the clearance of woodland or by road construction), so that the water running away in the rainy season can wash the ground surface. Often all that is left is a bare cliff, on which vegetation is hardly possible.

Desertification

It refers to the degradation in low rainfall and seasonally dry areas of the Earth. It can be viewed as both a process and the resulting condition. Desertification involves the impoverishment of vegetation and soil resources. Key characteristics include the degradation of natural vegetation cover and undesirable changes in the composition of foliage species, deterioration in soil quality, decreasing water availability, and increase in soil erosion from

wind and water. Desertification is a global problem. Various stages of desertification can be seen in most of the world's dry lands. In rare cases, desertification leads to abandoned, desert like landscapes.

Causes and Consequences of desertification

Although some authorities believe that climate change may be a causal factor, it is generally agreed that human activities, particularly excessive resource use and abusive land use practices, are the primary cause of desertification. Specific activities leading to desertification include clearing and cultivation of low rainfall areas where such cultivation is not sustainable, overgrazing of rangelands, clearing of woody plant species for fuel wood and building materials, and mismanagement of irrigated cropland leading to the buildup of mineral salts in the soil (salinization). Drought is often cited as a basic cause of desertification, however, it merely accelerates or accentuates land degradation processes already under way. Consequences of desertification include reduced biological productivity, reduction of biodiversity, a gradual loss of agricultural potential and resource value, loss of food security, reduced carrying capacity for humans and livestock, increased risks from drought and flooding, and in extreme cases, barren lands that are beyond restoration. Paleo studies, supported by model simulations, have shown that the intensity of Northern Hemisphere desert conditions has waxed and waned over the past 9,000 years in response to the precession of the Earth's orbit about the Sun. Thus, it may be that the causal factors of desertification, whether climate change or human activities, depend on the time scale being addressed,

Methods of Conservation

The challenge of conservation is to understand the complex connections among natural resources and balanced resource use with protection to ensure an adequate supply for future generations. In order to accomplish this goal, a variety of conservation methods are used. These include reducing consumption of resources; protecting them from contamination or pollution; reusing or recycling resources when possible; and fully protecting, or preserving resources.

Consumption of natural resources rises dramatically every year as the human population increases and standards of living rise. Between 1950 and 1990 the world population doubled to 5.3 trillion, with nearly 80 percent living in developing, or poorer, nations. The larger, developed nations, however, are responsible for the greatest consumption of natural resource because of their high standards of living. For instance, in 1992 the average American consumed as much energy as 27 Filipinos or 370 Ethiopians. Conservation education and the thoughtful use of resources is necessary in the developed countries to reduce natural resources consumption. For example reducing the high demand for tropical hardwoods such as teak and mahogany in the United States and Japan would slow the rate of tropical forest destruction.

To natural resources can be protected by prohibiting or limiting the use of pesticides and other toxic chemicals, limiting wastewater and airborne pollutants, venting the production of radioactive materials, and regulating drilling and transportation of petroleum products. Failure to do so results in contamination of air, soil, rivers, plants and animals.

In many cases it is possible to reuse or recycle resources to reduce waste and resource consumption and conserve the energy needed to produce consumer products. For example,

paper, glass, aluminum, metal scrap, and motor oil can all be recycled. A preventative measure called pre-cycling, a general term for designing more durable, recyclable products such as reusable packaging, encourages reuse. Many states in the United States have established mandatory recycling laws in an attempt to reduce waste and consumption.

Some resources are so unique or valuable that they are protected from activities that would destroy or degrade them. For example, national parks and wilderness areas are protected from logging or mining in the United States because such activities would reduce the economic, recreational, and aesthetic values of the resource. Forests and wetlands (areas with high soil moisture or surface water) may be protected from development because they enhance air and water quality and provide habitat for a wide variety of plants and animals. Unfortunately, these areas are often threatened with development because it is difficult to measure the economic benefits of cleaner air, water, and the many other environmental benefits of these ecosystems (the plants and animals of a natural community and their physical environment).

1. Biodiversity Conservation

Biodiversity or biological diversity denotes the number and variety of different organisms and ecosystems in a certain area. Preserving biodiversity is essential for ecosystems to respond flexibly to damage or change. For example, a single species of corn crop may be quickly destroyed by a certain insect or disease, but if several different species of corn are planted in the field, some of them may resist the insect or disease and survive. The same principle is applied to natural areas, which adapt to natural environmental changes such as wildfire, drought, or disease because of the biodiversity that has evolved in the area over thousands, or even millions of years. For example, many forests, are able to quickly regenerate because many of the plants that thrive there have adapted to fire. Some trees, such as pine, may even require fire to aid in reproduction. These trees produce cones that are opened by extreme heat. The fire opens the cones and the seeds are then released into the soil.

Humans benefit greatly from the many crops, and other products that biodiversity provides. As many as 40 percent of our modern pharmaceutical medicines are derived from plants or animals.

2. Forest Conservation

Forests provide many social, economic, and environmental benefits. In addition to timber and paper products, forests provide wildlife habitat and recreational opportunities, prevent soil erosion and flooding, help provide clean air and water, and show tremendous biodiversity. Forests are also an important defense against global climate change. Through the process of photosynthesis, forests produce life giving oxygen and consume huge amounts of carbon dioxide, the atmospheric chemical most responsible for global warming. By decreasing the amount of carbon dioxide in the atmosphere, forests may reduce the effects of global warming. However, huge areas of the richest forests in the world have been cleared for wood fuel, timber products, agriculture, and livestock. These forests are rapidly disappearing. The tropical rain forests of the Brazilian Amazon River basin were cut down at an estimated rate of 14 million hectares (35 million acres), each year. The countries with the most tropical forests

tend to be developing and overpopulated nations in the southern hemisphere. Due to poor economies, people resort to cleaning the forest and planting crops in order to survive. While there have been effective efforts to stop deforestation directly for exploitative logging, the most effective conservation policies in these countries have been efforts to relieve poverty and expand access to education and health care.

In the United States and Canada, forests are threatened by extensive logging, called clear-cutting, which destroys plant and animal habitat and leaves the landscape bare and unproductive if not properly reforested. As a result, the timber harvest was reduced and foresters were directed to follow a more sustainable policy called ecosystem management. This policy required foresters to focus on conserving natural habitats rather than maximizing tree harvest. Despite this change, many ancient forests remain unprotected.

3. Soil Conservation

Soil, a mixture of mineral, plant, and animal materials, is essential for most plant growth and is the basic resource for agricultural production. Soil-forming processes may take thousands of years, and are slowed by natural erosion forces such as wind and rain. Humans have accelerated these erosion processes by developing the land and clearing away the vegetation that holds water and soil in place. The rapid deforestation taking place in the tropics is especially damaging because the thin layer of soil that remains is fragile and quickly washed away when exposed to the heavy tropical rains. Globally, agriculture accounts for 28 percent of the nearly 2 billion hectares (5 billion acres) of soil that has been degraded, overgrazing is responsible for 34 percent, and deforestation is responsible for 29 percent.

In addition to reducing deforestation and overgrazing, soil conservation involves reforming agricultural soil management methods. Some of the most effective methods include strip roping, alternating strips of crop and uncultivated land to minimize erosion and water runoff. Terracing, which also reduces erosion and runoff on slopes, growing legumes, such clover or soybeans, to restore essential nitrogen in the soil; and minimizing tillage, or ploughing, to reduce erosion.

Conservation of soil depends upon the understanding of these complex interactions between vegetation, micro organisms and climate,

Maintenance of vegetal cover, with the ability to hold soil particles, checks erosion. The organic matter is gradually added, water holding capacity increases and the soil fertility is regained.

In hilly areas the terracing of the landscape and planting perennial species in dense rows across the slopes helps in checking erosion due to water.

In areas with wind blowing at high velocity, planting of several rows of dense rapidly growing tall trees is practiced.

4. Water Conservation

Clean freshwater resources are essential for drinking, bathing, cooking, irrigation, industry, and for plant and animal survival. Unfortunately, the global supply of freshwater is distributed unevenly. Chronic water shortages exist in most of Africa and drought is common

over much of the globe. The source of most freshwater supplies, groundwater (water located below the soil surface), reservoirs, and rivers, are under severe and increasing environmental stress because of overuse, water pollution, and ecosystem degradation. Over 95 percent of urban sewage in developing countries is discharged untreated into surface waters such as rivers and harbours. About 65 percent of the global freshwater supply is used in agriculture and 25 percent is used in industry. Freshwater conservation therefore requires a reduction in wasteful practices like inefficient irrigation, reforms in agriculture and industry, and strict pollution controls worldwide.

In addition, water supplies can be increased through effective management of watersheds (areas that drain into one shared waterway). By restoring natural vegetation to forests or fields, communities can increase the storage and filtering capacity of these watersheds and minimize wasteful flooding and erosion. Restoration and protection of wetlands is crucial to water conservation. Like giant sponges, wetlands stabilize groundwater supplies by holding rainfall and discharging the water slowly, acting as natural flood-control reservoirs.

Water can be conserved by holding maximum amount of rain water mainly in hilly tracts which serve as catchment areas. This is usually done by allowing the vegetation to grow on slopes of hills. Hence, aforestation is important by which plants can bind the soil and the soil intrun can hold water.

5. Energy Conservation

All human cultures require the production and use of energy that is, resources with the capacity to produce work. Energy is used for transportation, heating, cooling, cooking, lighting, and industrial production. The world energy supply depends on many different resources including traditional fuels such as firewood and animal waste, which are significant energy sources in many developing countries. Fossil fuels account for more than 90 percent of global energy production but are considered problematic resources. They are non renewable that is, they can be depleted, and their use causes air pollution. In particular, coal plants have been one of the worst industrial polluters since the beginning of the industrial revolution of the 19th century. Moreover, mining or drilling for fossil fuels has caused extensive environmental damage.

There is a global need to increase energy conservation and the use of renewable energy resources. Renewable alternatives such as waterpower (using the energy of moving water, such as rivers), solar energy (using the energy from the sun), wind energy (using the energy of the wind or air currents), and geothermal energy (using energy contained in hot-water deposits within the Earth's crust) are efficient and practical but largely underutilized because of the ready availability of inexpensive, nonrenewable fossil fuels in industrial countries.

While some countries, such as France, Japan, depend heavily on nuclear energy (energy produced by atomic fission, or splitting of the atom), it is still not a major energy source. Excessive production costs, serious safety concerns, and problems with the handling of the dangerous radioactive wastes have virtually eliminated it as a viable energy source in the United States.

In addition to using alternative energy resources such as solar and wind power, energy conservation measures include improving energy efficiency. Encouraging the expansion and use of public transportation systems and carpooling dramatically increases energy efficiency. In the household, energy can be conserved by turning down thermostats, switching off unnecessary lights, insulating homes, and using less hot water.

6- Mineral Conservation

Until recently little attention was paid to conservation of mineral resources because it was assumed that nothing could be done to save them anyway. But now these assumptions have proved wrong and it is believed that severe shortages would develop tomorrow. The conservation of minerals, therefore, has become a serious concern for conservationist all over the world. The future needs can be met by expanding reserves, finding substitutes, recycling and conservation.

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CHAPTER 3
ECOSYSTEMS

An ecosystem is defined as a dynamic entity composed of biological community and its associated abiotic environment. Often the dynamic interactions that occur within an ecosystem are numerous and complex. Ecosystems are also undergoing alterations to their biotic and abiotic components. Some of these alterations begin first with a change in the state of one component of the ecosystem, which then cascades and sometimes amplifies into other component because of relationships.

In recent years, the impact of humans has caused a number of dramatic changes to a variety of ecosystems found on the Earth. Humans use and modify natural ecosystems through agriculture, forestry, recreation, urbanization, and industry. The most obvious impact of humans on ecosystems is the loss of biodiversity. The number of extinctions caused by human domination of ecosystems has been steadily increasing since the start of the Industrial Revolution. The frequency of species extinctions is corelated to the size of human population on the Earth, which is directly related to resource consumption, land-use change, and environmental degradation. Other human impacts to ecosystems include species invasions to new habitats, changes to the abundance and dominance of species In communities, modification of biogeochemical cycles, and modification of hydrological cycling, pollution, and climatic changes.

Ecosystem is the basic functional unit in ecology, since it deludes both biotic and abiotic environment, influencing each other for maintenance of life. A.G. Tansley (1935) first proposed the term ecosystem and *"defined it as the system resulting from the interaction of all the living and non-living factors of the environment"*. Various ecologists have added much on this concept (Lindeman, 1942; Odum, 1963 and 1971; Billings, 1964; Misra, 1969; Mac, Fadyen, 1964). These include different microcosm, biocoenosis or geobiocoenosis, holocene biosystem, bioinert body and ecocosm. However, the term ecosystem is most preferred, where eco = environment, and system = an interacting and interdependent complex. Barrett (1978) explained the *"term ecosystem for its structural* and *functional aspects"*. He proposed a new term ecosystem to define *"a basic unit of study encompassing biological, physical, social, economic and cultural influences on the total system'*. The organisms of any community besides interacting among themselves always have functional relationship with the environment. This structural and functional system of communities and environment is called ecological system or ecosystem.

The complete ecological system of an area, including the plants, animals and the environmental factors is known as ecosystem. The ecosystem is that approach, in which habitat, plants and animals are all considered as one interacting unit; materials and energies of one passing in and out of the others.

Concept of an Ecosystem

An organism is always in the state of perfect balance with the environment. The environment literally means the surrounding. The environment refers to the things and conditions around the organisms which directly or indirectly influence the life and

development of the organisms and their populations. Organisms and environment are two non-separable factors. Organisms interact with each other and also with the physical conditions that are present in their habitat.

The concept of ecosystem was first put forth or the word ecosystem was first used by British plant ecologist A.G. Tansley in 1935. He described *"ecosystem is the major ecological unit", It has both Structure and functions."* The structure is related to species diversity. The more complex is the structure the greater is the diversity of the species in the ecosystem. The functions of ecosystem relates to the flow of energy and cycling of materials through structural components of the ecosystem. Later E.P Odum - 1963, described *"The ecosystem is basic functional unit of nature including both organisms and their non- living environment, each interacting with other and influencing each other's properties and both necessary for maintenance and development of the system."*

An ecosystem may be conceived and studied in the habitats f various sizes, Eg. One square meter of grass land, a large *0* ke a large tract of forest, balanced aquarium, a certain area of river and ocean. All the ecosystems of the earth are connected to one other. Eg. River ecosystem is conceited with the ecosystem of ocean and small ecosystem of dead logs is a part of large ecosystem. A complete self-sufficient ecosystem is rarely found in nature, 'But situations approaching self sufficiency may occur.

Structure of Ecosystem :

The structure of an ecosystem is basically a description of the organisms and physical features of environment including the amount and distribution of nutrients particular to a habitat. It also provides information regarding the range of climatic conditions prevailing in that area. From the structural point of view, all ecosystems consist of the following basic components.

1. Abiotic components (a = without, biotic = Life)
2. Biotic components (Life)

1. Abiotic Components:

They are the non-living components in the environment. Abiotic component of ecosystem includes basic inorganic elements and compounds, such as soil, water, Oxygen, Calcium, Carbonates, Phosphates and variety of organic compounds. It also includes such physical factors and ingredients as moisture, wind currents and solar radiation. Radiant energy of sun is the only significant energy source for any ecosystem. The amount of non-living component such as Carbon, Phosphorus, Nitrogen, etc. which are present at any given time is known as standing state or standing quantity.

2. Biotic Components :

The biotic components include all living organisms present |n the environment system. From nutrient point of view, the biotic components can be grouped into two basic components.

1. Autotrophic Components.
2. Heterotrophic components

The autotrophic components include all green plants which from radiant energy of sun manufacture food from inorganic substances.

The Heterotrophic components include non-green plants and all animals which take food from autotrophs. So, biotic components of an ecosystem can be described under the following three heads.

1. Producers (Autotrophic components)

2. Consumers

3. Decomposers or reducers and transformers.

Producers (Autotrophic elements):

The producers are the autotrophic elements chiefly "Green Plants." They use radiant energy of sun in photosynthetic process where by carbondioxide is assimilated and the light energy is converted into chemical energy. The chemical energy is actually locked up in the photosynthesis. This is used in respiration by all green living organisms and oxygen is evolved as by product in the photosynthesis processes. This is used in respiration by all living things. Algae and other hydrophytes of a pond, grass of the field, trees of the forest are examples of producers.

Consumers: (Heterotrophic elements)

Those living members of ecosystem which consume the food synthesized by producers are called consumers under this category are included all kinds of animals that are found in an ecosystem.

There are different classes of consumers

1. Primary Consumers

2. Secondary Consumers

3. Tertiary Consumers

4. Parasites Scavengers and saprophytes.

1. Primary Consumers: These are purely 'Herbivores' animals that are depended for their food on producers or green plants.

Ex : Insects, Rodents, Rabbit, Deer, Cow, Buffalo, Goat are of common herbivorous animals in terrestrial ecosystem.

The herbivorous serve as the chief food source for carnivorous.

2 Secondary Consumers: These are also called as "Omnivores" they are the animals that are adapted to consume herbivorous as well as plants and flesh eating animals. Ex. Sorrow, Crow, Fox, Wovles, Dogs, Cats, Frog etc.

3. Tertiary Consumers: They are the highly carnivorous, which prey other carnivores, Omnivores and herbivores. Eg. Lions, Tigers, Hawk, vulture, snake etc.

4. Besides different classes of consumers, the Parasites Scavengers and Saprophytes are also included in the consumers. The parasitic plants and animals utilize the living tissues of

different plants and animals. The scavengers and saprophytes utilize dead remains and plant as their food.

Decomposers or transformers

Decomposers and transformers are the living components of the ecosystem and they are Fungi and Bacteria. Decomposers attack dead remains of producers and consumers and degrade the complex organic substances into simpler compound. The simple organic compounds are then attacked by another kind of bacteria that are the transformers which change these organic components into the inorganic forms suitable for reuse by producers or green plants. Decomposers and transformers play very important role in Maintaining the dynamic nature of ecosystem.

Function of an Ecosystem

An ecosystem is a discrete structural, functional and life sustaining environmental system (Fig 1). The environmental system consists of biotic and abiotic components in a habitat. Biotic component of the ecosystem includes the living organism, plants, animals and microbes, whereas the abiotic component deludes inorganic matter and energy. Abiotic components provide the matrix for synthesis and perpetuation of organic components (protoplasm). The synthesis and perpetuate process involves energy exchange and this energy comes from the sun in the form of light or solar energy. Thus, in an ecosystem we have the following functional components.

1. Inorganic constituents (Air, water and mineral salts (Nitrogen, Phosphorous)
2. Organisms (Plants, animals and microbes)
3. Energy input which enters from outside (the sun)

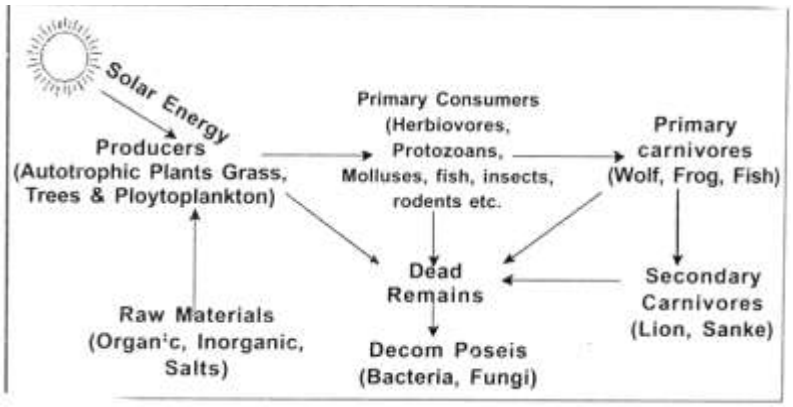

Fig 3: Diagrammatic Representation of Function of Ecosystem

Above three components interact and form an environment system. Inorganic constituents are synthesized into organic structures by green plants (Primary producers) through photosynthesis and solar energy for renewals (Herbivores) which, in turn become source of energy for the flesh eating animals (Carnivores). These are known as secondary producers. Animals of all types grow and add organic matter to their body weight and their source of energy is complex organic compounds taken as food.

All the living organisms whether plants or animals in an ecosystem have definite life span after which they die. The dead organic remains of plants and animals provide food for

microbes such as bacteria, fungi and many other animals the saprophytes. Ultimately decomposition of the organic structure by breaking the complex molecules and liberating the inorganic components into their environment is carried out by organisms known as decomposers. During the process of decomposition of organic molecules, the energy which kept the inorganic components bound together in the form of organic molecules gets liberated and deposited into the environment as heat energy Thus in an ecosystem energy from sun, the input is fixed by plants and transferred to animal components. Nutrients re withdrawn from the substrate and deposited in the tissue of plants and animals, cycled from one feeding group to another, this can be released by decomposition processes to the soil, water and then recycled.

The ecosystems operating in different habitats, such as deserts, forests, grasslands and seas are interdependent of one another. The energy and nutrients of one ecosystem may find their way in another so that ultimately all parts of the earth are interrelated, each, comprising a part of the total system that keeps the biosphere functioning.

Energy flow in the Ecosystem

Living organisms can use energy in several forms, both radiant and fixed energy. Radiant energy is in the form of electromagnetic waves, such as light. Fixed energy is potential and chemical energy bound in various organic substances that can be broken down in order to release their energy content. This can be summarized as follows (Fig 2),

1. The autotrophs convert the radiant energy of the sun into chemical energy by photosynthesis and store it in the bonds of the sugar molecules.

2. A part of this chemical energy is immediately used for metabolic activities (growth, maintenance and reproduction) by the process of respiration. Some energy is lost in the form of heat.

3. The autotrophs become the **food** and energy source for the herbivores (consumers) for their metabolic activities including movement. Energy is again lost as heat and in the form of compounds such as urea and uric acid, which still contains usable energy.

4. The Secondary consumers (carnivores) consume herbivores and use them as a source of energy with the same result as in the above level.

5. Tertiary consumers consume secondary consumers the same purpose and with the same result as above.

6. Decomposers consume dead bodies of plants and animals and also their waste products. Decomposition occurs' in several steps. The end products are without any energy They are returned to the a biotic environment and are used again by plants as nutrients.

As a result of the six processes described above energy passes continuously in an ecosystem (and matter is recycled again and again). Hence the radiant energy "fixed" by the autotrophs is ultimately source of energy in the biosphere. At each step between the various level of consumers, energy is lost as heat. That is, the transfer of energy is not 100% efficient and some energy is always wasted. This reminds us of the second law of thermodynamics and energy in the ecosystem obeys the physical laws.

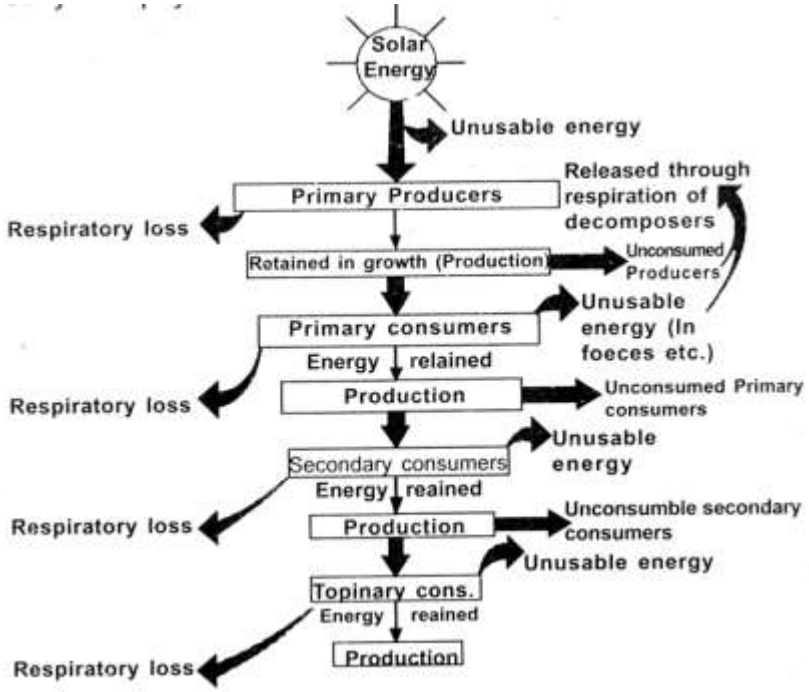

Fig 4: Loss of Energy in passage through the different trophic levels of a community

Trophic Level

Procedure and consumer ecosystems can be arranged in several feeding groups, each group as trophic level (feeding 'era' aggregation or assemblage of different trophic level - An ecosystem is known as trophic structure of the ecosystem. In an ecosystem, producers (P) represent the first trophic level {T1,}, herbivores (C1) represent the second trophic level T1)' Primary carnivores (C2) represent the third trophic level (T2) and top carnivores (C3) represent the last level (T4). Typically an ecosystem has 3 to 4 trophic levels through which energy flows. In other words there are usually 3 to 5 groups of organisms which derive their nutrition in the same general way.

3. Food Chain

In the ecosystem, green plants alone are able to trap solar energy and convert it into enemies! energy. The chemical energy is locked up in the various organic compounds, such as carbohydrates, lipids and proteins, present in the green plants. Since virtually all other living organisms depend upon green plants for their energy, the efficiency of plants in any given area in capturing solar sets the upper limit to long-term energy flow and biological activity in the community. The food manufactured by the green plants is utilized by themselves and also by herbivores. Animals feed repeatedly. Herbivores fall prey to some carnivorous animals. In this way one form of life supports the other form. Thus food from one trophic level reaches to the other trophic levels and a chain is established known as food chain (Fig 3).

It can be defend as" *Transfer of energy and nutrients through* a *succession of organisms through repeated process of eating* and *being eaten."* In food chain initial link is green plants or producers which produce chemical energy available for consumers.

Ex. Marsh grass → Grass hopper → Frog Snake → Hawk.

Food chains are of three types

1- Grazing food chain

2. Parasitic food chain

3- Detritus or saprophytic food chain

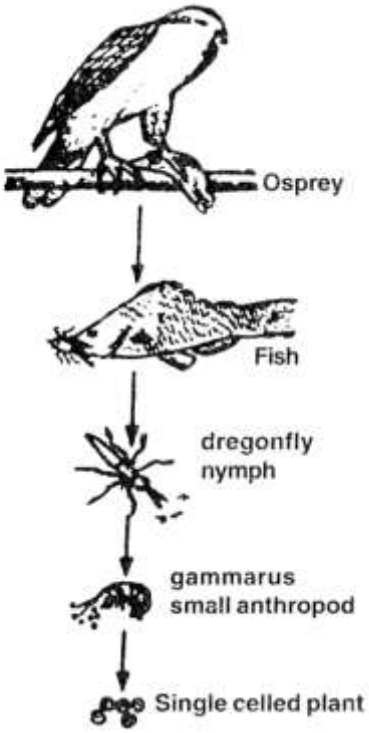

Fig. 5 Simple food chain of ecosystem

1. Grazing food chain: It is also called as predator food chain. It starts with green plants, going to grazing herbivores (primary consumers), to primary carnivores (Secondary consumers) and then to secondary carnivores (tertiary consumers) and so on.

In this food chain the killing and hunting nature is therefore this food chain is called as predator food chain.

2. Parasitic Food Chain: This also starts with green plants (large organisms) base. However, food energy passes into smaller organisms called parasites that live at the expense of the larger organism (host).

Ex. Tree → Birds → Insect parasites of Birds → fungal parasites of insects.

The Detritus Food Chain: It is also called as saprophytic food chain. The dead organic remains including tabolic waste and excreta's derived from grazing food chain 01 generally termed as "Detritus." The energy contained in Detritus is not lost in ecosystem as a whole, rather it serves as source of energy for a group of organism's called as detritivores that are separate from the grazing food chain. The food chain so formed is called detritus food chain. It starts with debris or decaying organic matter, of plant and animal bodies leading to larger organisms of a food chain.

Food Web

Many food chains exist in an ecosystem, but as a matter of fact these food chains are not independent. In ecosystem one organism does not depend wholly on another. The resources are shared specially at the beginning of the chain. However, a feeding relationship is never that simple. In most natural ecosystems the food chains are complicated by the presence of omnivores. These are animals that eat both plant and animal material. Bears, rats, many birds and men are omnivorous, it is very difficult to place them in a simple food chain, as there are many inter connections at different point in the food chain. Such interactions form a food web. Food maintains the stability of the ecosystem. The greater the number of alternative pathways more stable is the community living (Fig 4).

Ecological Pyramid

It is explained earlier that how energy and organic compounds are passed from one trophic level to the next. What was not mentioned is the efficiency of the transfer. In a highly efficient transfer almost all of the energy would be transferred namely 80% or more. In a low efficiency transfer very little energy would be transferred like less than 20%. In a typical food chain, not all animals or plants are eaten by the next trophic level. In addition, there are portions or materials (such as beaks, shells, bones, etc.) that are also not eaten. That is why the transfer of matter and energy from one trophic level to the next is not an efficient one.

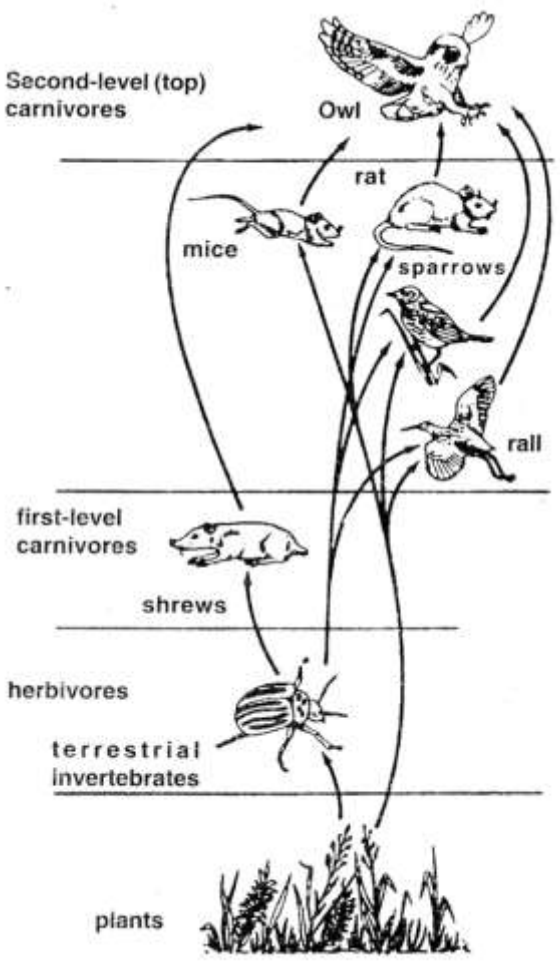

Fig 6: A food web in the Ecosystem

One way to calculate the energy transfer is by measuring or sizing the energy at one trophic level and then at the next. Calories are 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 depleted with an ecological pyramid.

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 looking at the pyramid, can you guess how much larger the volume of each layer is as compared to the one just above it? Take a guess. It might not look like it but they are close to 10 times larger.

Charles Elton (1927), a pioneer British Ecologist, developed the concept of ecological pyramids. According to him there is some sort of relationship between the number, biomass and energy content of the primary producers, consumers of the first and second orders and so on to top carnivores. In the ecosystem such relationship is represented graphically by means of pyramids, called ecological pyramid and the successive levels (the tiers) making the top. These are of three types:

1. Pyramid of numbers. It shows the number of organisms at each trophic level (number/m2).
2. Pyramid of biomass. It shows the total dry weight or any other suitable measure of the total amount of living matter (g/ m2).
3. Pyramid of energy. It shows the amount of energy flow and or productivity at successive trophic levels (calories/ m2/year).

Pyramid of Numbers

It indicates the numerical relationship between different trophic levels of a food chain. The more abundant species from the base of pyramid and the less abundant species remain near the top. It is the relationship between the number of producers, consumers of primary, secondary and tertiary orders constituted. The form of the pyramid of numbers depends and varies according to different communities and depends on whether producers are small (phytoplankton, grass) or large (oak trees). Sometimes, number of individuals varies so widely that it is difficult to represent the entire ecosystem on the same numerical scale. Such data could best be Presented in a tabular form.

In grassland ecosystem, the producers are mainly grass? And are always in maximum number. This number then show a successive decrease towards apex, as the primary consumers (herbivores), which are rabbits, mice, etc., are lesser in number than the grasses and green plants. Finally the top (tertiary) consumers, the hawks and birds, are least in number. Thus, the pyramid becomes upright.

The pond ecosystem can be a best example for this. The lowest trophic level is represented by algae and diatoms, which are more in number. The second trophic level is occupied by herbivorous Zooplankton (e.g. Copeodes), which are numerically less abundant. While third and fourth trophic levels are occupied by smaller and larger fishes respectively.

There is considerable reduction in the number of individuals from the base to the top of the pyramid. However in specialized parasitic, chains the pyramid of number becomes inverted.

In a forest ecosystem, however, the pyramid of numbers is somewhat different in shape. The producers which are mainly large-sized trees are lesser in number, and form the base of the pyramid. The herbivores, which are the fruit eating birds, deer, etc., are more in number than the producers. Then, there is a gradual decrease in the number of successive carnivores, thus making the pyramid again upright one.

In a parasitic food chain, the pyramids are always inverted. This is due to the fact that a single plant may support the growth of many herbivorous birds and each one of these, in turn, may provide nutrition to several hyperparasites like bugs and lice. Thus from the producers towards consumers the number of organisms successively show an increase, making the pyramid inverted one. In crop ecosystem, the pyramid is upright one where primary consumers, viz., grasshoppers are lesser in number than the crops, frogs, snakes, and eagle. The primary, the secondary and the top consumers respectively are present in decreasing number

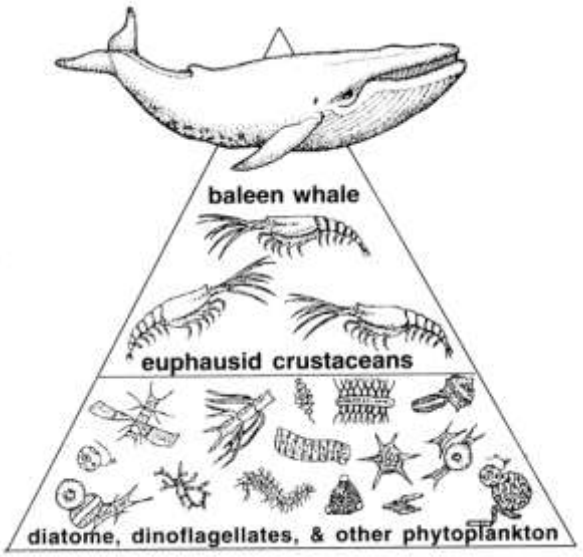

Fig 7: Pyramid of number of Ocean Ecosystem.

Pyramids of Biomass

Biomass may be defined as the total dry weight of dry matter present in the ecosystem at any one time. By using the weight of the organisms at different trophic level a pyramid of biomass results. This pyramid indicates the total bulk of organisms and gives a rough picture of the overall effect of food chain relationship for the ecological groups as a whole. In this type of pyramid, the relationship between different trophic levels is presented in terms of weight of organisms (biomass).

In grassland and forest ecosystem, there is generally a gradual decrease in mass of organisms at successive levels from the producers to the top consumers. Thus, pyramids are upright. In an aquatic ecosystem (like pond), however, the biomass of producers is least. This value gradually shows an increase towards the apex of the pyramid, thus making the pyramid inverted one.

The biomass of diatoms and phytoplankton (primary producers) is very little, as compared to small herbivore (primary consumers) that feed on them.

The biomass of large carnivore fishes (secondary consumers) which feed on smaller fishes is the highest of all the trophic levels. In fact, this is the case in most aquatic bodies In takes and sea, on the other hand, the phytoplankton's usually outweigh their grazers (zooplanktons) during periods of high primary productivity, as during the spring "bloom", but at other times, as in winter the reverse may be true. This difference in biomass trend can be explained if the time is also taken into account

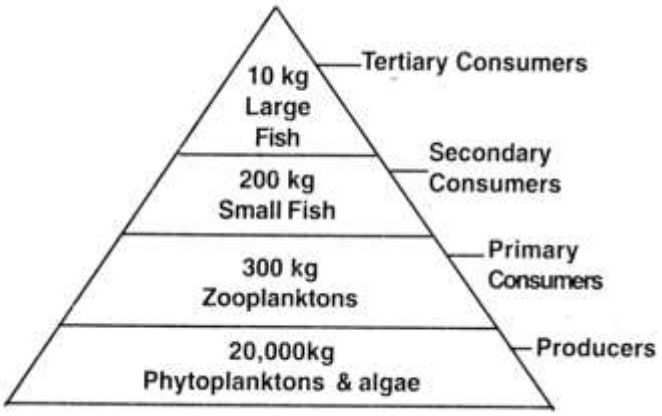

Fig 8: Pyramid of Biomass of Aquatic Ecosystem Pyramid of Energy

This pyramid indicates the amount of energy flow at each trophic level in the ecosystem as well as the role played by different organisms in the transfer of energy. Energy pyramids are always slopping. Energy production of the primary consumers (Herbivores) is greater than that of the secondary consumers (Primary Carnivores), which form next link in the energy chain. The energy remaining at the tertiary consumer level (Secondary carnivores) is very little in amount.

The trapped radiation energy flows in the food chain from the producers to the top carnivores, decreasing at successive trophic levels. If the relationship of total quantity of energy utilized in unit area over particular period of time by different trophic levels is diagrammatically represented, an upright pyramid is invariably formed. As against the pyramid of numbers and biomass the shape of the pyramid of energy is always upright in this the time factor is taken into account.

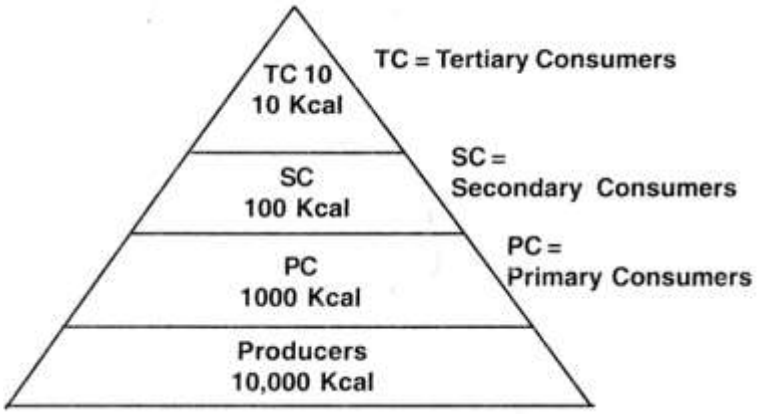

Fig 9: Pyramid of Energy

In grassland the green plants (primary producers) trap the maximum light energy in a particular area over a fixed period of time. Similarly in a pond ecosystem, the phytoplankton, in a particular area, trap and accumulate much more energy than the herbivore fishes in the course of year because of the large numbers and quicker rate of multiplication. Comparatively, the amount of energy utilized in a year by the top carnivores is much less than that of herbivore fishes.

The energy pyramid gives by far the best overall picture of the functional role of communities in an ecosystem. Energy pyramid is a picture of rate of passage of food mass though the food chain, where as number and biomass pyramids are pictures of standing states, i.e. organisms present at any moment. Its shape is invariably an upright one, and not affected by variation in the size and metabolic state of individuals, if all the sources of energy in the ecosystem are considered. The number and biomass pyramids on the other hand, may be upright or inverted depending upon the size and biomass of the producer organisms as compared to consumers. Below f'9ure shows all the three relationship of biotic animals in ecosystem.

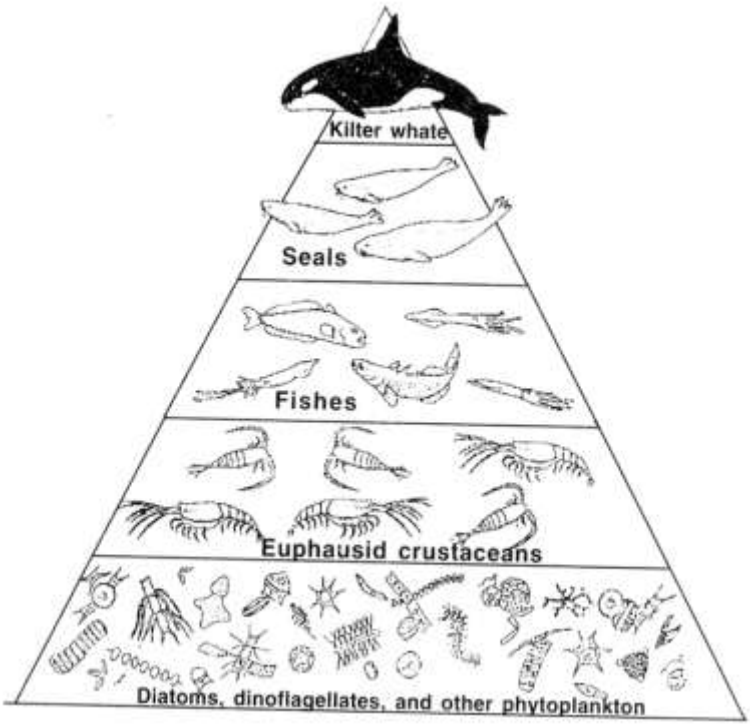

Fig 10: Figure showing biotic relationship between different organism

TYPES OF ECOSYSTEMS

Life on Earth continued to evolve around 420 million years ago. During the Silurian Period, ancient plants and arthropods began to occupy the land, over the millions of years that followed. These land colonizers developed and adapted to their new habitat. The first .forests were dominated by giant horsetails, club mosses, and ferns that stood up to 40 feet tall. In the late Paleozoic period, gymnosperms appeared. By the Triassic Period (245-208 mya), gymnosperms dominated the Earth's forests. In the Cretaceous Period (144-65m mya), the first flowering plants (angiosperms) appeared. They evolved together with insects, birds, and mammals and radiated rapidly, dominating the landscape by the end of the period. The landscape changed aging during the Pleistocene Ice Ages. The surface of the planet that had been dominated by tropical forest for millions of years changed, and temperate forests spread in the Northern Hemisphere.

In the biosphere various ecosystems like pond, lake, river, stream spring estuary, the sea, forest, grassland, desert, coral reef and cropland are operating as self-sufficient interacting t rns These ecosystems have more or less similar fundamental plan of their gross structure and function. However, hw differ in respect of their species, composition and productivity rates. In brief, organization pattern of some of the major ecosystems is described here

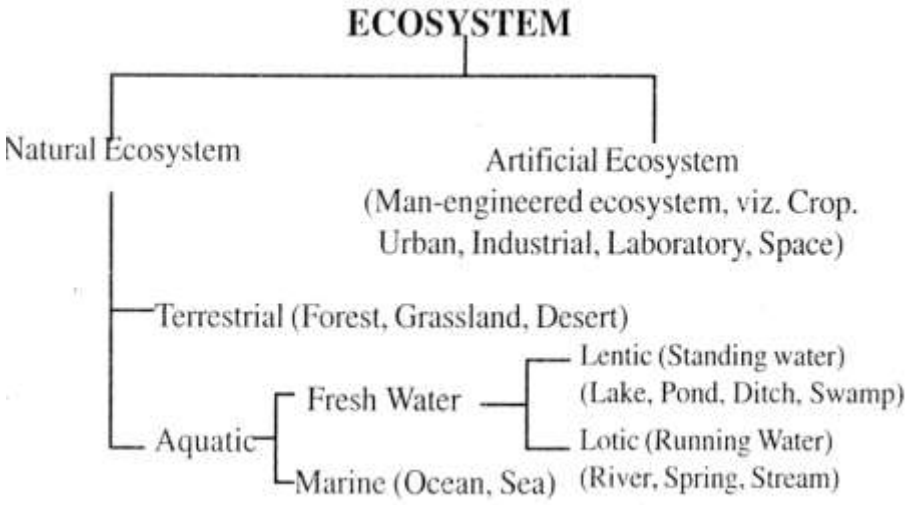

Fig 11: Showing different types of ecosystems on the earth

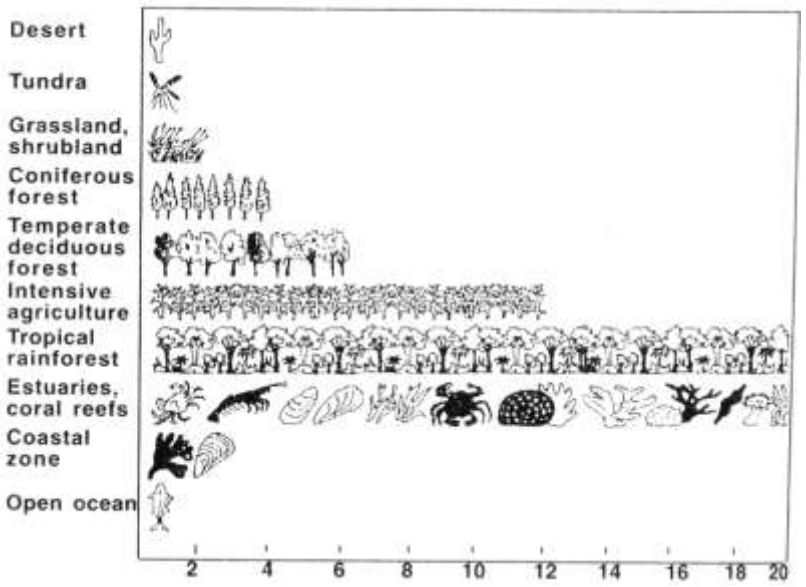

Fig 12 : Relative biomass accumulation of world major ecosystems. Only plants and bacteria capture solar energy. Animals consume plant biomass to build their own biocides.

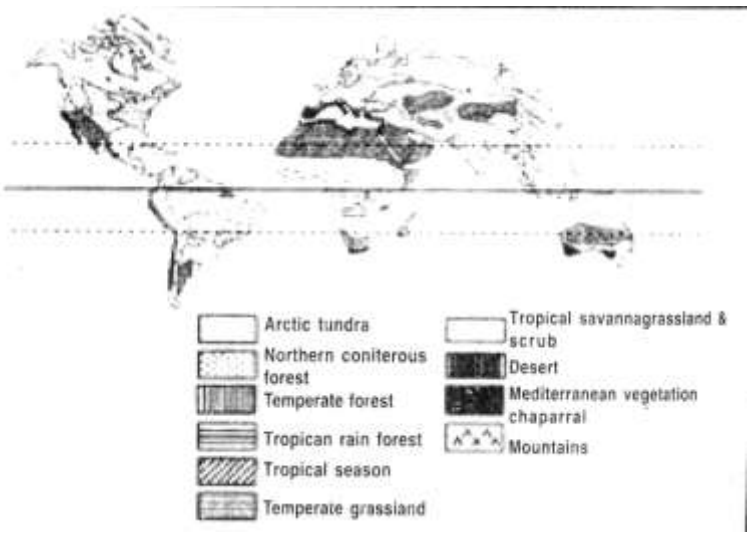

Fig. 13 : Different Types of Ecosystems in the World

TERRESTRIAL ECOSYSTEMS

Terrestrial habitats are naturally quite different from the aquatic habitats. Most aquatic organisms die relatively soon after being exposed to air. Water diffuses and evaporates so quickly from their bodies that cellular metabolism is disrupted and then destroyed. The conservation of water is, therefore, a major problem for land organisms. Terrestrial animals and plants have special devices to conserve water. On land great variation for availability of water, occurs ranging from marshes at one extreme to waterless desert at the other. This determines the habitability of particular land masses.

Important abiotic and biotic factors which control and determine the nature of all terrestrial ecosystems are given below:

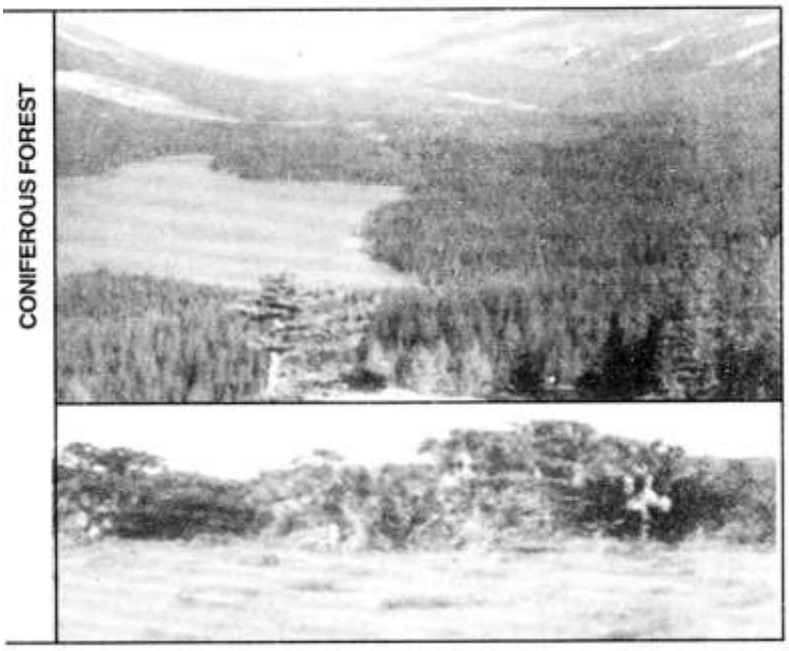

Fig 14: Showing occurrence of different ecosystem based on altitudes Abiotic Components

The ecosystems of the terrestrial environments are most variable. Factors having significant effect on life are given in the following lines.

Soil: The major life supporting element of the terrestrial environment is soil, composed of mineral matter interspersed with varying quantities of organic substances, air and water. Soil generally consists of three layers. At the surface is the top soil, which contains particular mineral matter as well as appreciable quantities of organic substances that give the layer a darkish hue. The top soil is of key importance to most terrestrial habitats. The combined presence in the top soil is of minerals, organic compounds, and animal life. The fertility and structure of soil in various regions determines the amount and type of vegetation. This in turn determines the number and varieties of consumers within the ecosystem.

Water: The body of all organisms is composed of about 60-70 percent of water. That is why water is a major limiting factor "i terrestrial life. The availability of ample and continuous supply °f water will determine the amount of freedom or conservation °f an organism will required for its use. Usually terrestrial organisms living in moist habitats freely consume and excrete large amounts of water. In arid regions, all organisms are physiologically adapted for conservation of water.

Temperature: Temperature varies greatly on land, not only from place to place but also with the season. The surface temperatures in some desert may fall far below 0°C in the winter and rise above 50°C in the summer. No organism, in its active state, can withstand the entire range of environmental difference encountered on land. Each species has evolved adaptations for life in a specific ecosystem.

Oxygen and Carbon Dioxide: Oxygen and carbon dioxide are the only required substances in all terrestrial ecosystems that are nearly constant in amounts. They are constant for the same reason that the sea is constant. They are part of a continuous and ever moving mass. In air, oxygen is about 20% and carbon dioxide 0.4% by volume.

Light: Light is the most important factor for producers or autotrophs for their photosynthetic activities. Consumers depend upon producers. Light intensity on the earth's surface varies greatly. The variations in the intensity, quantity and quality of light are caused by the angle of incidence, degree of latitude, climatic and various biological factors,

Geographical Barriers: Land has also got geographical barriers which check free movement and result in the development of ecosystem free from outside biotic forces.

Biotic Components

Biotic components include producers, consumers and decomposers as stated in the following lines:

Producers: Photosynthetic organisms are the producers in the terrestrial environment. This category includes Monera and Protista kingdoms but their contribution to specialized ecosystems is very small and limited. Flowering plants are the main and dominant producers. These producers provide the initial source of food in food chain and secondly provide habitats for other organisms. They are the prime agents in soil formation and in modifying the non-living environment.

Consumers: In terrestrial ecosystems, the primary consumers are numerous and belong to almost all phyla of invertebrates and venerates. The number of species of primary consumers is greater than the number of species of producers upon which they feed. The activity and growth of the population of consumers are directly related to the vegetation, the number and kinds of other consumers.

Decomposers: In terrestrial ecosystems too, bacteria and fungi are the main decomposers. They break down the organic compounds of dead organisms and their wastes. Thus the accumulation of such dead organic matters is checked up. The activity of the decomposers depends upon temperature and moisture. Thus we see that there is more accumulation of undecomposed organic matter where there are long dry and cold periods. However, in moist, warm, tropical climates, there are small heapings of organic matter. The process of decomposition changes the essential minerals to a soluble form, which is removed by run off water from heavy rains. The terrestrial environment is affected by greater changes than the stable aquatic environment. The terrestrial ecosystems are affected by the unpredictable climate, weather, water supply, fire, farming and industrialization and grazing.

Organisms are distributed roughly around the earth in latitudinal belts and vary according to major differences in climate and temperature. The latitudinal distribution is similar to the pattern seen along the slopes of high mountains, because weather factors are altitudinally much the same as they are latitudinal.

From the north Polar Regions to the equator there are seven major ecosystems.

ARCTIC ECOSYSTEM

The polar regions, together with snow capped peaks constitute *arctic zones*, similar in many ways, though not identical. Except in a more or less sporadic form the arctic *one is without life.

TUNDRA ECOSYSTEM

Tundra is a Siberian term that means a treeless marshy Plain. The *alpine zone*, above the tree line on mountains corresponds to the tundra. The land is fiat or gently rolling and reticulated by ponds, small lakes, and bogs. On certain mountains the alpine zone is subjected to winds in excess of 160 kilometers per hour and temperature down to - 21 ℃. Light energy and ultraviolet radiations are intense at this altitude. The tundra has a very fragile ecological balance because the growing season is so short and there are few animal and plant species. The productivity of the tundra ecosystem is low. Very little energy is left for consumers after the plants have met their own energy requirements. Of all the ecosystems, the tundra is probably the most inhospitable, least productive and least utilized by man.

Tundra means a barren land or a hostile territory. Tundra biomes occur in the polar regions in northern Canada, Greenland, other island of Arctic oceans, and northern Europe (northern hemisphere). This biome has been designated as Arctic Tundra. Tundra biome also occurs on the peaks of High Mountain of world and has been called as the Alpine Tundra.

The biotic components existing in the Tundra ecosystem are as follows;

Plants: Although tundra has extremely cold environment, yet there is life. Only a few kinds of vegetation can survive in the tundra environment. Most of them are perennials that reproduce in a very short time. They have only a month or two of favourable weather to complete growth and reproduction. The dominant plants are grasses, sedges, mosses, and lichens, and a few shrubby bushes. In some places there are few dwarfed woody species. The flowering herbaceous plants of the tundra are noted for their snowy blossoms. When warm summer temperature melt the ice and snow on the soil surface, plants rapidly renew growth from sub-surface parts which stood the long periods of freezing temperature. Thus plants are well-adapted to the cold climate.

Animals: The variety of animal life on the tundra is also limited. The animals that have adapted to survive in tundra are caribou or reindeer, the arctic hare, arctic fox, polar bear, wolf, lemming, snowy owl, and ptarmigans. In the brief summer, an insect especially flies and mosquitoes and nesting migratory birds are abundant.

The mammals found in the tundra fall into two groups in terms of size and behaviour. Large migratory species like carbibou, musk, ox and reindeer, migrate from one suitable feeding ground to the next. This is followed by large predators like arctic wolves, and small non migratory species namely rodents, which occupy a defined territory and- are preyed by the lvnx and arctic fox- In the summer months, the poorly drained ponds of the marshes and lakes found there make an deal breeding ground for ducks, geese, and countless other water fowls.

GRASSLAND ECOSYSTEM

The world's Grassland occur in five major areas, the prairies of the Great Plains of North America and the pampa of South. America, the veldt of South Africa,the steppes of Central Eurasia, and surrounding the deserts in Australia. Soils associated with grasslands are typically moist soils which are deep, dark, and rich but arid soils may occur in drier regions. Most of these grasslands have been extensively disturbed and are now major crop growing regions of wheat, corn and other grains. These lands are dominated by grasses, rather than large shrubs or trees. In the Miocene and Pliocene Epochs, which spanned a period of about 25 million years, mountains rose in western North America and created a continental climate favourable to grasslands. Ancient forests declined and grasslands became widespread. Following the Pleistocene Ice Ages, grasslands expanded in range as hotter and drier climates prevailed world wide (Fig 14). There are two divisions of grass lands.

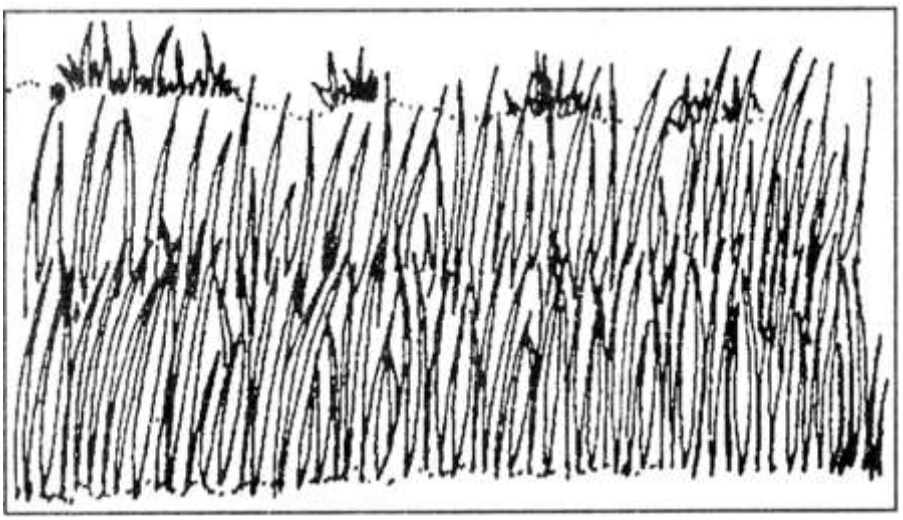

Fig 15: Figure showing grassland ecosystem

1. Tropical grassland or Savannas
2. Temperate grassland

1. Tropical Grasslands or Savannas

Savanna is grassland with scattered individual trees. It covers about half the surface of Africa (about five million square miles, generally central Africa) and large areas of Austral South America, and India. Climate is the most important fact9' in creating a savanna. Savannas are always found in warm *t*\ hot climates where the annual rainfall is from about 50 8 t 127 cm (20-50 inches) per year. It is crucial that the rainfall js concentrated in six or eight months of the year, followed by a long period of drought when fires can occur. If the rain were well distributed throughout the year many such areas would have become tropical forest. Savanna may be of following types'

1. Climatic savannas: Savannas which result from climatic conditions.
2. Edaphic savannas: Savannas that are caused by soil conditions.
3. Derived savannas: It is a result when people clearing forest land for cultivation.

Some of the abiotic characteristic features of savannas

Savannas are sometimes classified as forests. The predominant vegetation consists of grasses and forbs (small broad leaved plants that grow with grasses). Different savannas support different grasses due to disparities in rainfall and soil conditions. Deciduous trees and shrubs are scattered across the open landscape. One type of savanna common in southwestern Kenya, Tanzania, and Uganda are known as grouped tree grassland. It has trees growing only on termite mounds where the intervening soil is thin or poorly drained to support the growth of trees at all.

Soil: It is porous, with rapid drainage of water and has only a thin layer of humus (the organic portion of the soil created by partial decomposition of plant or animal matter). This provides vegetation with nutrients.

Rainfall: Savanna has both a dry and a rainy season. An average annual rainfall of 76.2-101.6 cm (30-40 inches). However, certain savannas can receive as little as 15.24 cm (6 inches) or as much as 25.4 cm (1 inch) of rain a year.

Seasonal fires play a vital role in the savanna's biodiversity-Most of the animals killed by the fires are insects with short life spans. A fire is a feast for some animals, such as birds that comes to sites of fires to eat grasshoppers, stick insects, beetles, mice and lizards that are killed or driven out by the fire underground holes and crevices provide a safe refuge for small creatures. Larger animals are usually able to run fast enough to escape the fire. Although the dry stems and leaves Harasses are consumed by fire, the grasses deep roots remain unharmed. The savannas experience a surge of new life at this time. For example, many antelope calves are born. With so much grass to feed on, mothers have plenty of milk. Calves die if the rains fail to come. Other animals (which do not all occur in the same savanna) include giraffes, zebras, buffaloes, kangaroos, mice, moles, grasshopers, ground squirrels, snakes, worms, termites, beetles, lions, leopards, hyenas, and elephants. The major environmental concern of savannas are poaching, overgrazing and clearing of the land for crops.

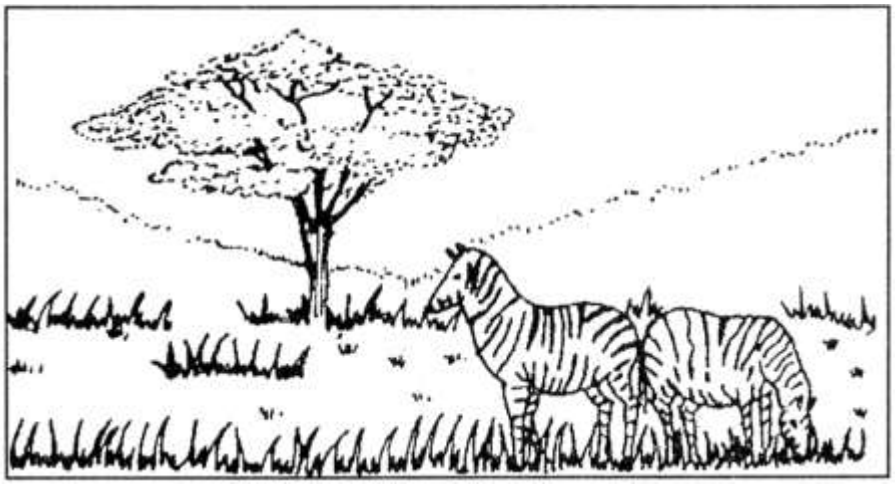

Fig 16: Figure showing Savanna grassland nature

2. Temperate Grassland

It is grasses dominant land where trees and large shrubs are absent. Temperatures vary more from summer to winter, and the amount of rainfall is less in temperate, grassland in savannas. Such lands are found in Such Africa, the puszta of Hungary, the pampas of Argentina and Uruguay, the of the former Soviet Union, and the plains and prairies of central North America.

Temperate grasslands have hot summers and cold winters. Rainfall is moderate. The amount of annual rainfall influences the height of grassland vegetation, with taller grasses in wetter regions. Similar to savanna, seasonal drought and occasional fires occur which are very important for biodiversity. The soil of the temperate grasslands is deep and dark, with fertile upper layers. It is nutrient rich due to the growth and decay of deep and other branched grass roots. The rotted roots hold the soil together and provide a food source for living plants.

The occurrence of grasses depends on temperature, rainfall and soil conditions. The seasonal drought, occasional fires, and grazing by large mammals all prevent woody shrubs and tree from invading and becoming established in these areas. A few trees (cotton woods, oaks, and willows) grow in river valleys. A few non woody plants, specifically a few hundred species of flowers, grow among the galleta. Flowers include asters, blazing stars, coneflowers, goldenrods, sunflowers, clovers, psoraleas, and wild indigos.

The Abiotic Condition for the Temperate Grassland Precipitation: In the temperate grasslands it usually occurs in the late spring and early summer. The annual average is about 50.8 to 88.9 cm (20-35 inches).

Temperature: It is very large over the course of the year. Summer temperature can be well over 38°C (100 Degrees Fahrenheit), while winter temperatures can be as low as -40°C.

The fauna: It includes gazelles, zebras, rhinoceroses, wild horses, lions, wolves, dogs, jackal, rabbits, deer, mice, foxes, badgers, blackbirds, grouses, meadowlarks. Quails, sparrows, hawks, owls, snakes, grasshoppers, leafhoppers and spiders.

Temperate grasslands can be further subdivided into Prairies (Grasslands with tall grasses) and steppes (grasslands with short grasses).

Grasslands occupy about 24 per cent of the earth's surface. Grassland is of 8 types classified on the basis of, their floral characteristics.

DESERT ECOSYSTEM

The vegetation of deserts around the world are quite variable. The Mojave Desert is known for its unusual Joshua Trees from the Lily Family. The Sonoran Desert, which wraps around the northern portion of the Gulf of California like an upside down U. has the thorn covered Ocotillo as well as the huge Saguaro. Cactus. The Great Basin of the American West is covered with sagebrush. The Chihuahua Desert, which straddles Mexico and Texas, is known for its mesquite trees and Agaves. The Namib Desert of Southern Africa and the deserts of Australia have their own unique desert vegetation. Desert cover about one fifth of the Earth's surface and occur where rainfall is less than 50 cm /year. Most deserts, such as the Sahara of North Africa and the deserts of the southwestern U. S., Mexico, and Australia, occur at low latitudes. Another kind of desert, namely cold deserts, occurs in the basin and range area of Utah and Nevada and in parts of Western Asia. Most deserts have a considerable amount of specialized vegetation, vertebrate and invertebrate animals. Soils in deserts often have abundant nutrients because they need only water to become very productive and have little or no organic matter. Disturbances are common in the deserts in the form of occasional fires or cold weather, and sudden, infrequent, but intense rains that cause flooding.

There are relatively few large mammals in deserts because most of them are not capable of storing sufficient water and withstand the heat Deserts often provide little shelter from the sun for large animals. The dominant animals of warm deserts are non mammalian vertebrates, such as reptiles. Mammals are usually small, like the Kangaroo mice of North American deserts.

Desert biomes can be classified according to several characteristics. There are four major types of deserts 1) Hot and Dry 2) Semiarid and arid 3) Coastal and 4} Cold desert.

Hot and Dry Desert

The four major North American deserts of this type are the Chihauhuan, Sonoran, Mojave and Great Basin. Others outside U S. include the Southern Asian realm (including Great Indian Desert). Neotropical (South and Central America), Ethiopian (Africa) and Australian.

The seasons are generally warm throughout the year and very hot in the summer. The winters usually bring little rainfall. Temperatures exhibit daily extremes because the atmosphere contains little humidity to block the Sun's rays. Desert surfaces receive a little more than twice the solar radiation received by humid regions and lose almost twice as much heat at night. Mean annual temperatures range from 20 to 25°C. The extreme maximum ranges from 43.5 to 49°C. Minimum temperatures sometimes drop to -18°C. Rainfall is usually very low or are concentrated in short bursts between long rainless periods. Evaporation rates regularly exceed rainfall rates.

Soils are course textured, shallow, rocky or gravely with good drainage and have no subsurface water. They are coarse because there is less chemical weathering. The finer dust and sand particles are blown elsewhere, leaving heavier pieces behind. Canopy in most deserts is very rare. Plants are mainly ground hugging shrubs and short woody trees. Leaves are replete (fully supported with nutrients) with water conserving characteristics. They tend to be small, thick and covered with a thick cuticle (outer layer). In the cacti, the leaves are much reduced (to spines) and photosynthetic activity is restricted to the stems. Some plants open their stomata (microscopic openings in the epidermis of leaves that allow for gas exchange) only at night when evaporation rates are lowest. These plants include: Yuccas, Ocotilo. Turpentine bush, Prickly pears, False Mesquite. Sotol. Ephedras, Agaves and brittlebush.

Semi Arid and Arid Desert

The major deserts of this type include the sagebrush of Utah, Montana and Great Basin. They also include the Narcotic realm (North America, Newfoundland, Greenland, Russia, Europe and Northern Asia). The climatic zones of dry lands may be semi which we may also call as the ecosystems. In these zones during summers, the climate is moderately dry, hot deserts, while in winters there is a low concentration of rainfall, temperature is usually average between 21 to27°C. It normally does not go above 38°C and evening temperatures are cool at around 10°C. Cool nights help both plants and animals h' reducing moisture loss from transpiration, sweating and breathing. Furthermore, condensation of dew caused by night cooling may equal or exceed the rainfall received by some deserts. As in the hot desert, rainfall is often very low or concentrated. The average rainfall ranges from 2 to 4 Cm annually.

The soil can range from sandy and fine textured to loose rock fragments, gravel or sand. It has a fairly low salt concentration, compared to deserts which receive a lot of rain acquiring higher salt concentrations as a result. In areas such as mountain slopes, the soil is shallow, rocky or gravely with good rains. In the upper bajada (lower slopes) they are coarse textured,

rocky, well drained and partly laid by rock bench. In the lower bajada (bottom land) the soil is sandy and fine textured.

The spiny nature of many plants in semiarid deserts provides protection in a hazardous environment. The large numbers of spines shade the surface enough to reduce transpiration. The same may be true of the hairs on the woolly desert plants. Many plants have silvery or glossy leaves, allowing them to reflect more radiant energy. These plants often have an unfavourable odour or taste. Semiarid plants include: Creosote bush, but sage *(Franseria dumosa* of *Fdeltoidea),* white thorn, cat claw, mesquite, brittle bushes *(Eencella fannosa),* lyclums, and jujube.

During the day, insects move around twigs to stay on the shady side. Jackal, rabbits follow the moving shadow of a cactus or shrub. Naturally, many animals find protection in underground burrows where they are insulated from both hot and humidity. These animals include mammals such as the kangaroo rats, rabbits, and skunks, insects like grasshoppers and ants. Reptiles are represented by lizards and snakes. Birds such as burrowing owls and the California thrasher.

Coastal Desert

These deserts occur in moderately cool to warm areas such the Narcotic and Neotropical realm. A good example is Atacama of Chile. The cool winters of coastal deserts are followed by moderately long warm summer. The average summer temperature are 5°C or below. The maximum annual temperature is about 35°C and the minimum is about -4°C. !n Chile, the temperature ranges from -2 to 5°C in July and 21 to 2500 in January. The average rainfall measures 8 to 13 cm in many areas. Maximum annual precipitation over a long period of years has been 37 cm with a minimum of 5 cm.

The soil is fine textured with a moderate salt content, it is fairly porous with good drainage. The plants may have extensive root system close to the surface where they can take advantage of any rain showers. The plants with thick and fleshy leaves or stems can take in large quantities of water when it is available and store it for future use. In some plants, the surfaces are corrugated with longitudinal ridges and grooves. When water is available, the stem shrinks so that the grooves are deep and ridges close together. The plants living in this type of desert include the salt bush, buckwheat bush, black bush, rice, grass, little leaf horse brush, black sage, and chrysothamnus. Some animals include: insects, mammals (coyote and badge) amphibians (toads), birds (great horned owl, golden eagle and the bold eagle) and lizards and snakes.

Cold Desert

These deserts are characterized by cold winters with snowfall and high overall rainfall throughout the winter and occasionally over the summer. They occur in the Antarctic, Greenland and the Narcotic realm. They have short, moist, moderately warm summer with fairly long, cold winter. The winter temperature is between -2° to 4°C and the mean temperature is 21 to 26°C.

The areas with an annual rainfall of less than 25 cm come in deserts. They occupy about 17 per cent of land. Due to extremes of both, water and temperature factor the biota much varied and is poorly represented.

The winters receive quite a bit of snow. The mean annual precipitation ranges from 15-26 cm while annual precipitate has reached maximum of 46 cm and a minimum of 9 cm. The heaviest rainfall of the spring is usually in April or May. In some areas, rainfall can be heavy in autumn. The soil is heavy, silty and salty. It contains alluvial soil relatively porous and drainage as good so that most of the salt has been leached out.

The plant is widely scattered. In areas of shade scale, about 10 per cent of the ground is covered but in some areas to sage bush it approaches 85 percent. Plant heights vary between 15 cm and 122 cm. The main plants are deciduous, most having spiny leaves. The animals of these areas are jackal, rabbits, kangaroo rats, kangaroo mice, pocket mice, grasshopper mice, antelope and ground squirrels.

AQUATIC ECOSYSTEM

The seas are characterized by constancy and lands by variability- The seas have always existed and been connected. if contrast, land masses have been considerably shifted, both vertically and horizontally. At one time or another nearly every bit of land had been covered by sea. Even areas where we now find great mountain ranges were once under water. For example, the deposits comprising the Himalaya mountains were once, many millions of years ago, the floor of an eastward continuation of the Mediterranean.

Water maintains link between the five biomes and ii makes up the largest part of he biosphere, covering nearly 75% of the Earth's surface. Aquatic regions house numerous species of plants and animals, both large and small. In fact, this is where life began billions of years ago when amino acids first started to come together. Without water, most life forms would be unable to sustain themselves and the Earth would be a barren, desert like place. Although water temperatures vary widely, aquatic areas tend to be more humid and the air temperature on the cooler side. The aquatic biome is classified into two basic regions, freshwater (ponds and rivers) and marine (oceans and estuaries).

The Pond Ecosystem

The characters and extent of community succession in a given area depends on climate and soil condition. The climax community is achieved only if environmental factors permit a full sequence of serial stages. All ecosystems resemble each other in the sense that all have same components, i.e. autotrophic and heterotrophic, interacting upon each other thus Ringing about circulation of materials. In one ecosystem, the climate and soil conditions are relatively uniform and they favour the growth of a certain kind of climax community.

Aquatic ecosystems are usually, divided into: (I) Freshwater, (ii) Marine water, and (iii) Estuarine water.

Freshwater Ecosystem

Freshwater biomes have suffered mainly from pollution. Runoff containing fertilizer and other wastes and industrial dumping enter into rivers, ponds, and lakes and tend to promote

abnormally rapid algae growth. When these algae die, dead organic matter accumulates in the water. This makes the water-unusable and it kills many of the organisms living in the habitat Stricter laws have helped to slow down this thoughtless pollution Freshwater has low salt concentration (less than 1 per cent) therefore, the plants and animals living in freshwater adjust themselves with low salt content and unable to survive in areas of high salt concentration (Ocean). Following are the freshwater regions.

Ponds and Lakes

These regions range in size from just a few square meters to thousands of square kilometers. Scattered throughout the earth, several are remnants from the Pleistocene glaciations. Many ponds are seasonal, lasting just a couple of months (such as sessile pools) while lakes may exist for hundreds of years or more. Ponds and lakes may have limited species diversity since they are often isolated from one another and from other water sources like rivers and oceans. Lakes and ponds are divided into three zones on the basis of depth and distance from the shoreline

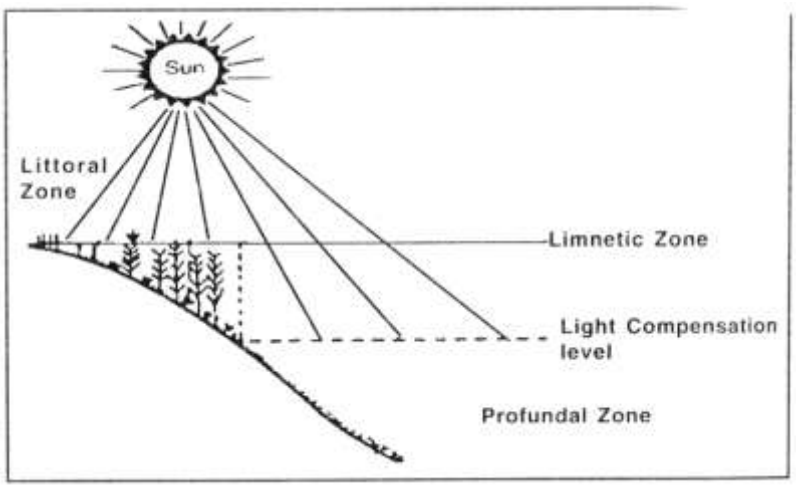

Fig 17: Illustration of different /on at ion of a lake

Littoral Zone: It is the topmost **zone** near the shore of a lake or pond and is the warmest since it is shallow and can Iahs0rb more of the Sun's heat. It sustains a fairly diverse community, which can include several species of algae (like diatoms)' rooted and floating aquatic plants, grazing snails, clams, insects crustaceans, fishes, and amphibians. In the case of the insects, such as dragonflies and midges, only the egg and larvae stages are found in this zone. The vegetation and animals living in the littoral zone are food for other creatures such as turtles, snakes and ducks.

Limnetic zone: This occurs near the surface of open water and is well lighted (like the littoral zone). It is through the limnetic zone into the profundal zone. The fauna are heterotrophs, meaning that they eat dead organisms and use oxygen for cellular respiration.

In general temperature of ponds and lakes varies seasonally. During the summer, the temperature can range from 4°C near the bottom to 22°C at the top. During the winter, the temperature at the bottom can be 4°C while the top is 0°C (ice). In between the two layers, there

is a narrow zone called the thermocline where the temperature of the water changes rapidly. During the spring and fall of seasons, there is a mixing of the top and bottom layers, usually due to winds, which results in a uniform water temperature of around 4°C. This mixing also circulates oxygen throughout the lake. Of course there are many lakes and ponds that do not freeze during the winter, thus the top layer would be a little warmer.

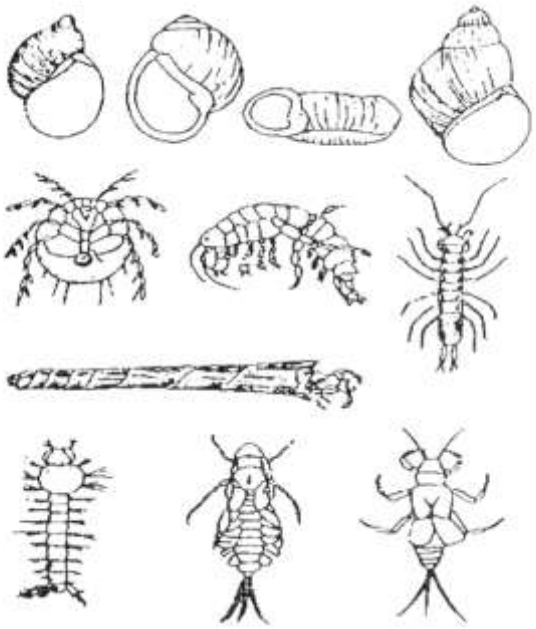

Fig 18: Some representative animals of the littoral zone of the pond and lake.

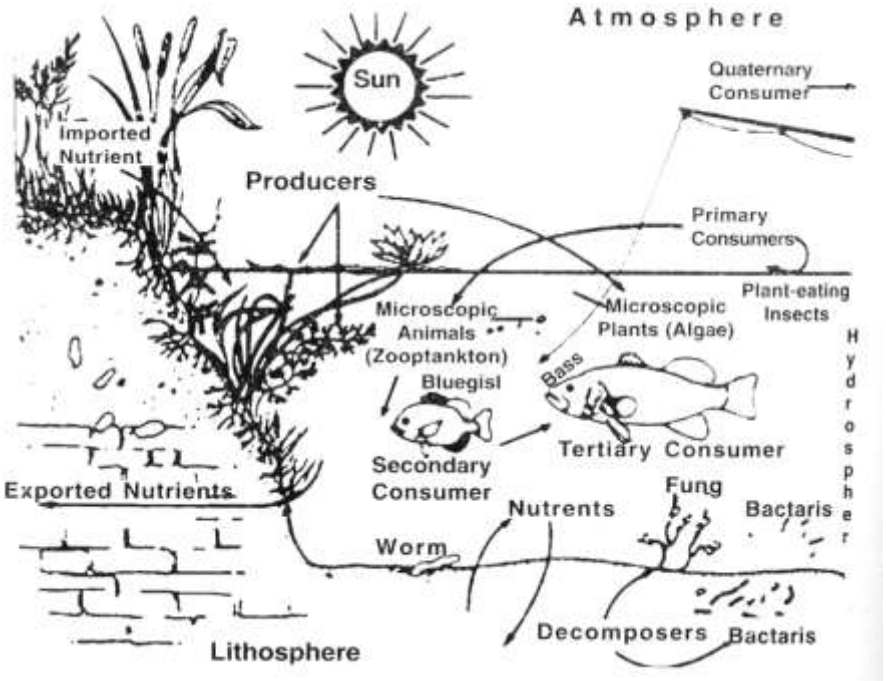

Fig 19: Illustration of Pond Ecosystem

Streams and Rivers

These are flowing water bodies, which move in one direction. They are found everywhere and they get their starts t head waters, which may be springs, snowmelt or even lakes, and then travel all the way to their mouths, usually another water channel or the ocean. The characteristics of a river or stream change during the journey from the source to the mouth. The temperature is cooler at the source than it is at the mouth. The water is also clearer, has higher oxygen levels, and freshwater fish such as trout and heterotrophs can be found there.

In the middle part of the stream or river, the width increases, this causes diversity in the species. Various aquatic green plants and algae are found. Towards the mouth of the river or stream, the water becomes muddy from all the sediments that it has picked up upstream, decreasing the amount of light that can penetrate through the water. Since there is less light, there is less diversity of flora, and because of the lower oxygen levels, fish that require less oxygen, such as catfish and carp, can be found.

Wetlands

Wetlands (Marshes, swamps, and bogs) are characterized by standing water and have the highest species diversity of all ecosystems. They support growth of aquatic plants. Plant species adapted to the very moist and humid conditions are called hydrophytes (pond lilies, cattails, sedges, tamarack and black spruce). In marshy areas the common plants are cypress and gum. The common animal species are amphibians reptiles, birds (such as ducks and waders), and furbearers found in wetlands. Wetlands are not considered freshwater ecosystems as there are some, such as salt marshes, that have high salt concentration which support different species such as shrimp, shellfish, and various grasses.

There are two categories of fresh water ecosystems: (a) letuic (letuis -standing or stagnant water) including ponds, lakes, swampsets; (b) lotic (running water) waters are those which occur in fast running streams, springs, rivers and brooks.

Fresh water ecosystems have low percentage of dissolve salts.

Biotic components present in wetlands are the following;

(i) Producers

They are two types. (I) the rooted or large floating plants like ocellatoria, Chara, Hydrilla, Azola, Utricularia, Vallisnaria Lamnea, Ceratophyllum, etc., and (ii) phytoplankton including Volvox, Euglena, algae etc. Sometimes in certain of the ponds the rooted plants remain absent, thus phytoplanktons are distributed throughout the pond as deep as light penetrates. They play a significant role in the production of food.

(ii) Consumers

In pond ecosystem the primary consumers or herbivores remain dependent upon the living green plants or the plant remains. The herbivores are further divided into two categories: the primary consumers that are bottom dwellers like molluscs and certain insects, and Zooplanktons. The secondary consumers or the carnivores which feed on the primary consumers may be fishes (Catla, Labeo, Barbus, Chela, etc.), frogs, insects and larger carnivorous fishes.

(iii) Decomposers

In pond ecosystem bacteria, flagellates and fungi serve as decomposers. These are distributed throughout the pond but are abundant in the mud. Under favourable conditions, the decomposition occurs rapidly in water and their broken pieces are consumed by the combined action of detritus feeding animals and microorganisms. Their nutrients are released for reuse.

Thus we see that all the four basic components abiotic substances, producers, consumers and decomposers are found in the freshwater ecosystem.

MARINE ECOSYSTEM

Marine regions cover about three fourths of the Earth's surfaces and include oceans, coral reefs, and estuaries. Marine algae supply much of the world's oxygen supply and take in a huge amount of atmospheric carbon dioxide. The evaporation of the seawater provides rainwater for the land.

The Ocean Ecosystem

The oceans, which cover 70 percent of the earth's surface, constitute one of the greatest reservoirs of living things and of le essential nutrients needed by both land and marine organisms. The average depths of the oceans are roughly a 000 meters. Since the organisms are found throughout the depths of the oceans, the actual space available for marine life is about 300 times as great as the space available for terrestrial life. As in other ecosystems, the life in the ocean also depends upon light. With light the ocean becomes a factory for life. The energy of tight is stored in carbon compounds, which are used for the substances and energy of all organisms. The life in the ocean is affected by important physical factors like currents, tides, depth, temperature, light penetration, salinity and pressure etc.

The oceans are divided into several general regions depending on the depth of the bottom i.e. Neritic Zone, Oceanic Zone and Euphotic Zone.

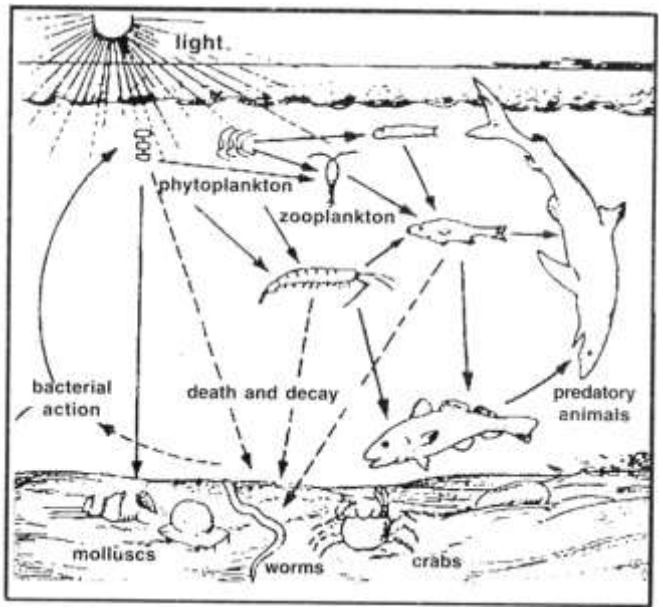

Fig 20: Oceanic ecosystem

The largest of all the ecosystems, oceans are very large bodies of water that dominate the Earth's surface. The ocean regions are separated into four separate zones (internal pelagic, abyssal, and benthic) which have a great diversity of species.

Internal Zone: In this zone ocean meets the land. It is sometimes submerged and at other times exposed, as waves and tides come in and out. Because of this, the communities are constantly changing on rocky coasts. The zone is stratified vertically where only the highest tides reach. A few species of algae and molluscs are found. In those areas usually submerged during high tide, there is a more diverse array of algae and small animals, such as herbivorous snails, crabs, sea stars, and small fishes. At the bottom of the internal zone, which is only exposed during the lowest tides, many invertebrates, fishes, and seaweed can be found. The intertribal zone on sandier shores is not as stratified as in the rocky areas. Waves keep mud and sand constantly moving. Thus very few algae and plants can establish themselves and the fauna include worms, clams, predatory crustaceans, crabs, and shorebirds.

Pelagic zone: It includes those waters further from the land, basically the open ocean. This zone is usually cold. However, there is no specific temperature range. Similar to ponds and lakes, there is thermal stratification with a constant mixing of warm and cold ocean currents. The common floras of this zone are surface seaweeds while fauna include various species of fish and some mammals (whales and dolphins) which feed on the abundant plankton.

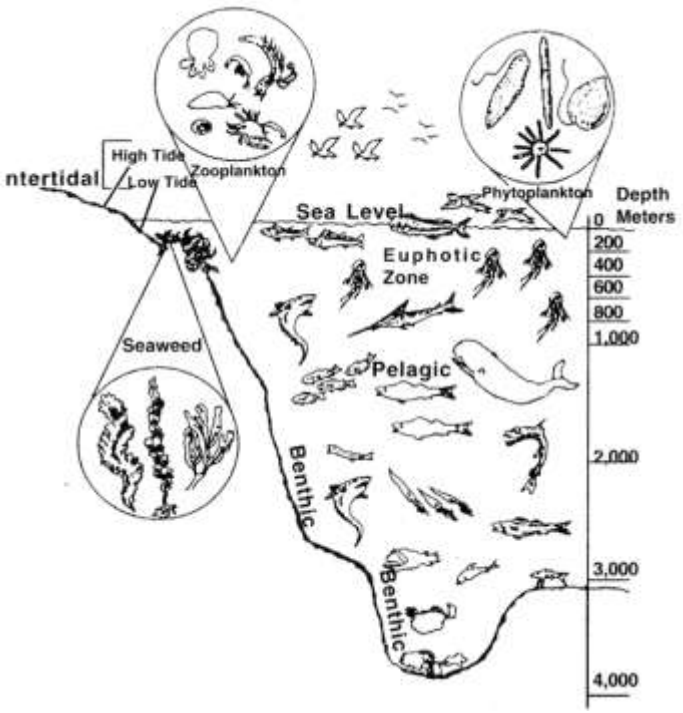

Fig 21: Illustration of marine ecosystem

Benthic zone: This zone is found below the pelagic zone, but does not include the very deepest parts of the ocean. It is very nutrient rich. The bottom of the zone consists of sand, salt, and dead organism. Here temperature decreases as depth increases towards the abyssal zone, since light can't penetrate through the deeper water. This zone supports growth of flora (seaweed) and fauna {bacteria, fungi, sponges, sea anemones, worms, sea stars, and fishes).

Abyssal zone: It is the deepest region and is very cold (around 3°C), highly pressured, high in oxygen content, but low in nutritional content. The zone supports growth of various species of invertebrates and fishes. Mid ocean ridges (spreading zones between tectonic plates), often with hydrothermal vents, are found in the abyssal zones along the ocean floors. Chemosynthetic bacteria thrive near these vents because of the large amounts of hydrogen sulfide & other minerals they emit. These bacteria are thus the start of the food web as they are eaten by invertebrates & fishes.

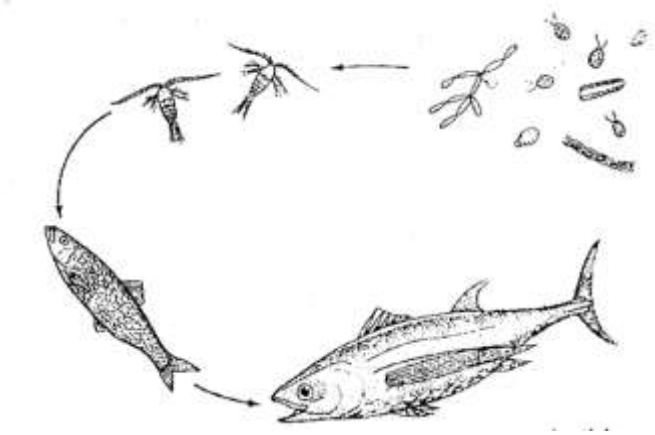

Fig.22 A marine food Chain the Producers in this case are phytoplankton, they are fed upon by small crustaceans called copepods. Copepods form the food of herring, which are fed upon

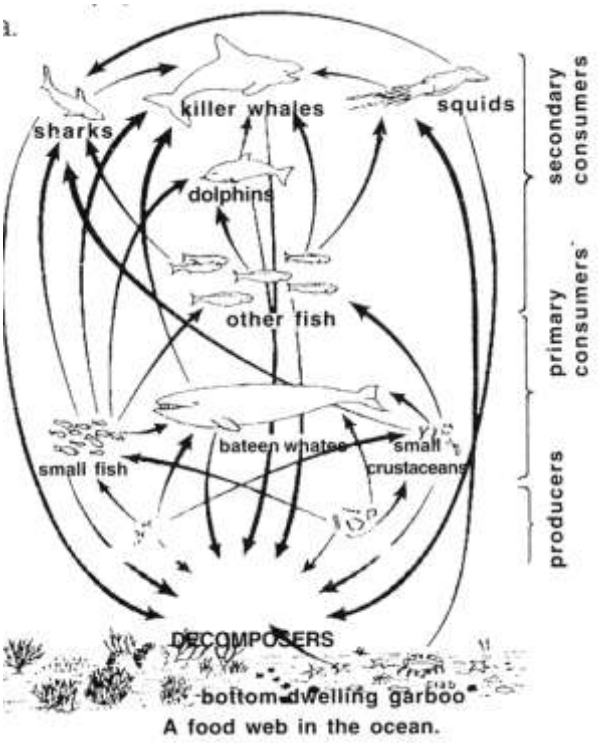

Fig 23: Food Web of Ocean Ecosystem Coral Reefs

These are widely distributed in warm shallow waters. It is nutritionally poor. They can be found as barriers along continents (eg. the Great Barrier Reef of Australia), fringing islands, and L lolls. Naturally, the dominant organisms in coral reefs are corals. Corals are interesting since they consist of both algae (Zooanthellae) and tissues of animal polyp. Corals obtain nutrients through the algae via photosynthesis and also by extending tentacles to obtain plankton from the water. Since reset waters tend to be besides corals, the fauna include various species of microorganisms, invertebrates, fishes, sea urchins, octopuses, and sea stars.

Abiotic Components

In the marine environment, the most significant abiotic components affecting the marine life are light, temperature, pressure, salinity, currents and tides.

(i) Light: Light is the basic and most important biotic factor for life. The energy of light is stored in carbon compounds, which are used for the substances and energy of all organisms. The amount of light affecting photosynthesis depends upon the intensity of light and turbidity of water. For instance, a ten meter deep turbid coastal zone receives an equal amount of light energy as a hundred meters deep clear oceanic zone, but the maximum intensity at ten meter coastal water is greater. Light is also responsible for the diurnal migrations and color pattern of marine animals.

(ii) Temperature : Temperature of sea water with location and with seasons changes. The temperature of the oceans ranges from about-2°C in the polar seas to 32°C or more in the tropics. But the annual range of variation in any given region is usually not more than 6°C. Deep regions of the sea always have cold water. Seasonal and daily temperature changes are larger in coastal waters than in the open sea.

(iii) Pressure: In oceans, the pressure changes are many times greater in the sea than in terrestrial environments. It varies from 1 atmosphere at the surface to 1,000 atmospheres at the greatest depth. It has a pronounced effect on the distribution of life. Some organisms are adapted to live near the surface while some others to live at great depths, some animals like sperm whale, seals etc, can dive at great depths and come back to the surface.

(iv) Salinity : The salinity of sea water fluctuates from place to place and it is caused due to the dissolved salts such as chlorides of sodium, potassium, calcium, and magnesium, and also the sulphates of calcium and magnesium. The salinity of the open ocean is about 35 parts per thousand, In the western Baltic it is 12 parts per thousand and 0.6 parts per thousand in the Gulf of Finland owing to the inflow of fresh water. In the Red Sea, with no source of fresh water and a high rate of evaporation, it reaches 46.5 parts per thousand.

Biotic Components

Producers :

In the marine environment as in all others, the primary producer organisms, equivalent to the flowering plants on land, are the phytoplankton. These are algae having an outer skeleton composed largely of silica which is almost identical to glass. Diatoms contain chlorophyll similar to that of green plants, enabling them to transform light energy to chemical energy.

The primary producers next in order of abundance are the dinoflagellates, plus a few other larger floating seaweeds and microscopic algae some of them, greens, brown, and red algae are the bases for all other life in the open sea. Being photosynthetic, the marine algae can live only where there is light. Therefore, it is not surprising to find them restricted to the surface layers of the water nearly always to the top 100 meters.

Consumers:

The primary consumers are the protozoan, various crustaceans, larval fishes, and representatives of every other group of animals. The primary consumers serve as food for secondary consumers which range in size up to the whale, whale shark, and giant squids.

(i) Zooplankton : These are the small non-photosynthetic, free swimming or floating organisms living side by side with the photosynthetic phytoplankton in the open waters. The *permanent plankton or holplankton are the mature forms of rhizopods, foraminifera, actinopods, ciliates, colenterates,(flat worm), Tomopteris* (segmented worm). Pteropods (molluscs), Calonus (arthropods), and Oikopleura (tunicates) are the most important permanent components of Zooplankton. Temporary plankton or meroplanktons are the larval forms of large organisms.

(ii) Nekton: This category includes free swimming consumers like fishes (sharks, flying fish, herrings, mackerels), marine birds *(Penguin*, *Pelicans* etc.), mammals, seals, tortoise, dolphins, whales, large crustaceans and molluscs.

(iii) Benthos: It includes crawling or creeping marine consumers like crabs, lobsters, amphipods, snails, echinoderms and some bivalves. Sessile organisms like sponges, barnacles, mussels, oyster, corals, hydroids etc. also belong in this category.

Decomposers

There are numerous decomposers, primarily bacteria, which change the bodies of dead organism to inorganic and simple organic compounds. According to Zobell (1963), the density of bacteria in sea water ranges from less than per litre in the open ocean to a maximum of 108 per millilitre in shore.

THE ESTUATINE ECOSYSTEM

The word 'estuary' refers to the mouth of a river or coastal bay where the salinity is greatly affected by tidal action and within it sea water is mixed with fresh water from land drainage. The examples of estuarine ecosystems are: *river mouths, coastal bays, tidal marshes* anybodies of water behind barrier breaches. Most estuaries, particularly those in temperate and arctic regions undergo marked variations in temperature, salinity and other physical properties in the course of a year, and to survive, estuarine organisms must have a wide range of tolerance to these changes.

The waters of estuaries are among the most naturally fertile m the world, frequently having a much greater productivity than the adjacent sea or the freshwater of the river. This is mainly due to the action of the tides. It promotes a rapid circulation of nutrients and aid in the removal of waste products. By the presence of many kinds of plants, estuaries provide an extensive photosynthetic carpet.

Estuaries are areas where freshwater streams or rivers merge with the ocean. This mixing of waters with such different salt concentrations creates a very interesting and unique ecosystem. Microflora like algae, and macroflora, such as seaweeds, marsh grasses, and mangrove trees (only in the torpics), can be found here. Estuaries support a diverse fauna (worms, oysters, crabs, and waterfowl).

The estuarine ecosystem may be described as follows:

Abiotic Components

Like marine environment the estuarine ecosystem has significant abiotic factors like temperature, light, salinity etc. as stated in the following lines:

(i) Temperature: The temperature in estuaries varies considerably diurnally and seasonally. The temperature of estuarine waters increases by solar radiation, tidal currents, and effect of high tide on the mud flats, etc.

(ii) Salinity : As stated already waters of all streams and rivers ultimately drain into the sea. The place where this fresh water joins the salt water is called as estuary. The salinity of estuaries varies vertically and horizontally and fluctuates amazingly between 0.5-0.35 percent. Further, salinity of estuaries remains highest during the summer and during periods of drought, when less fresh water flows into the estuary. It is lowest during winter and spring, when rivers and streams are discharging their peak loads.

Biotic Components

The estuarine waters are among the most fertile natural ecosystem of the world which is why it contains very rich fauna. Estuarine communities consists of a mixture of endemic species i.e., species restricted to estuarine zone, and those which come in from the sea plus a very few species with the osmoregulatory capabilities for penetrating into or from fresh water environment. Gopalakrishanan has reported an abundance of phytoplankton forms, several species of diatoms; several species of green algae like *pediastrum, Spirogys, Endorina, Zygonema, Pondorina, Volvox, Chlorella;* and blue green aigae like *Miscrocystis, Osctllatoria, Anabaena,* and *r^rh'odesmus.* He has also reported the penetration of the polychaets like *Marphya gravelyi, Diopatra uanabillis, Gtycera embranchiata, Loimia medusa.* The estuarine animal ^immunities include Zooplankton forms like *Euglena, creratium, Noctiluca, Difflugia, Arcella, Vorticella* etc. Other animal forms like oysters (the best known estuarine detritus animals) clams, lobsters, crabs, some annelid worms, fishes *(Hilsa, Harpodon, Mugil* etc.) have also been reported from various Indian estuaries.

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CHAPTER 4

BIODIVERSITY AND ITS CONSERVATION

Introduction

Biodiversity: It is the term given to the variety of life on earth and the natural patterns it forms. The bio-diversity we see today is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend.

This diversity is often understood in terms of the wide variety of plants, animals and microorganism. So far, about 1.75 million species have been identified, mostly small creatures such as insects. Scientists reckon that there are actually about 13 million species, though estimates range from 3 to 100 million. Biodiversity is the combination of life forms and their interactions with each other and with the rest of the environment that has made earth a uniquely habitable place for humans. Bio-diversity provides a large number of goods and services that sustain our lives.

Bio-diversity also includes genetic differences within each species for example, between verities of crops and breeds of livestock. Chromosomes, genes, and DNA the building blocks of life determine the uniqueness of each individual and each species. Yet another aspect of bio-diversity is the variety of ecosystems such as those that occur in deserts, forests, wetlands, mountains, lakes, rivers, and agricultural landscapes. In each ecosystem, living creatures, including humans, form a community, interacting with one another and with the air, water, and soil around them.

Bio-diversity can be understood at 3 levels.

Genetic bio-diversity: It is a well-known fact about rice that they are available in different varieties, e.g. Basmati, which has larger grain size, other variety of rice, which has smaller grain size etc. This special internal distinction among rice varieties is due to genetic diversity. It is the diversity of the genes. These genes are basic units of hereditary information. These contain the instruction for the development of a generation to another. These variations need not be always visible like colour or size. They can be sensed through other organs also such as taste or flavour. Sometimes they can be invisible also for e.g. resistance to diseases, resistance to natural disasters (like cockroaches who have with-stood the effects of disasters since ages).

Species Bio-diversity: Species is a form of unit used to classify the millions of life forms on earth. Species diversity refers to the variety of species within a region. Each species is distinct from every other species for e.g. Lions and Tigers are distinct species, horses and donkeys are distinct. At the same time, members of an individual species will be very similar, that they can produce fertile off spring.

Generally the total number of species within a particular area is referred to as species diversity. It is the most commonly used level for describing the bio-diversity of countries.

Ecosystem Diversity: It refers to difference among groups of organisms in different physical settings. It is the place where an organism or a population naturally occurs. There can

be two phenomena as far as ecosystem diversity is concerned a) the variety of species within different ecosystem, b) Variety of ecosystems found within a biogeographical or political boundary.

Bio-diversity doesn't confine only to wild animals and plants, but speaks also about the considerable varieties among domesticated plants and animals. This is known as domesticated bio-diversity. Similarly there also exists the microorganism diversity. Microorganisms or microbes include bacteria, virus, protozoa, yeast, and fungi etc. These were indeed part of the earth's atmosphere since 3.8 billion years.

Bio-geographical Classification of India :

The identification and conservation of the world's natural heritage depends on an understanding of the ecosystems and Biodiversity and Its Conservation habitat of the plant and animal species within it. Classification of natural world heritage sites by habitat or bio-geographic province helps us better appreciate the wide range of ecosystems already protected.

India has ten bio-geographic regions including the Trans Himalayan, The Himalayan, The Indian Desert, The Semi Arid Zone (s), The Western Ghat, The Deccan Peninsula, the Gangetic Plain, North East India, the Islands and Coasts. India has two major realms called the palaearctic and the Indo Malayan and three bio-mass, namely The Tropical Humid Forests, The Tropical Dry/Deciduous Forests and The Warm Desert/Semi Deserts.

Values of Biodiversity

It is not strange thing to notice the extinction of some species and evolution of new ones, which are very natural process of evolution. This is because the rates of extinction and evolution usually get balanced. But now the rate of evolution has failed to cope up with the alarmingly fast rate of extinction. Biodiversity loss is a cause for a genuine concern because its survival is of utmost importance not only for human society but also for the total health of our planet. Hence its values are to be sensed by all.

Bio-Diversity at Different Levels

Global Level

It is estimated that there exist 5-30 million species of living forms on our earth and of these, only 1.5 million have been identified. It includes 3,00,000 green plants, fungi, 8,00,000 species of insects. 40,000 species of vertebrates and 3,60,000 species of microorganisms. Recently it has been estimated that the number of insects alone may be as high as 10 million, but many believe it to be around 5 million.

The tropical forests are regarded as the richest in biodiversity. According to the opinion of the scientist more than half of the species on the earth live in moist tropical forests which is only 7% of the total land surface. Insects (80%) and primates (90%) make up most of the species.

The species diversity in tropics is high as:

1. In tropics, as the conditions for evolution were optimum and for extinction fewer.

2. In tropics, species diversity was conserved over geological time. Due to low rates of extinction prevailing there; and
3. Biological diversity is the result of interaction between climate, organisms, topography, parent soil materials, time and heredity.

However, these explanations need experimental observations and confirmation.

Country Level

India is located in South Asia, between latitudes 6° and 38° and longitudes 69° and 97°E. India's landmass extends over a total geographical area of about 3029 million hectares. Is bounded by Himalayas in the north, the Bay of Bengal in the east, the Arabian Sea in the west, and Indian Ocean in the South. The wide variety in physical features and climatic situation has resulted in a diversity of ecological habitats. The Indian region having a vast geographical area is quite rich in bio-diversity with a sizable percentage of endemic flora and fauna. These vary from the humid tropical Western Ghat to the hot desert of Rajasthan, from the cold desert of Ladakh and the icy mountains of Himalayas to the warm casts of peninsular India.

In India, about 1,15,000 species of plants and animals have identified and described. For example, the following crops been in the country and spread throughout the world: rice, sugarcane, Asiatic vignas, jute, mango, citrus, banana, several SlJ9cies of millets, several cucurbits, some ornamental orchids, several medicinal and aromatics. In flora, the country has been recognized as one of the world's top 12 mega diversity nations. This region is also secondary centre of diversity for grain amaranthus, maize, red pepper, soyabean, potatoes and rubber plant.

In flora, the country can boast of 45,000 spec.es, which accounts for 15 per cent of the known world plants. Of the 15,000 species of flowering plants, 35 percent are endemic and located in 26 endemic centers. Among the monocotyledons, out of 588 genera occurring in the country, 22 are strictly endemic.

The North Eastern region boasts of being unique treasure house of orchids in India. The important Indian Orchids; are Paphiopedilum Fairienyanum, Cymbidium Aloifluim, Aerides Crispum, etc. India is very rich in faunal wealth and has nearly 75,000 animal species. About 80 per cent of which is insects. The distribution of major animal groups are shown in the Table 4.

In animals, the rate of endemism in reptiles is 33% and amphibians 62%. Further there is wide diversity in domestic animals, such as buffalo, goat, sheep, pig, poultry, horse^ camels and yaks. Domesticated animals too have come from the same cradles of civilization as the major crops. There are no clear estimates about the marine biota though the coastline is 7000 km long with a shelf zone of 4,52,460 sq. km and extended economic zone of 20,13,410 sq. km. There is an abundance of seaweed's, fish, crustaceans, molluscs, corals reptiles and mammals.

Information regarding other flora and fauna are patchy. Hundreds of new species may be present in the country-awaiting discovery. The Western Ghat in Peninsular India, which extend in the southern states, are a treasure house of species diversity and has about 5000

species. It is estimated that almost one third of the animal varieties found in India have taken refuge in Western Ghat of Kerala alone.

The Indian Gene Center is among the twelve-mega diversity regions of the world. More than 20 crop species were domesticated here. It is known to have more than 49000 species of plant 18,000 species of higher plants, including major and minor crop (166) and their wild relative (326). Around 1,000 wild edible plant species are widely exploited by native tribes. These include 145 species of roots and tubers, 512 of leafy vegetables and greens, 101 of buds and flowers, 647 of fruits and 118 of seeds and nuts. In addition, nearly 9,500 plant species of ethno-botanical uses have been reported from the country of which around 7,500 are the ethno-medicinal importance and 3,900 are multipurpose, edible species.

HOT SPOTS OF BIODIVERSITY

Bio-diversity is not distributed uniformly across the globe. Some habitats, particularly tropical forests among terrestrial systems possess a greater number or density of species than others. Thus a 13.7 sq. km area of the La Selva Forest Reserve in Costa Rica contain almost 1,500 plant species, more than the total found in 2,43,500 sq. km of Great Britain, while Ecuador harbours more than 1,300 bird species, or almost twice as many as the USA and Canada combined (Myers, 1988). it is widely accepted that the identification and prioritization of important centres of bio-diversity are necessary at both national and the global scale for conservation action. A number of methods by which such areas could be determined have been suggested.

The most widely accepted approach of suggesting target areas for conservation action is to identify areas with the greatest number of endemic or restricted range species. An endemic species is one restricted to some given area, which might be a mountain top, a river, a country or continent.

An important study that has attempted to use endemic species to identify areas of global conservation concern was that of Myers (1988,1990). Focusing on tropical forests, Myers identified 25 regions or 'hot spots' that are characterized by high concentration of endemic species and are experiencing unusually rapid rates of habitat modification or loss. Together, these 18 site contain approximately 49,955 endemic plant species, or 20% of the world's recorded plant species, in only 7,46,400 sq. km or 0.5% of the earth's land surface.

Hot Spots in India

India has two of the 25 identified 'hot spots'. These are Eastern Himalaya and Western Ghat.

Eastern Himalayas

Phytogeographically, the Eastern Himalaya forms a distinct floral region and comprises Nepal, Bhutan, neighbouring states of East and Northeast India, and a contiguous sector Yunnan province in south Western China. In the whole of Eastern Himalaya, there are an estimated 9,000 plant species, with 3,500 (i.e. 39%) of them being endemic. In India's sector of the 3' a there occur some 5800 plant species, roughly 2,000 (i.e. 36%) of them being endemic-

At least 55 flowering plants endemic to this area are recognized as rare, for example, the pitcher plant (Nepenthes Khasiana)

The area has long been recognized as a rich center of primitive flowering plants and the area is recognized as 'Cradle of Speciation'. Species of several families of monocotyledons, Orchindaceae, Zingiberaceae and Arecaeceae abundant. Gymnosperms and pteriodophytes (ferns) are also well represented in the area.

The area is also rich in wild relatives of plants of economic significance, e.g. rice, banana, citrus, ginger, chili, jute and sugarcane. The region is regarded as the center of origin and diversification of five palms of commercial importance namely, coconut, areca nut, palmyra palm, sugar palm and wild date palm.

Tea is reported to be in cultivation in this region for the last 4000 years. Many wild and allied species of tea, the leaves of which are used as substitute of tea, are found growing in the Northeast in their natural habitats.

The 'taxol' plant *Taxus wallichiana* is sparsely distributed in the region and has come under red data category due to its over exploitation for extraction of a drug effectively used against cancer.

As regards faunal diversity, 63% of the genera of land mammals in India are known from this area. During the last four decades, two new mammals have been discovered from the region: Golden Langur from Assam, Bhutan region and Namadapha flying squirrel from Arunachal Pradesh indicating in the species richness of the region.

The area is also rich center of avian diversity. More than 60% of the Indian birds are recorded in the Northeast. The region also has two endemic genera of lizards, and 35 endemic reptilian species, including two turtle. of the 204 Indian amphibians, at least 68 species are known from Northeast? of which are endemic.

From Namadapha National Park itself, a new genus of mammal, a new subspecies of bird, 6 new species of amphibian, four new species of fish, at least 15 new species of beetles and 6 new species of flies have been discovered

Western Ghat

The Western Ghat region is considered as one of the most important biogeographic zones of India, as it is one of their richest centers of endemism. Due to varied topography, and micro climatic regimes, some areas within the region are considered to be active zone of speciation.

The region has 490 arborescent taxa, of which as many as 308 are endemics. This endemism of tree species shows a distinct trend, being the highest (43%) in 8N-100 30'N location and declining to 11% in 16 N-160 30'N location.

About 1,500 endemic species of dicotyledonous plant are reported from the Western Ghat. 245 species of orchids belonging to 75 general are found here, of which 112 species in 19 genera are endemic to the region.

As regards the fauna, as many as 315 species of vertebrates belonging to 22 genera are endemic, which include 12 species of mammals, 13 species of birds, 89 species of reptiles, 87 species of amphibians and 104 species of fish.

The extent of endemism is high in amphibians and reptiles. There occurs 117 species of amphibians in the region, of which 89 species (i.e. 76%) are endemic. Of the 165 species of reptiles found in Western Ghat, 88 species are endemic.

Many of the endemic and other species are listed as threatened. Nearly 235 species of endemic flowering plants are considered endangered. Rare fauna of the region includes' Lion Tailed Macaque, Nilgiri Langur, Nilgiri Tahr, Flying Squirrel, and Malabar Gray Hornbill.

Conservation Efforts in Hot Spots

A number of programs are currently being implemented for conservation and sustainable utilization of Bio-diversity in the two 'not spots'. These include survey and inventorization, in-situ conservation, through protected area network, and ex-situ conservation. In addition, the Ministry also supports Bio-diversity elated research in the two hot spots. A brief account of these efforts is given below.

Eastern Himalaya

The Botanical Survey of India through its Sikkim Himalayan Circle in Gangtok and Arunachal Field Station in Itanagar, is engaged in botanical exploration, inventorisation and documentation of the plant diversity of Eastern Himalaya. About 6000 species of flowering plants have been inventorised so far from the region and two publications namely 'Flora of Sikkim Vol. I Monocotyledons' and 'Flora of Arunachal Pradesh Vol. I Dicotyledons', have been brought out.

The faunal survey of Eastern Himalaya has been carried out by the Zoological Survey of India through its Arunachal Pradesh Regional Station in Itanagar. Status Faunas of Sikkim, Meghalaya, Tripura and Mizoram and Fauna of Namdapha Biosphere Reserve have been published by ZSI.

Some of the important parks and sanctuaries in the Eastern Himalaya region are Beara Valley and Singalile National Parks, Senchal and Jorpokhari sanctuaries in West Bengal; Mouling, Namdapha, Kamlang, Sessa Orchid, D'Ering, Mehao, Debang Valley, Itanagar, Eagles Nest and pakhui in Arunachal Pradesh and Kanchendzong, Fambong Kyongonsata, Maenam and Singalia in Sikkim.

Four Biosphere Reserves have been designated in the Eastern Himalayan region; These are Nokrek in Meghalaya, Manas and Dibru Saiilkowa in Assam and Dehang Dibang in Arunachal Pradesh.

The Ministry for strengthening their infrastructure facilities undertakes ex-situ conservation of endemic plant species and has supported five botanic gardens in this region.

The Tura Range in Garo Hills of Meghalaya is a gene sanctuary for preserving the rich native diversity of wild citrus and musa species. Sanctuaries for rhododendrons and orchids have been established in Sikkim.

In order to understand ecosystem functioning and t scientifically manage protected areas, a number of research projects are being supported in the region. GB Plant Institute of Himalayan Environment and Development of the Ministry Of Environment and Forests undertakes action oriented research for development of technologies and demonstration

packages towards sustainable development of Himalayan regions suited to local specificity's. This Institute has a regional centre in Gangtok.

A proposal to set up Institute of Bio-diversity Studies in Arunachal Pradesh for focussing on Bio-diversity conservation and sustainable utilization is under the consideration of the Ministry.

Western Ghat

The phytodiversity of Western Ghat is explored, identified and documented by the Southern and Western circles of BSI located at Coimbatore and Pune, respectively. This documentation has been published in the form of District and State Floras such as Flora of Karnataka: Analysis (Vol. 1) Flora of Tamil Nadu : Analysis (Vol. 1-3) Flora of Maharasthra Monocotyledons (Vol. 1) Flora of Goa (two volumes) Flora Of Kerala (Grases), Flora of Cannanore, Flora of Thiruvanantapuram, Flora of Palaghat, flora of Nasik and Flora of Mahabaleshwar.

Faunal surveys of Western Ghat are being conducted by ZSI through its Regional Stations in Pune, Chennai and Kozhikode. A document on faunal diversity of Nilgiri Biosphere Reserve is in the final stage of printing.

Some of the protected areas declared as National Parks and sanctuaries include Sanjay Gandhi National Park, Bhimashankar, Shandioli, Chaprala, Koyna, Shivpuri sanctuaries of Maharasthra; Bhagvan Mahavir National Park, Molem, Bondla, Khotigao Santuaries in Goa; Nagarhole, Bandipur, Bhadra, Brahmagiri, Sharavati, Shettihalli and Someshwar in Karnataka; Periyar Silent Valley, Idukki, mbikulam, peppara ancj Wyanad in Kerala and Madumalai and Nilgiri Tanr sanctuary in Tamilnadu.

Nilgiris region in the Western Ghat contiguous in three states /Karnataka, Kerala and Tamilnadu) has been designated as a Biosphere Reserve. Twelve research projects are presently being funded in the Nilgiri Biosphere Reserve.

Eighteen botanic gardens in the Western Ghat region have been supported by the Ministry of Environment and Forests on. plant species.

Under the Center of Excellence program, the Center for Ecological Sciences (CES), Bangalore and the Tropical Botanic Garden and Research Institute (TBGRI), Thiruvananthpuram are being supported by the Ministry. The CES conducts research in frontline areas of basic and applied ecology and ecology related extension programmes of Western Ghat. The thrust areas of activities of TBGRI are conservation and sustainable utilization of tropical plant diversity, with emphasis on medicinal plants.

THREATS OF BIO-DIVERSITY

With the Current rate of development, population growth and migration communities are increasingly unable to meet their sustained needs. Growing demand for fuel wood, other forest *5* Hurts pollution due to industrialization, market for rare animal species and medicinal plants have all threatened the biological diversity and thereby hampered a sustainable human development. Further, the race for development and cultivation of improved varieties in larger area has threatened Bio-diversity to *a* considerable extent.

In biosphere, where the evolution is in operation, extinction of unfits and rarity of fewer fits in natural selection is an evolutionary necessity. Therefore, it is not an abnormal process in the life of a species. Whenever all the niches of an ecosystem are occupied, extinction occurs as a part of origin of new species Thus, it is a must for the survival of the fittest.

However, the present day drastic changes in the environment and habitat due .to population explosion and unmanaged developmental activities are so unnatural that the species are not getting full liberty of time and space for their survival and adaptive radiation. Therefore, resulting in loss of biodiversity, this is a global crisis. Biological extinction has been a natural phenomenon in geological history and mans intervention has speeded up extinction rates all the more. Between 1600 and 1950 the rate of extinction went up to one species every 10 years. Currently it is perhaps one species every year.

The destruction of the world's tropical forests, which are disappearing at an alarming rate, is one of today's most urgent global environmental issues. According to the report, people and the environment, released recently by the US based WRI, the current rate of bio-diversity loss is the fastest ever known. The report based on studies carried out by FAO and WCS, found that the tropical forest is shrinking at the rate of 0.8 per cent each year. Between, 1980-90 154 m ha of tropical forests equivalent to almost three times the size of France have been destroyed. Recently Cart-Dieter Spranger, the German Minister of Economic Cooperation pointed out that every year, g0rr, 17 m ha tropical forests are destroyed, this is equal to half of the entire area of Germany. If the current rate of deforestation continues scientists estimate that roughly 5 to 10 per cent of tropical forest species may face extinction within next 30 years

CAUSES FOR THE LOSS OF BIODIVERSITY Proximate Causes

The important proximate causes for the loss of biodiversity are as follows,

1. Destruction of habitat : The natural habitat may be destroyed by man for his settlement, grazing grounds, agriculture, mining, industries, highway construction, drainage, dam building, etc. As consequence of this the species must adapt to the changes, move elsewhere or may succumb to predation, starvation or disease and eventually die. In our country, several rare butterfly species are facing extinction with the uncannily swift habitat destruction of the Western Ghat. Of the 370 butterfly species available in the Ghat, up to 70 are at the brink of extinction.

2. Wildlife Hunting : From time immemorial, man has hunted for food. Commercially, wild animals are hunted for their product such as hides and skin, tusk, antlers, fur, meat, pharmaceuticals, perfumes, cosmetics and decoration purposes. For example, in Africa, in recent years 95% of the black rhino populations have exterminated by poachers for their horn. Today, rhino horn fetches more than $ 15,000 in the pharmaceutical market. In the last seven years alone. Over one third Africa's elephants have been wiped out for some 3,000 tonnes of ivory. In the international market the cost of ivory is about $ 150 per kg, whereas in the Indian Market it varies between Rs. 2,000 to 2,500 per kg. Africa produces about 700 tones of raw ivory every year. The major buyers are Japan, Hong Kong, followed by US, Germany and the UK. The U.S. alone imports about $ 30 million worth of ivory annually. CITES regulations have, to a great extent, reduced illegal trading and poaching of African Tuskers. Carving and

sale of African ivory banned in India from April 2, 1992. In January 1987 Central Government also banned the trade in Indian ivory (Agrawal, 1993). The scarlet macaw, once common throughout South America, has been eliminated from most of its range in Central America. Several species of spotted cats such as the ocelot and jaguar have been jeopardized by the demand for their fur- In 1962' nearly 70,000 whales were slaughtered. However, international trade in whale products is banned now.

In our country, rhino is hunted for its horns, tiger for bones and skin, musk deer for musk (have medicinal values), elephant for ivory. Gharial and crocodile for their skin, and jackal for thriven fur trade in Kashmir. One of the most publicized commercial hunts is that of whals. The whalebone or 'baleen' is used to make combs and other products. According to WWF Report, the spiny tailed lizard of the Indian desert, locally known as Sanda, is being hunted to extract the oil used for making 'Sanda katel' for its so called aphrodisiac properties. The lizard is listed in scheduled II of the Indian Wildlife Protection Act, 1972, which bans trade in the endangered species. But the WWF says because of the huge demand from the quacks and doctors the killing continues unchecked.

CITES lists nine Indian animal species, which have been severely depleted due to international trade. These are Fine Whale (Balenoptera physalus), Himalayan Musk deer (Moschus moschiferus), green Turtle (Chelonia mydas), hawksbill Turtle (Retmochelya imbricate), Olive Ridley Turtle (Dermochelys olivacea), Salt Water Crocodile (Crocodylus porosus), Desert Monitor Lizard (Varanus griseus), yellow Monitor Lizard (V. flavescens), and Bengal Monitor Lizard (V. Bengalensis).

Official of TRAFFIC India say poaching of the Indian tiger has risen because of the increasing demand from South East Asian countries and China, where pharmaceutical factories consume the bones of 1000 tigers each year. Such demand has decimated the tiger population in China and brought the Russian tiger to the brink of extinction. As a result, in recent years poachers in India have met much of the demand. Smuggling of tiger bones and skins is a lucrative business.

One kg of tiger bones fetches $ 90 in India and $ 3000 jn the international market. Hunting for sport is also for loss of animal biodiversity.

3. Over exploitation : This is one of the main causes the loss of not only economic species but also biological curiosities like the insectivorous and primitive species and other texas needed for teaching or laboratory work (like Nepenthes Gnetum, Psilotum, etc). Commercial exploitation of biodiversity has been as true in the case of Indian wild mango trees which were turned into plywood as of the whales, that where hunted for tallow, in the oceans.

Plants of medicinal value like Podophyllum hexandrum Coptis teeta, Aconitum, Discorea deltoidea, Rauvolfia serpentine, Quaphipedilum druri, and horticultural plants like orchids and rhododendrons come under the over exploited category. Faunal losses have been mainly because of over exploitation. For instance, excessively harvesting of marine organisms such as fish, molluscs, sea-cows and sea-turtles has resulted in extinction of these animals.

4. Collection for zoo and research : Animals and plants are collected throughout the world for zoos and biological laboratories for study and research in science and medicine. For

example, primates such as monkeys and chimpanzees are sacrificed for research as they have anatomical, genetic and physiological similarities to human beings.

5. Introduction of exotic species : Native species are subjected to competition for food and space due to introduction of exotic species. For examples, introduction of goats and rabbits in the Pacific and Indian regions has resulted in destruction of habitats of several plants, birds and reptiles.

5. Control of pests and predators : Predator and pest control measures, generally kill predators that are a component of balanced ecosystem and may also indiscriminately poison non target species.

6. Pollution : Pollution alters the natural habitat. Water pollution especially injurious to the biotic components of estuary and coastal ecosystem. Toxic waste entering the water bodies disturbs the food chain, and also the aquatic ecosystems.

Insecticides, pesticides, sulphur and nitrogen oxides, acid rain, _ne depletion and global warming too, affect adversely the plant and animal species.

The impact of coastal pollution is also very important. It is en that coral reefs are being threatened by pollution from industrialization along the coast, oil transport and offshore mining-Noise pollution is also the cause of wildlife extinction. This has been evidenced by the Canadian Wildlife Protection Fund. According to a study Arctic Whales are seen on the verge of extinction as a result of increasing noise of ships, particularly ice breakers and tankers.

7. Deforestation : One of the main causes for the loss of biodiversity is population explosion and resultant deforestation. Deforestation mainly results from population settlement, shifting cultivation, development projects, demand for fuel wood, demand of wood for industry and other commercial purposes. The report, based on studies carried out by the FAO and WCU, found that tropical forest areas are shrinking at the rate of 0.8 percent each year. 1980-90,154 rn hectare of tropical forests equivalent to almost 3 times the size of France have been converted to other uses. This represents an average annual loss of 1,55,000 hectare In India, the rate of deforestation is 13,000-sq. km. annually If this rate of deforestation continues, one can imagine the ultimate fate of our forest and biological richness. It is presumed that in coming years, the global loss of biodiversity from deforestation alone would be 100 species everyday.

8. Other factors: Other ecological factors that may also contribute, to the extinction of plant and animal species are as follows-

1. Distribution range. The smaller the range of distribution, the greater the threat of extinction.
2. Degree of specialization. The more specialized an organism is, the more vulnerable it is to extinction.
3. Position of the organism in the food chain. The higher the organism is in food chain, the more susceptible it becomes.
4. Reproductive rate. Large organisms tend to produce fewer offspring's at widely spaced intervals.

Status of Nature Reserves in India

There are 54 national parks and 3,725 sanctuaries with a total area of 1,09,652 square kilometer. Their numbers may go tip to 148 national parks and 503 sanctuaries totaling to 1,51,342 square kilometer. These include 13 biosphere reserves for which detailed documents about their holdings were prepared. The biosphere reserves are: the Nilgiris (Tamilnadu, Kerala and Karnataka), Namdapha (Arunachal Pradesh), Nanda devi (Utter Pradesh), Valley of Flowers (Uttar Pradesh), Great Nicobar, Gulf of Mannar (Tamilnadu), Kaziranga (Assam). Manas (Assam), Sundarban (West Bengal), Thar Desert (Rajasthan), Kanha (Madhya Pradesh), Nokrek Tura (Meghalaya) and the Rann of Kutch (Gujarat). The Gulf of Mannar is marine biosphere reserve (Khoshoo, 1991). A list of national parks and some important sanctuaries along with their respective fauna is given in Table 9.

National Parks

The first nature reserve of m6dern times was established by a group of French painters known as Barbizon School, who in 1853 secured the protection of part of the forest of Finatinebleau to preserve its natural beauty. We owe to them the creation by law in 1861 of the series artistiques covering some 124 hectares of beech grove (Jouanin, 1970)

However, the foundation year as far as the national concerned is traditionally fixed as 1972. A federal promulgated in the United States on March 1 of that year created the first national park in the world, that of the Yellowstone in Wyoming. The law prohibited any development that might alter its character in order to preserve the region as a public park or pleasure ground for the benefit and enjoyment of the people.

During the later part of the nineteenth century, only the British followed the American example and set out to transform vast tracts of their large empire into national parks. The Glacier National Park was created in Canada in 1888 and the Royal National Park in Australia a little later. Lastly, the Sabie National Reserve was established in South Africa in 1898 and this became the famous ruger National Park in 1926.

In Western Europe, Sweden was first to create national parks: Six were set up in 1909, among them those of Sarek and Stora Sjofliet in Lapland. Switzerland established a national park in the Engadine in 1915. French created the zoological and botanical nature reserves in the Camargue in 1928. Even then, this was not set up as a result of government action. A private scientific and philanthropic association the Society National de Protection de la Nature, one of the oldest such orgranisation in the world: established in 1853 under the name Societe d' Acclimation. It was not until 1869 that a law on national parks was passed and it was 1963 before the first of them was created: The Pare National de la Vanoise.

According to criteria laid down by IDCN, the status of national park should be granted to areas that enjoy protection within a legal framework: Protection of their natural resources from all human exploitation and defense against any other attract on their territorial integrity resulting from human activity. In addition, a national park should be equipped with sufficient material and human resources to ensure that the laws are adequately applied. The final criterion laid down by the IUCN is that of a minimum area, depending upon geographical location and the population density in the country concerned.

Indian Board of Wildlife has defined a national park as an area dedicated by stature for all times to conserve scenery, natural or historical objects of national significance and wildlife and where provision is made for the enjoyment of the same by the public'-

Wildlife Sanctuaries

They represent the most rigorous form of protection. Unlike national parks in which tourism is not only permitted but often encouraged, Sanctuaries are forbidden territory as far as human visitors are concerned: Only the wardens and scientists carrying out research on some special biological feature, have right to access and even then it is only on foot.

Sanctuaries can be situated outside national parks. On the other hand the IUCN thinks that a national park ought always to include a certain number of sanctuaries as 'an area where killing or capturing of any species of animal is prohibited except under order of the component authority and whose boundaries and character should be sacrosanct as far as possible."

While the principles underlying a national park and a wildlife sanctuary are essentially the same, the fundamental difference is that a sanctuary is created by order of a compelent authority, while a national park is created and correspondingly may be abolished, mutated or changed, only by the legislature of a state. The status and degree of permanency and protection is therefore much higher in a national park than in a sanctuary.

Biosphere Reserves

They have been created at the instigation of UNESCO from 1974 onwards, to protect ecosystems, whether natural or Modified by human activity. Reserve of this type should satisfy 7 essential criteria (Maldague, 1984):

1. They should provide a network of protected terrestrial and coastal environments, which form a coherent system on a world scale.
2. They should occur in each of 193 biogeographical provinces of the world distinguished in the classification of 1975s. So as to exhibit the maximum genetic diversity.
3. They should show a complete range of the different types of human interference, from ecosystems untouched by any anthropic action to those which have been degraded by human beings very severely for a very long time.
4. Their structure and size should ensure the efficient conservation of the ecological system they are designed to protect.
5. They should have sufficient resources available for ecological research to be carried out on the spot together with education and training in matters concerning nature conservancy.
6. They should if possible have geographical continuity with other types of protected zone.
7. They should receive adequate protection under the law with long-term safeguards.

In the original concept, biosphere reserves consists a central zone with maximum protection and in the case of virgin areas, complete exclusion of people other than those

carrying out research. Outside the core are two concentric buffer zones in which controlled exploitation of natural resources is possible.

In a cluster type of biosphere reserve two or more core areas, with integrated research and experimental areas must be protected to facilitate migration of animals and plants from one section to another.

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CHAPTER 5

ENVIRONMENTAL POLLUTION

Environmental pollution may be defined as the *"unfavourable alteration of our surroundings, wholly or partly by human action"*. According to National Environmental Research Council (NERC) Pollution is viewed as *"the release of substance and energy as waste products by human activities which result in changes, usually harmful, within the natural environment"*.

The factors responsible for the pollution crisis are population explosion, unplanned urbanization and deforestation, profit oriented capitalism, technological advancement, industrial revolution etc. The problem of environmental pollution is one of the terrifying ecological crises faced by man.

Definition: *Environmental pollution is unfavourable alteration of our surroundings, wholly or largely as a by product of man's actions, through direct or indirect effects of the changes in the energy pattern, radiation levels, chemical and physical constitution and abundance of organisms.*

Environmental pollution is a global problem and is common to both developed as well as developing countries. The decline in environmental quality as a consequence of pollution is evidenced by loss of vegetative cover and biological diversity, excessive concentration of harmful chemicals in the ambient atmosphere, in food grains, growing risks of environmental accidents and threats to life support system.

Detergents, pesticides, biocides, chlorofluorocarbons, plastics and plasticizers, solvents, paints, dyes, medicines and food additives, etc., are some examples of the multiplicity of chemical products made and disseminated for the benefit of man. All these have the inherent capacity to disturb the ecosystem.

Increase in radiation in the biosphere as a result of man's manipulation of atom bomb posed another problem to environment. Even to date no plan for the permanent safe of radioactive waste has evolved. Similar is the case with several other industrial wastes, particularly, poisonous gases which are invading the atmosphere. Expanding use of fuels, fertilizers, agrochemical, disposal of domestic, industrial, agricultural, hospital and other hazardous wastes threatens further the deterioration of man's surroundings. Mining activities constitute one of the largest producers of solid waste.

Auto vehicles and noise are common pollution problems of urban areas, specifically of metropolitan cities like Delhi, Mumbai, Kolkata, Chennai etc.

Bhopal MIC gas tragedy of December 3rd, 1984, Chernobyl nuclear reactor accident of April 25th, 1986, gulf war, 1990 and Takimura nuclear accident of 1999 are some of the man made catastrophes that remind us to take stringent measures to control environmental pollution to save humanity from being put into jeopardy.

The timely action can only save the humanity from a morbid bieak future. All those activities, which result in irreparable damage in environmental quality and to the biosphere, have to be regulated carefully. This needs planning and execution of all development projects

in such a way that achieves a sustainable development without impairing ecological balance and deteriorating environment.

Environmental is degrading rapidly in the Third World. Air pollution from industrial activity, vehicular emission and burning of fossil fuel claims for more than 2.7 million lives every year, as it results in respiratory diseases and cancer. According to the Human Development Report, 1998, more than 90 percent of these deaths take place in the developing world. Soil degradation and scarcity of potable water are some other problem of the Asia and Africa, which further deteriorates the environment.

Pollution and Pollutants

Pollutants can be defined as *"any solid, liquid or gaseous substances in such concentration which may be injurious to environment'.* Pollutants may be natural or man made. Natural Pollutants are manageable. But unfortunately, it is not an easy task to manage the man made Pollutants. Pollutants may be invisible like smoke, gases, dusts etc or visible in the form of bacteria, toxic, chemicals etc.

Sources of Pollutions

Sources of pollutions are many. On the basis of sources of pollution, they can be divided into two natural and man made. Natural sources include the materials produced by volcanic eruption (smoke, ash, gases, and dusts), forest fires, floods, cyclones etc. Man made sources of pollution include i) industries ii) urbanization iii) agriculture iv) population explosion (v) automobiles vi) nuclear explosion etc. But industries and urban centres are the major sources of pollution.

Industries ejects several pollutants such as gaseous matter, solid matter, dissolved and suspended solids, waste water that contains many chemical ingredients, heat etc. Sources of urban pollution include sewage water, solid waste, gaseous exhaust and liquid effluents etc. The use of chemical fertilizers, pesticides and insecticides are the sources of agricultural pollution. Rapid growth of population also increases pollution. All forms of man made pollution are the product of human activities.

Man's activities disturb the eco-balance by deteriorating the environmental condition suitable to sustain life, causing pollution. *"Any undesirable change in the physical, chemical or biological characteristics of air, water and soil that may create a hazard or potential hazard to the health, safety or welfare of any living species is called pollution".* In other words, the pollution matter causes direct or indirect changes in one or more component of the atmosphere that are harmful to the living entities. In particular, undesirable for which adversely affect not only to him directly or through his water as culture assets. In a broad sense, pollution means the presence of any substance (solid, liquid or gas) or agent (noise or heat) in the atmosphere in such concentration that may be or tend to be injurious to environment affectiving living or non-living things. Holdgate (1979) defined environmental pollution as the introduction by man, into the environment of substances or energy liable to cause interference with legitimate uses of environment.

Population explosion along with urbanization and industrialization greatly increased the intensity of pollution. With more people, there has been more sewage, more solid waste, more fuel being burnt, more fertilizers and insecticides being used to produce more food for millions of hungry mouths.

The substances, which cause pollution, are known as pollutant. Pollutants may be defined as *"any chemical (radionudide, organophosphorous compound or trace gases) or geo-chemical substance (dust, sediment, grit, etc) biotic component or product (pollens or products of microbial activity), or physical agent (heat, sound etc.) that released intentionally or inadvertently by man into the environment in such concentration that may have adverse, harmfull or unpleasant and inconvenient effects".* According to the Indian Environment (Protection) Act, 1986, it has been defined "as *any solid, liquid or gaseous substance (including noise, heat etc) present in such concentration as may be or tend to be injurious to environment".* A pollutant thus may be a synthetic compound or a naturally occurring element or compound whose toxic are capable of disrupting ecology of an area. The undesirable or residues of things which we make, use or throw away are also pollutants. In common usage, pollutant is a term applied usually to non-living, man-made substance or other nuisances that refer to them being in excess or not desired in a particular matter.

Principal Pollutants

The various principal pollutants are:

i) Gaseous pollutants - Oxides of Nitrogen (NO, N02), Sulphur compounds (SO2, H2S), Carbon compounds (CO2, CO), Ozone, Halogens (Chlorine, Bromine, Iodine, etc) and Chlorofluorocarbons.

ii) Fluoride compounds

iii) Metals : Mercury, Lead, Iron, Nickel, Zinc, Tin, cadmium etc.

iv) Agricultural pollutant: Pesticides, Herbicides,Fungicides and Fertiliser,

v) Complex organic pollutants: Benzene, Benzpyrens Acetic acid, ether, etc.

vi) Biotic component: Pollens, fungal spores, bacteria viruses etc.

vii) Deposited matter: Soot, smoke, tar, dust, grit etc.

viii) Solid waste: Domestic, municipal and industrial

ix) Radioactive waste: Plutonium, Strontium, Krypton, Iodine, Cobalt, etc.

x) Noise-Unwanted and unpleasant sound

xi) Heat - Hot water, steam etc.

Classification of Pollutants

Pollutants may be classified in many ways :

1) On the basis of their origin in the environment, they may be

• **Primary Pollutants:** These substances are released directly into the atmosphere from an identifiable source. Examples are sulphur dioxide, carbon dioxide, nitrogen oxides etc.

• **Secondary Pollutants:** These are derived from primary pollutants by chemical reactions. For examples formation of peroxyacetyl nitrate (PAN) in the atmosphere by photochemical reactions during smog formation.

2. From the ecosystem point of view, the pollutants can be classified into two basic types: biodegradable pollutants and non-biodegradable pollutants.

• **Biodegradable Pollutants:** The domestic sewage, heat, noise, etc. are the biodegradable pollutants as they decompose or dilute gradually in nature or in man-engineered system like a municipal sewage treatment plant. Biodegradable pollutants are thus less harmful, but create problems when their input in the environment exceeds the decomposition or dispersal capacity.

• **Non Biodegradable Pollutants:** The materials and poisonous substances like aluminium cans, mercuric salts, iron chain phenolic compounds and DDT are the non bio-degradable pollutants as they do not degrade at all or degrade very slowly in the natural environment. Such non bio-degradable pollutant not only accumulate in the environment hut often get biologically magnified in course of their bio-geochemical cycling as they move along the food chain from one trophic level to another trophic level.

Types of Environmental Pollution

More commonly, pollution is classified according to the environment in which it occurs as air pollution, water pollution and soil pollution, or according to the type of pollutant i.e., mercury pollution, lead pollution, noise pollution thermal pollution, oil pollution etc. Sometimes, it may also be classified as natural and artificial pollution depending upon its origin in nature or as a result of human activities. At present we do not have any systematic classification of environmental pollution. However, for the sake of convenience we may classify environmental pollution as follows,

- Air Pollution
- Water Pollution
- Soil Pollution
- Noise Pollution
- Marine Pollution
- Thermal Pollution
- Nuclear Hazardous and Waste Pollution

AIR POLLUTION

In general air pollution may be referred to the in equilibrium of the air caused by the interference of foreign elements from natural and man-made sources, that form of air becomes injurious to plants and animals.

According to WHO air pollution is defined as *"Substances put into the air by the activity of mankind in concentration, sufficient to cause harmful effect to his health, vegetables and property"* In other words *"addition of harmful substances to the atmosphere is called air pollution"*.

Definition: *"Air pollution means any solid, liquid or gaseous substance (including noise present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plant or property or environment".*

Air pollution is becoming an increasingly important aspect of environmental degradation in the wake of rapid industrialization, and has assumed a stage of concern in these days in many urban centres in India. It is mainly caused by industrial emission, transport emissions and domestic consumption of low-grade fuels, resulting in intensely smoky atmosphere. The important industries that are responsible for air pollution are in the fields of power generation petrochemicals, fertilizers, metallurgy, sulfuric acid, nitric acid pharmaceutical industries, and various other chemical and ceramic industries. The problem of pollution posed by transport has also become acute because the vehicles discharge carbon monoxide, hydrocarbons, and oxides of nitrogen, and sulfur dioxide (besides large quantities of particulate matter, including lead) which are very injurious to health.

Environment is degrading rapidly in the third world. Air pollution from industrial activity, vehicular emission and burning of fossil fuels claims more than 2.7 million lives every year, as it results in respiratory diseases and cancer. According to the Human Development Report, 1998, more than 90% of these deaths take place in the developing world.

Air pollutants and their sources

Air pollution is caused by both natural and human sources.

1. Natural Sources: are volcanic eruption, forest fires; rosmic dust, which is produced by asteroids, meteors, comets etc' pollen of flowers, carbon dioxide from bacteria, fungal spores, viruses, parthenium plants, carrot weed etc., slate spray from sea and ocean, dust and oil particles from the earth's surface.

2. Human Sources: includes a) gases from kitchen, industries, incineration of garbage's, automobiles, railway engines, air crafts, etc. b) solid matter from mines, industries and urban centers c) Radio-active substances from nuclear plants, nuclear explosions, etc.

Air Pollutants

1) Carbon-dioxide is one of the gaseous components of the atmosphere and essential to plants. It is largely released in the atmosphere from burning of fossil fuels, (Coal, Petroleum etc.) combustion, the thermal power plants and industries. It is also emitted by volcanic eruption. Its higher concentration in the atmosphere increases the temperature on the earth's surface.

2) Carbon-monoxide is produced due to incomplete burning of fossil fuels and charcoal. About 80% of it's given out by automobiles. Besides it is also produced by stoves, furnaces, factories and smoking. This is a deadly poisonous gas when it is in high concentration.

3) Nitrogen-oxides are formed through natural as well as man induced processes. They are produced mainly by automobiles, aircraft, thermal power stations and factories. High concentration of nitrogen oxides causes several diseases.

4) Sulphur-dioxide is the second most important air Pollutant and it causes acid rain. It is produced by thermal power Plants, oil refineries and automobiles.

5) Chlorofluorocarbon compounds of chlorine, fluorine and carbon, are popularly known as CFCs. These are emitted from industries, spray cans, air conditioners, refrigerators, foam plastics, cosmetic goods etc. higher concentration of CFCs is one of the most dangerous forms of air pollution and causes ozone depletion.

6) Hydrocarbons are primary air pollutants which cause damage to the biological system. They mainly consist of benzene, benzpyrene and methane produced partly from burning of petroleum, decomposition of organic wastes and garbage.

7) Particulate matter refers to small particles (aerosols) floating in the atmosphere. They consist of smoke, soot, fly ash, dust, grit etc. They are commonly produced by dust storms, forest fires, slash burning, burning of agricultural waste, automobiles, airways, railways, water ways, incinerators, industries, cigarette smoking, ocean salt spray, volcanic actions etc. Particulates are injuries to health.

Effects of Air Pollution

Air pollution has now become a widespread problem. The atmosphere, human health, animals and plants are affected by it.

1) Effects on Atmosphere: Weather and climatic conditions of a region are severally affected by air pollution. The concentration of carbon dioxide in the air absorbs heat strongly and causes the rising of temperature and depletion of zone. This is one of the big global problems.

Air pollutants have impact on humidity, clouds, and rainfall as it causes acid rain, smog etc.

2) Effects on Human Health: Air pollution is highly injurious to human health. Some toxic gases like sulphur dioxide and carbon monoxide can cause acute illness and even death. It affects the respiratory system and causes bronchitis, asthma and lung cancer. Carbon dioxide often affects the oxygen carrying capacity of blood, nitric oxide may cause pulmonary irritation etc. Sudden leakage of toxic gases from chemical and gas plants causes loss of life that we have seen in the case of Bhopal gas tragedy of India (1984). Particulate pollutants like lead, asbestos, silica, carbon, beryllium, zinc, copper, dust etc. cause many diseases.

3) Effects on Animals and Plants

The metallic contaminants in the air namely arsenic, lead, molybdenum and fluoride etc have adversely affected animals. The increase of temperature on the earth's surface, due to ozone depletion would affect the type, density and stability and yield of plants (crops) substantially. Marine organisms are badly affected. Acid rain and smog also cause damage to plant life.

4) Other Effects: Air pollution can also cause damage to property and materials. The smoke grit dust and oxides of sulphur have harmful effect on Structures. For example : The oil refinery at Mathura (India), has affected the whiteness of Tajmahal.

Control of Air Pollution

Some of the measures to control air pollution are as follows:

1. Control of gaseous pollutants. They are removed by spraying water, filtration or absorption.
2. Control of emission from automobiles, which are a major source of air pollution. Redesigned engines, catalytic converters, and use of other fuels that are free from lead and taking good care of automobiles should control it. Emission tests for vehicles should be legalized.
3. Control particulate matter by using different instruments e.g. electrostatic precipitators, fabric filters and scrubbers.
4. To avoid fossil fuels and non conventional sources of energy.
5. Incineration should be there in building to burn the domestic wastes.
6. The industrial areas should be located at certain safe distance from the residential areas.
7. There should be a green belt around township, industrial areas and villages.
8. Traditional use of fuel wood (India) should be controlled checked and newly devised smoke free furnace should be used.
9. Steps should be taken to check on forest fires and restrict deforestation and encourage aforestations.
10. The height of smoke chimneys should be for diluting the smoke.
11. Legal controls are also necessary. All the countries of the world should formulate laws regarding prevention of air pollution.
12. Create awareness among the people about ill effects of air pollution on health and property.

Worldwide efforts have been made to control air pollution. Scientist, technologists and environmentalists have developed certain measures. But still progress in this field is not satisfactory.

WATER POLLUTION

The earth is a planet with water-and oxygen, which an very essential for life on earth. Water is one of the mo important elements in the biosphere. We drink it, bathe in it relax in it, fish in it, keep cool with it, irrigate plants, generate energy and also use it for transportation and recreation. Water helps as a media in the movement, circulation and cycling of nutrients for living things. Further it is essential for clearing of sewage and maintenance of sanitation.

The planet earth has 71% of its areas filled with water bodies. But less than 1% of water is suitable for human and other biotic uses. Water is available from various sources such as rivers, lakes, ground water, soils etc. So, fresh water is scarce. In recent years demand for it has increased due to increase in population, industrialization and urbanization. The quality of water has also degraded to a large extent.

Water has self purifying capacity during water cycle. But it gets polluted when undesirable substances are added by man to water beyond the tolerance level.

Definition : The contamination of water due to external materials mixed with natural water which makes it unsuitable for human consumption is called water pollution. It may be defined as *"Alteration in physical, chemical and biological characteristics of water which may cause harmful effects on human and aquatic life"*. Whenever undesirable substances are mixed with water either by the natural processes or by human activities, invariably, they change the quality of water and it gets polluted.

Sources of Water Pollution

Water pollution is caused by several pollutants. Generally there are two sources of water pollutants. They are :

1. Natural Sources: Natural water pollutants are soil erosion, landslides, volcanic eruption, mineral decay and decomposition of plants and animals. During heavy rain we can see the direct impact of soil on the water of rivers, tanks and other water bodies. The brown and dirty water is the result Of mud mixed in the water, due to soil erosion. Landslides near lakes bring down large amount of debris into the lake and water gets polluted. Some harmful minerals are added and they are responsible for water pollution, i.e. nickel, lead, cobalt, mercury etc.

2. Human Sources : Man and his activities are greatly responsible of water pollution. Human source of water pollution include pollution from cities and towns, industries, agriculture, pilgrim centers, religious fairs etc.

3. Urban Sources of water pollution include the pollutants like domestic effluents and sewage waste. For example: food preparation, bathing, house cleaning, cooking, washing clothes etc. Dirty water is discharged into drains. In many cases domestic waste water flows into nearby rivers, tanks or lakes. Other waste materials such as paper, plastic, detergents, cloth etc., are mixed with sewage water.

4. Industrial Source of water pollution include the effluents generated from the industrial activities. Major contributor are the pulp and paper, chemicals and petrochemical industries, oil refineries, metal works, food processing, distilleries, textiles etc. Most of the Indian rivers have been polluted by industrial effluents, i.e., Ganga, Damodarand so on.

Agricultural sources are associated with the excessive use of fertilizers, pesticides, insecticides, farm animal waste and sediments. The chemicals used as fertilizers and pesticides enter the ground water and poison it.

Thermal and other power plants and also certain factories, discharge large quantities of heated water into nearby rivers, lakes or ponds and cause thermal pollution of water. It has become a serious problem for the water bodies and aquatic ecosystem.

The oil slicks or oil spill in the sea causes pollution of water frequently. Oil is transported across the seas by tankers. If there is an accident or leakage, oil spreads on the water surface -and cause serious pollution problem.

Offshore drilling operation contributes their share of water pollution. Rivers and lakes are also polluted from the nearby oil refineries, work shops, garages etc. Oil spill affects fish

and other aquatic organisms adversely. Sometimes the oil spilled over water surface may catch fire and endanger aquatic life.

Emission of radio active elements (radium and uranium) during nuclear tests may encircle the globe. The same often come down to the earth as rain carried out into streams and rivers, percolates into the ground and water may be contaminated.

Types of water pollution : There are three types of water pollution :
i) Inland water pollution ii) Ground water pollution iii) Sea water pollution.

1) Inland water Pollution

It includes rivers, lakes and pond water. But river water pollution is a very important matter for discussion. The river water is polluted due to the mixing of inorganic matter in the form of ions. The ions present in fresh water from the land are mostly derived from non living sources.

The industries, urban centres, agricultural and human activities are the chief sources of river water pollution. Many industrial units like sugar factories, meat packing, distilleries, lac and paints, rayon, silk, DOT plants, petro-chemicals and fertilizers, paper, cement, leather tanners etc. are discharging industrial effluents and waste through sewage drains into nearby river and pollute the water. Most of the Indian rivers which flow close to large cities are heavily polluted by urban sewage and industrial effluents. For example, Yamuna river at Delhi, Ganga at Kanpur, Kapila at Nanjangud, Bhadra at Bhadravathi, Hoogly at Kolkata, Vagai at Madurai.

Lakes are polluted by siltation due to dumping of large amount of sediments by streams from their hilly course where trie rate of deforestation and soil erosion is rapid. Some lakes in Kumaon region of Uttaranchal have disappeared due to rapid rate of erosion and reckless cutting of trees.

Most of the reservoirs behind major dams are facing acute problem of siltation. Washing and dumping of waste sludge from factories into lakes and tanks pollute them. It is more severe than the river pollution because lake water is stagnant. The concentration of a single matter increases contamination and turn it into killer water. E.g. the concentration of asbestos in the lake water causes lung cancer, called Asbestosis. Besides, inorganic matter from the agricultural fields, nitrates, phosphates and organic matter from sewage treatment plants and toxic chemicals from the factories enter the lakes and pollute them.

1) Ground water pollution

Ground water is polluted through the leaching and infiltration of pollutants like fertilizers, insecticides, fungicides, herbicides used in agricultural fields, effluents from factories, garbage's from urban areas, from polluted septic tanks, polluted tanks and ponds. Many problems arise from the pollution of ground water, especially the water drawn up by hand pump and wells for domestic purposes. Such problems have been reported from different parts of the world viz. Patancheru industrial complex, 30 km away from Hyderabad, in Medak district of Andhra Pradesh. The toxic water discharged from 300 Industrial units leaching into ground water has adversely affected the 14 villages around the complex.

2) Sea water pollution

This is most common near the coast. The disposal of industrial, waste, urban effluents and toxic chemicals into sea water, leakage of crude oil from the oil tankers, offshore oil wells and oil refineries have polluted sea water and caused ecological damage to the coastal ecosystem. Like lakes, concentration of single matter in the coastal water causes serious problems. Eg. Concentration of mercury in the Minamatha Bay. Dumping from Minamatha city (Japan) caused a disease known as Minamatha. It claimed several lives in the city (1950). Similarly during the Gulf War (1991) there was oil leakage in Persian Gulf due to heavy bombing on oil tanks in the Middle East. This has affected the organisms and created environmental hazards.

Effects of Water Pollution

The following are the main effects of water pollution:

1) Polluted water is greatly responsible for several water borne diseases and epidemics e.g. Cholera, typhoid, diarrhoea, dysentery, jaundice etc.

2) Polluted water containing toxic chemicals causes death of aquatic life, including water plants and fish.

3) The use of polluted water of rivers, lakes and ground water for irrigation adversely affects crops and reduces the yield.

4) Highly polluted water destroys soils, decreases its fertility and also kills useful micro organisms.

5) Heavily polluted water obstructs the process of photosynthesis, which affects the growth of vegetation.

6) Besides, polluted water changes the physical and physiological nature of water, i.e. colour, taste, odour and transparency of water.

Measures of Control for Water Pollution :

Water pollution now has become a world wide problem. |t requires several remedial measures. Some of them are as follows:

1. The drinking water sources and their areas must be kept clean.
2. The municipal corporation must have proper arrangements for sewage treatment.
3. Industries should not be allowed to discharge their effluents into the water bodies without treatment.
4. Use of pesticides in agriculture should be limited.
5. There should be a ban on the disposal of dead bodies into water bodies.
6. Waste water (bath and sinks) should be regulated and be used for irrigation and other purposes.
7. Lastly people must be educated not to pollute water. This awareness will help in solving problem of water pollution to a greater extent.

SOIL POLLUTION

One of the definitions of soil pollution is *"decrease in the quality of soils either due to human sources or natural sources or by both is known as soil pollutiori'.* This is due to several reasons, e.g. rapid rate of soil erosion, deforestation, loss of nutrients and soil micro organisms, excessive use of chemical fertilizers, pesticides, excess or deficit of moisture soil, temperature variation, lack of humus and different types of pollutants.

With rapidly advancing technology, man's impact upon the world of natural resources is beginning to prove overwhelming. Rapid urbanization, with the consequent increase in population and building construction has resulted in the reduction of lands for the wastes to be disposed. Every year solid wastes are increasing tremendously all over the world, depending upon the living standards of the people. More over, as every day passes, the garbage in the street corner bin spilled over sooner than it could be emptied. Several hazardous chemicals and the mountains of wastes are ultimately dumped on the lands. pumping industrial and municipal wastes causes toxic substances to be leached and seep into the soil and affects the ground water course. Modern agricultural practices introduce numerous pesticides, fungicides, bactericides, insecticides, biocides, fertilizers and manures, resulting in severe biological and chemical contamination of land. Apart from all these, direct pollution of soil by deadly pathogenic organisms is also of major importance.

The crux of the waste problems on land lies in the leaching and mounting amount of wastes. Such leaching which ooze out of the garbage heap are known to move slowly through the layers of the soil beneath and contaminate the water resources deep down the land. However, the problem of soil pollution differs from air and water pollution in the respect that the pollutants remain in direct contact with the soil for relatively longer periods. The wide-spread industrialization and increasing consumption have changed the very complexion of soil. Thus the soil is getting heavily polluted day by day by toxic materials and dangerous micro organisms which enter the air, water and the food chain. For all this, man is the original and basic pollutant responsible for pollution hazards and toxic effects.

Sources of Soil Pollution : The sources of soil pollution are: domestic water wastage from municipalities, industries, mines, agricultural activities, radio-active materials, biological agents, air borne sources etc.

Soil pollution mainly results from the following sources

1. Industrial Wastes
2. Urban Wastes
3. Radioactive Pollutants
4. Agricultural Practices
5. Chemical and metallic pollutants
6. Biological agents
7. Mining
8. Resistant objects
9. Soil sediments.

Soil Pollution by Industrial wastes

Disposal of industrial waste is the major problem responsible r soil pollution. These industrial pollutants are mainly discharged from pulp and paper mills, chemical industries, Oj| refineries, sugar factories, tanneries, textiles, steel, distilleries fertilizers, pesticide industries, coal and mineral mining industries, metal processing industries, drugs, glass, cement petroleum and engineering industries etc.

With the advent of technology, newer types of industrial wastes are produced and deposited on the land. These waste products are also tipped on soil, enhancing the extent of soil pollution. Thermal, atomic and electric power plants are also the villain to add pollutants to the soil. The furnaces of such industries generate fly ash i.e. unburnt brownish black substance, which severely pollute air, water and soil. Many industrial effluents are either discharged into streams or dumped into the surrounding land. Industrial wastes mainly consist of organic compounds along with inorganic complexes and non-biodegradable materials. These pollutants affect and alter the chemical and biological properties of soil. As a result, hazardous chemicals can enter into human food chain from the soil or water, disturb the biochemical process and finally lead to serious effects on living organisms.

The industrial effluents which pollute air and water pollute the soil too. For example, cement and steel industries disturb the salt balance of soil and destroy its fertility. The alkalinity of the soil is increased and the heavy metals and certain chemical compounds may reach soil and enter plants causing bioaccumulation on which are health hazards. For example, lead content in soil may result in the risk of neuro behavioural effects in children. Toxic effects can also be seen in the plants and animals of the area.

Soil Pollution By Urban Wastes

Urban wastes comprise both commercial and domestic wastes consisting of dried sludge of sewage. All the urban solid wastes are commonly referred to as refuse.

Solid wastes and refuse, particularly in urban areas contribute to soil pollution. This refuse contains garbage and rubbish materials like plastics, glasses, metallic cans, fibers, paper rubbles, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products. Recent reports indicate that in United Kingdom nearly 15 million tons of domestic sewages are disposed off into the land. In the United States also, each sunset sees a new mountain to be precise, 4,10,000 tonnes of solid wastes. New York itself throws out 25,000 tons of solid stink. When none of the city's fourteen land fills, in use for more than 20 years, can take any more. Across the atlantics, the situation of refuse is also critical. It is estimated that in India alone, about 115 million of urban population produces nearly 15 million tones of solid wastes causing chronic pollution of land and water. In critically polluted cities like Bombay, Calcutta, Kanpur and Madras about 4000 tonnes of waste material collects in a day and for its disposal to the dumping site about 750 boggies are used. In our own backyard Delhi, which is the third most polluted city amongst 41 critically polluted cities, collects about 3000 tons of garbage from its streets every day, to be thrown into its five land fills, thereby polluting the land areas. Urban domestic wastes though disposed of separately from the industrial wastes, can still be dangerous. This is so because they can't be easily

degraded. Over population and increasing consumption have totally changed the very complexion of domestic wastes into a complex mixture of food-remains, paper, plastic and many notorious chemicals. Other items like paints and varnish which we use to add colour and gloss to everyday life also add poison to the urban wastes posing soil pollution problems. The leaching from dumping sites and disposal tanks of sewage mixed with industrial effluents and wastes are extremely harmful and toxic. Actually the leaching that oozes out of the polluted soil, contain poisonous gases along with the partly decomposed organic material especially food remnants, vegetables, toxic hydrocarbons and pathogenic microbes many of which can be disease causing. Pollution concentration in urban areas and unplanned industrial progress in and around these urban areas, have to a greater extent contributed to soil pollution problems in India. About 12 crore population of India lives in cities while its six times more population lives in villages which dump their waste products into the soil, posing compositing and thermally decomposing the refuse of Bombay and Calcutta only.

Radioactive Pollutants

Radioactive substances resulting from explosions of nuclear devices, atmospheric fall out from nuclear dust and radioactive wastes {produced by nuclear testing laboratories and industries) penetrate the soil and accumulate there creating, land pollution! Radio nuclides of radium, thorium uranium, isotopes of potassium (K 40) and carbon (C 14) are very common in soil, rock, water and air. Explosion of hydrogen weapons and cosmic radiations induce neutron-proton reactions by which nitrogen (N 15) produces Carbon14. This Carbon14 participates in the carbon metabolism of plants which is then introduced into animals and man. Radioactive waste contains several radio nuclides such as strontium 90, Iodine 129, caesium 137 and isotopes of iron which are most injurious. Sr 90 gets deposited in bones and tissues instead of Calcium, Nuclear reactor produces waste containing Ruthenium 106, Iodine 131, Barium140and Lanthanium 140, Caesium 144, Promethium 144 along with the primary nuclides Sr 90 having 28 years. Rain water carries Sr.90 and Cs 137 to be deposited on the soil where they are held firmly with the soil particles by electrostatic forces. Soil erosion and heavy rains carry away the deposited Cs 137 and Sr 90 with the silt and clay. All these radionuclides deposited on the soil emit gamma radiations.

Recently it has been indicated that some plants such as lichen and mushroom can accumulate Cs 137 and other radio nuclides which concentrates in grazing animals.

Agricultural Practices

Modern agricultural practices pollute the soil to a large extent. Today with the advancing agro-technology, huge quantities of fertilizers, pesticides, herbicides, weedicides and soil conditioning agents are employed to increase the crop yield.

Many agricultura1 lands have now excessive amounts of plant and animal wastes which are posing soil pollution problems. Apart from these farm wastes, manure, slurry, debris, soil erosion containing mostly inorganic chemicals is reported to cause soil pollution. USA alone produces about 18 million tones of agricultural wastes every year. Some of the agents responsible for this pollution are as follows;

a) Fertilizers : Now-a-days agricultural practices rely heavily on artificial fertilizers, which generally contain one or more of the plant nutrients i.e., nitrogen, phosphorous and potassium. Critical pollution problems arise mainly from their excessive application rates. Although the fertilizers are used to fortify the soil, yet they also contaminate the soil with their impurities. When the fertilizers are contaminated with other synthetic organic pollutants, the water present in the soil may also get polluted. Generally fertilizers are retained by the soil and crop efficiently but there are some possibilities for the nitrates to be washed out due to negligence of appliances in applying fertilizers to arable lands particularly in a wet spring. These nitrates cause several undesirable effects on the water quality of lowland lakes or rivers creating numerous health hazards. Reports indicate that if phosphate and nitrate concentration exceeds one part and thirty parts per hundred million parts of water respectively, it results in eutrophication chocking the whole stretch of aquatic ecosystem.

However it is not only the increasing utilization of fertilizers, but also escalated production which creates soil pollution hazards.

Let us first review what happened to Indian soils in the last 50 years as far as nutrient management is concerned. The green revolution was mainly caused through application of chemical fertilizers to the soil in large quantities to increase the yield of miracle varieties of cereals, mainly wheat and rice, which form the bulk of our grain production. The green revolution fallout was : a) Breakdown of Miracle Varieties b) Fresh Onslaught of Pests and Diseases, and c) Build up of Potentially hazardous inorganic constituents such as nitrates in the soil, leading to ground water contamination.

Pesticides: Indian farmers and agricultural technologies have made tremendous efforts in increasing food production during the last 35-40 years. There has been more than a two fold increase in food grains production since 1960-61. This is largely due to the introduction of high yielding crop varieties fertilizers, assured irrigation and improved agronomic practices. However, to exploit the potential of these improved varieties and to ward-off pests, chemical pesticides became essential. The consumption of chemical pesticides increased to 75,033 tonnes in 1994-95 from a mere 2330 tonnes at the beginning of the planning period. Most of the pesticides are used on crops like cotton, rice, pulse, oil seed and vegetable crop. The pesticides are used in houses and fields to eradicate pests and protect stored food grains. They kill many disease transmitting insects, rodents, snails etc. and hence they are immensely beneficial to man. Pesticides generally belong to two major groups.

a) Chlorinated hydrocarbon insecticides, and

b) Organophosphorus insecticides.

The chlorinated hydrocarbon insecticides are synthetic chemicals which are characterized by the presence of carbon, chlorine, hydrogen and cyclic carbon chains including benzene rings. The three most common chlorinated hydrocarbon insecticides are DOT, BHC, and cyclodiene compounds, which are the collective group of cyclic hydrocarbons consisting of such important insecticides as chlordane, heptachlore, aldrin, dieldrin and endosulphan.

Thus herbicides can modify plant communities which in turn affect herbivores and then carnivores.

The other biocides like fungicides are used to kill the disease causing fungi. They are dangerous to the host if used in large concentrations. The bactericides are used to kill bacteria while nematicides are used to kill nematodes. Rodenticides, which are used to kill rodents may be left to rot but they cause pollution of soil because they are non-biodegrada Despite large scale use of pesticides, which are basically toxic and do not increase the yield, various states in India have experienced most pest out-brakes like bollworm and whitefly in cotton. BPH and leaf folder in rice, pyrilla and borers in sugarcane, aphid in mustard, and pod borer in pigeon pea. Recent reports of resistance resurgence of Phalaris minor in wheat to Isoproturon herbicides in various states such as Haryana, Punjab and UP and resistance in insect species like bollworms, whitefly and borers add another dimension to destabilize food production.

The chlorinated hydrocarbon pesticides on land destroy the soil fauna reducing the productive capacity of the soil.

Birds are most affected because of aerial sprays of insecticides like DOT as their nests and feeding sites are near the field, which are sprayed. Birds pick up food from soil, especially when ground is wet. There is thus an indirect source of insecticides for birds as they feed on burrowing animals like earthworms which take a large amount of soil which has been sprayed with insecticides.

In addition to the fertilizers, pesticides and biocides, soil conditioners and fumigants are also employed to the land system to increase and protect the soil fertility as well as to kill the hazardous insects. These chemical agents are reported to cause alterations in both agricultural and horticultural soil area. They contain several toxic metals like lead, arsenic, cadmium, mercury and cobalt etc. Which when applied to land will accumulate on the soil permanently thereby introducing these chemical components into growing crops. However, research are being carried out to synthesize pesticides of short lived degradable residues so that the persistence of the pesticide residues and their degraded products on soil, food and forage crops may be reduced considerably.

Soluble Salts - Salt accumulation has been a perpetual problem of civilization in arid and semiarid regions. Today a number of industries discharge their particulate, pollutants in the form of calcium sulphate, calcium carbonate, bicarbonates, dirt, dust and as soluble salts. The Untied Nations Food and Agricultural Organization (FAO) states that half of the irrigated farms in the world are damaged by soluble salts deposited in soil. Even the scientists in their attempts to determine water effluents (less water per unit of crop yield) have sometimes increased salt problems, when leaching is too little.

All natural water systems contain dissolved mineral substances commonly referred to as soluble salts. Some rain waters, far from coastal safe sprays, may be very low in salt content. As water flows over and through soils, it picks up salt loads. If water rapidly evaporates as it flows on the surface, it results in increasing the concentration of salt. It actually happened in Colorado River in Western United States. The erosion of salts and return flow of water with salts in them add to the increased load of salt. Deicer slats, salty wastes dumped in lakes, rivers or streams and sea sprays are all the chief sources of soluble salts in soil. Actually salts washed

from one field ends up in ground water or river to be used by someone else. There spreading pollution nuisance.

Food Processing Wastes: These wastes are the outcome of food processing and include potato peels, tomato, peanut, cotton seed, pea-pods, pulp after extracting oils, sugar cane pulp, and wastes left after cheese making, complex mixture of paper and toxic chemicals. These products are organic in nature so can be added to soil, composted, burned or used as animal feeds. Food wastes contain nitrogen, phosphorus and other micro-nutrients and their disposal can result in large nitrate concentration in the soil. Most serious environmental threat posed by food processing waste disposal is that of severe water pollution by nitrogen. If such wastes are dumped into soil or eroded into surface water, they also reduce oxygen in water because of high chemical oxygen demand. Nitrogen and phosphorus contained in wastes cause eutrophication in water bodies which results in excessive growth of phytoplankton and other aquatic organisms. Consequently fish production in lakes or rivers, aesthetic value, utility for aquatic sports and other uses get considerably reduced. However, chemicals employed to treat these food processing wastes as sodium hydroxide for potatoes, salts, waste syrups and clean up detergents should be disposed off or added to soil under rigid disposal regulations. Agricultural land containing sugarcane trash is the nuclei of several pathogens, bacteria, viruses and other microorganisms. Now restrictions on its burning, to reduce the extent of air pollution, seriously concern sugarcane growers who customarily burn tonnes of cane leaves in fields before harvest.

Chemical and Metallic Pollutants

A number of industries including textiles, pesticides, paints, dyes, soap and synthetic detergents, tanneries, drugs, batteries, cement, asbestos, rubber, petroleum, paper and pulp, sugar, steel, glass, electroplating and metal industries pour their hazardous effluents in soil and water creating disastrous effects on living organisms.

Today the most commonly anticipated problem is the contamination of soil with toxic chemicals. Well documented constituent include mercury, chloride, nitrate, zinc, iron and cadmium etc. which have significant adverse effects on crop productivity. Mercury behaves as a cumulative poison which has chronically affected the entire planet. This mercury along with iron, cobalt, chromium antimony and selenium has been reported in sewage sludge in North California and U.S.A.

The toxic metals may be absorbed by plants grown in contaminated soil which then accumulate in animals eating those plants perhaps reaching to chronic toxic levels. Most heavy metals become quite insoluble in soil at pH 6 or more. Cadmium, being highly soluble than other heavy metals, is a frequent contaminant. Other metals such as Nickel, Copper, Molybdenum, Zinc are also soluble but to a lesser extent.

Biological Agents

Soil gets large quantities of human, animals and birds excreta which constitute the major source of land pollution by biological agents. Digested sewage sludge as well as heavy application of manures to soils without periodic leaching could cause chronic salt hazard to plants within a few years. In addition to these excreta, faulty sanitation, municipal garbage,

waste 1 water and wrong methods of agricultural practices also induce -' heavy soil pollution. Sludges do have faults as they contain enough live viruses and viable intestinal worms. In developing western countries, intestinal parasites constitute the most serious soil pollution problems. The pathogenic organisms that pollute the soil may be classified into three categories as follows.

I) Pathogenic organisms occurring naturally jn contaminated soil: Soil has its own distinctive flora and fauna i.e. it is inhabited by bacteria, fungi, algae, protozoans, actinomycetes, nematodes, rotifers, earthworms, fungi, molluscs and anthropods etc. These organisms are important agents in increasing fertilizers and organic matter to water. One report suggests that 80% of phophorus and 73% of nitrogen loading of surface water are brought from eroded soils. Crop land erosion accounts for one third of these (27% phosphorus and 24% nitrogen) chemicals. Due to siltation of river beds in Ganga, Yamuna, Ghaghra, Gomti and Kosi etc. these rivers have become menace during every rainy season. Kosi river has become notorious due to sudden changes in its course. Ultimate sedimentation results in drying of rivers and lakes etc.

Slow removal of soil is caused by the erosion of loose and unconsolidated material as well as parent rocks. Accelerated erosion refers to the increased soil erosion caused by man's activities due to various land use changes. This erosion and sedimentation deteriorate the environment and brings about some catastrophic event also. Human activities such as deforestation, urbanization, industrialization, construction of dams, roads, reservoirs, farming practices and overgrazing etc. enhance such events at alarming rate.

Detrimental Effects of Soil Pollutants

Today ecological changes have a direct impact on living organisms. The environment has deteriorated owing to industrial stress, urbanization, population density and numerous other villains which make the earth as a paradise for infectious agents. Such chronically accumulated environment contaminates our air, water, food and soil etc. thereby severely affecting the health .Nearly 80% of the world's diseases, particularly in developing world can be linked with soil and water. About 90% of the pollution load in river system is due to faecal matter. The soil on which we grow our food is highly polluted by several pathogenic organisms and hazardous industrial effluents. Soil pollution is the result of urban-technological revolution and speedy exploitation of every bit of natural resources.

Mining

In surface mining and strip mining man removes top soil and sub soil. This leaves deep salts in the earth. The uncontrolled mine fires may also destroy the productivity of certain land area permanently.

Soil damage and environmental degradation during surface mining is inevitable as vegetation has to be removed and huge quantities of top soil and waste rocks are to be shifted to a new location. Mining lead to loss of grazing and fertile land, soil erosion from waste dumps, sedimentation or siltation., danger to aquatic life, damage to flora and fauna as well as water and soil pollution.

A recent estimate shows that in India about 20,000 hectares of land has been degraded from mining and another 55,000 hectares of fertile land was degraded to meet our requirements of bricks. Even open-cast coal mining alone affects seriously 2,00,000 hectares of land area. It is reported that 73% of the blocks identified for exploration by CIL and Singereni Coal-fields involved drilling in forest areas.

Mining have also resulted in displacing a large section of people from their resources base. Since the mines are mostly in forest areas, they severely affect the symbiotic relationship existing between tribes and forests. Mining activities cause ecological damage and affect natural bio-diversity leading to erosion of environmental richness. Mining would result in high evolution of carbon dioxide, enhancing green house effect, acid rain, global warming and over all climatic changes.

Modified techniques from dig dump mining to continuous system have been adopted recently by western countries along with sequential technique. Promotion of acceptable substitutes and recycling of all metallic wastes will reduce the potential hazard and will help to achieve sustainability in the long run The methods are not only environmentally efficient, but cost effective also.

NOISE POLLUTION

The word noise is derived from the Latin word, nausea, meaning a feeling of sickness at the stomach with an urge to vomit. It is usually defined as unwanted (unpleasant or disagreeable loudness) sound, or sound without value that causes discomfort to the listener. A particular sound may be musical to one but noise to another, pleasant when soft, but noise when loud. Perhaps a better definition of noise is *"worn sound, In the wrong offensive, persistent or startling sound, in the wrong place, at the wrong time"*, in Law, it may be defined as an *'excessive, offensive, persistent or startling sound'.* Sometimes, even a comparatively low level of sound interferes with human conversation and causes emotional or behavioral stress. It is, therefore, more appropriate to call sound a 'noise' only where it is not liked or wanted by the recipient. Noise pollution, thus, refers to the unwanted sound dumped into the atmosphere leading to health hazards.

With the growing population, heavy traffic and urban crowd, and electrical entertainment, noise has become a new irritant and a source, of environmental annoyance. It affects the physiological and mental health, and reduces job efficiently and enjoyment of life at home. Prolonged exposure to noise beyond decibel (dB) may cause hearing loss. In some cases, it causes fatigue, nervousness, irritability, increased blood pressure, and cardio vascular, respiratory, glandular and neurological disorders. The hazardous effects of noise on plants, animals and buildings have also been noted.

Sources of Noise Pollution :

Noise may be either natural such as thunder or man made. Man made sources may broadly be outlined as follows;

Industrial: Industries of various kinds such as textile, iron and steel, utensils, automobile, fertilizer, paper, ceramics, and thermal power stations are the major contributor of

noise pollution. Noise originates from various machines in connection with crushing of different materials, grinding, drilling, blanching, weaving, boiler making, forging, pressing, and boasting operations.

MARINE POLLUTION

"Marine pollution is the introduction by man, directly or indirectly substances into the marine environment, resulting in such deteriotous effects that harm living resources, hazards to human health, or hindrance to marine activities and reduction of amenities"

Marine Pollutants: The major pollutants associated with marine environment are pathogens, sediments, solid wastes, heat, toxic organic and inorganic, petroleum, nutrients, radioactive materials etc.

The *pathogens include a* wide variety of bacteria, protozoa, viruses and fungi. These are normally found in sewage. They create sickness in either plants or animals within the ocean water itself or human who eat the organisms caught in the water.

The *sediments* deposited in the marine environment effect plant growth by blocking out the light and decreasing photosynthesis activity. Further they will cover up bottom dwelling organisms.

Solid wastes from industry and urban areas discharged to ocean, which has been used as a dumping ground for solid waste causes marine pollution.

Excess heat changes the surrounding conditions and these may be harmful to the organism living in sea. Electric generating plants are the sources of heat.

Toxic includes the biocides, petroleum and industrial chemicals. They discharge into the marine environment and cause pollution.

Petroleum enters into marine environment due to accidents, transfer loss, natural seepage, offshore production disposal of used automobiles lubricants etc.

Nutrients like nitrogen, phosphorus and potassium compounds (called fertilizers) are required by plants. When a nutrient level becomes out of hand, plant grows unchecked so the decaying plants exist in such great numbers that the oxygen supply becomes rapidly depleted. The main sources of nutrients are agricultural run off, sewage effluents, soil erosion and industrial waste).

Radioactive material have been discharged to marine environment by nuclear plants, nuclear fuel reprocessing plants, nuclear power generating reactors, coal burning, weapon testing, mine drainage etc. The storage of these materials pose threat to the health of marine life.

Acidic and basic materials are produced by industries and rupturing of tankers leads to acid or bases introduced into marine system and the element of the marine environment gets affected. The main sources of marine pollutants are marine commerce industry oil spills, power plants, sewage, recreation and coastal construction, agricultural, tourism.

Effects of Marine Pollution :

1. The pollutants of marine pollution lead to the creation of epidemics caused by pathogenic pollutants. Such diseases may be fatal.
2. The introduction of toxic inorganic chemicals and toxic pesticides are harmful to the marine organisms.
3. The oil spills and discharge may damage the biota of marine environment.

Control of Marine Pollution :

1. Maintenance dredging is required to prevent sediment accumulation near the coast.
2. Prevent the disposing of contaminants into the sea.
3. Stop or reduce manufacturing and using many dangerous chemicals.
4. Preventing the oil spill is most essential.
5. Runoff of nutrients from farms has to be reduced by preserving and increasing natural vegetations, wetlands bordering rivers and coasts.

Besides solid waste pollution, sewage, clean up of coastal ocean areas etc are other measures to control marine pollution.

THERMAL POLLUTION

The term thermal pollution has been used to identify the detrimental effects of heated discharges. It denotes the impairment of the quality of environmental air or water by raising jts temperature. The discharge of hot trade effluents from industries and mills and large volumes of warm cooling water from electricity generating stations may cause a temperature rise of several degrees in a river, lakes or lands, cause thermal pollution. Hence, the thermal pollution may be defined as *"addition of excess of undesirable heat to water that makes it harmful to man, animal or aquatic life."*

Sources of Thermal Pollution

The power plants, cooling towers, industrial effluents and domestic sewage are the major sources of thermal pollution. Of these nuclear power plants and thermal power stations constitute the major sources of thermal pollution of rivers and lakes. The discharged water from the above has a higher temperature. This result in the rise of steam temperature to a level at which natural dissipation of heat will be in-sufficient.

Apart from power plants various industries like textiles, paper and pulp, sugar mills etc release heat in water. Another contributor to thermal pollution is domestic sewage. It is usually discharged into rivers, lakes or canals with or without treatment. The sewage normally has higher temperature than the receiving water. The rise in temperature will have a profound effect on water quality and aquatic life.

Effects of Thermal Pollution

The effect of thermal pollution is mainly on aquatic and water quality. Rapid temperature changes produce thermal shock and sometimes death.

As water temperature rises, the concentration of dissolved oxygen gets diminished and the sensitivities offish to the change vary. The temperature rise causes rise in metabolic rates

which implies that an animal will need more food. Higher temperature also results in faster growth rates and shorter life spans.

Thermal discharges are favourable to bacteria and pathogens as well. Higher temperature influences the physical and chemical properties of water, e.g. Density, salinity, cooler etc. These effects on aquatic life pathogens attack fishes and a massive fish kill oceans.

Thermal pollution also affects urban areas. The weather in cities gets affected.

Control of Thermal Pollution

Using artificial lakes or cooling ponds, cooling towers and improved electric generating plants can solve the problem of the thermal pollution.

1. Artificial lakes are the man-made bodies of water which offer one possible alternative. The heated effluents can be discharged into the lake at one end and the water for cooling purposes may be drawn at the other.

2. Cooling towers are able to transfer heat from cooling water to the atmosphere, most probably through the evaporation of water. Evaporative cooling towers are mainly of two types a) Natural draft towers and b) Mechanical draft cooling towers.

In Natural draft towers hot water is sprayed through a rising current of air. The water vapour gives its heat to the counter current air and gets cooled. The cooled water is collected at the bottom and returned to the water body.

In mechanical draft cooling towers airflow is forced or induced by fans, Hot water, during its passage to the water course gets cooled by the action of air.

Thermal pollution could be drastically reduced by direct conversion of the heat into electricity. Another method to reduce thermal pollution is to use water heat for a number of purposes which will simultaneously help to conserve our fuel resources e.g. heating of buildings, heating swimming pools, desalination, aquaculture and warm water irrigation.

As our future generation will need more and more electricity, pollution problems will continue. In future, this problem can be alleviated by improving the efficiency of the electricity power generating plants.

NUCLEAR HAZARDS

Nuclear hazard occurs due to radioactive pollution. Radioactive pollution is caused by radioactive substance, which is the result of human activities.

E.g. Radiation can be defined as *"Energy given off by nucleus of an atom in the form of particles or rays".* In other words *"Hadiation is a physical phenomenon in which energy travels through space".*

It occurs naturally in radioactive elements present in rocks, water, air and in all living organisms. Recently the man-made radiation has increased and can be expected to increase further. Man-made radiation includes radiation from X-ray machines, radioactive fall out, nuclear reactors, research laboratories, industrial and medical uses etc.

Sources of Radiation

Sources of radiation in the environment are partly natural and partly man-made.

The natural sources are,

1. Cosmic (Solar) radiation from the outer space reaching the earth's surface i.e. infra red rays, X-rays, ultra violet rays etc.

2. Terrestrial Radiation from natural radioisotopes present in the earth crusts e.g. uranium and thorium. **The man made sources:**

1. Radiation from medical and dental exposure e.g. X-ray.

2.Radiation from television sets, radium dial wrist watches etc.

3. Radiation from nuclear power plants.

4. Radioactive fall out from nuclear weapons.

5. Dumping of nuclear waste into disposal site.

The above sources are contaminating air, water, and land by radioactive liquid nuclear wastes. They can pollute the atmosphere, soil and ground water. Also it can get into the food chain and through it reach animals and human beings.

Effects of Nuclear Hazard :

Prevention and Control

Monitoring of radiation is very necessary for the control of radiation. For this, sampling as well as its proper analysis is necessary. The samples of air, water and soil have to be collected regularly and their analysis done to know the level of radioactive pollution and for its control.

The industrial wastes having radioactive elements have to be discharged after proper treatment. The high activity wastes should not be discharged.

The emission of radioactive pollutants should be controlled e.g. uranium mines and nuclear reactors.

There is a need to control radiation hazard for workers and officials working in reactors or other places having danger of radioactivity. Also it is required to keep clean to protect from radiation effects and health care of workers.

Personnel at power station must be trained in radiation protection and radiation hazard control measures.

Disaster Management

Instantaneous damage on a large scale to the community due to natural catastrophes is called disaster e.g. Earthquakes, Volcanoes, Cyclones, Flood, Land catastrophes slides, Fires, etc. Every year nature kills thousands of people and cause property damages.

Earthquakes

An earthquake - a sudden motion of the earth caused by an abrupt release of slowly accumulating stress - is a potent natural hazard. Although more infrequent than other types of natural disasters, an earthquake can cause devastation and loss of life on a scale far greater than any other individual natural hazard and is, therefore, generally regarded as the most destructive of the various forces of nature.

Seismic activity is well monitored and documented throughout the world by a number of national and international recording networks. Comprehensive listing of seismic events are held by several agencies such as the International Seismological Centre (ISC) in Newbury. UK and the National Earthquake Information Centre at the World Data Centre in Boulder, Colorado, USA. Much research has also been conducted on areas particularly prone to earthquakes with a view to improving predictive capabilities. Over the year, earthquake prediction on a scientific basis is making slow but steady progress (Tyler, 1990).

At least 35 countries face a high probability of being struck by earthquakes (NASA, 1987). Although there are thousands of relatively small earthquakes around the world each year, it is those of magnitudes 6-8 on the Richter scale which generally cause the greatest damage.

An earthquake is a sudden vibration and shaking of earths crust. It is one of the destructive phenomenons of nature. They cause damage to buildings, bridges, towers, roads, dams, telephone wire and cable, power supplies etc. They cause severe fires in houses, mines and factories due to short circuits, land slides, avalanches and debris fall causing damage to settlements, transport system, farm etc. Sometimes sesonal waves are also causing great loss to life and property near the coast e.g. Tsunamies in Japan, India and Indonesia.

Management of Earthquakes

It is not possible to stop the occurrence of earthquakes. But it is possible to minimize the loss of life and property. The following precautions are to be taken during earthquakes.

1. Using **Scisuno** graphs for the observation of Scisonic waves.
2. Observing rustlers movement of some birds animals before an earthquake,
3. Sudden appearance or disappearance of springs can be symptoms of the occurrence of earthquakes.
4. Strengthen old and weak buildings, use bamboo's cardboard and other light materials for houses.
5. Remain in the building until the tremors stops.
6. Stand in the doorway against the wooden window.
7. If you are near the table/bed, then get under a table/ bed.
8. Stand against a wall provided it has no shelves,
9. Turn off electric connecting, gas, and water. 10, If you are driving a vehicle, stop it at a vacant place, come out of the vehicle and stand in the open space.

Cyclones

Winds blowing spirally inwards into regions of low pressure in the center are known as "Cyclones" these are better known as depressions center of low pressure surrounded by high presence. They are one of the natural hazards.

Huge loss of life occurs along with devastation of habitation and agriculture. They cause wide range of environmental stress for rural and urban communities. They leads to torrential rains, floods and structural damages to buildings, transport systems, water and power

supply, disruption of communication system, destruction of crops, domestic and wild animals, natural vegetation etc.

The prevention and control of cyclones is not possible. But, precautionary measures can be taken due to loss of life and property. Effort should be made to forecast the origin and travel paths of cyclones. Advance monitoring and prediction of this disastrous cyclone at least a week earlier is necessary. For this purpose weather forecasting or meteorological stations or disaster warning systems should be developed. Recently weather satellites (weather water) and weather Rador have been successfully placed in space, which are useful for the collection of data, observation and information of cyclones and weather phenomena. India has set up more than 100 disaster warning system and 'INSAT B' etc. which provide important information about the distance cyclones.

Floods

An unusual accumulation of water above the ground caused by high tide, heavy rain and melting snow is called flood. Generally, floods are considered to be associated with rivers and people. Flood is one of the natural hazards. They damage natural environment, loss of human lives and property.

Causes:

1. Excessive heavy rain-falls and surface runoff.
2. Meandering courses of rivers.
3. Extensive flood plains,
4. Break in slope with long profiles of the rivers.
5. Blocking of free flow of the rivers
6. Nature of river valleys and channel etc.
7. Large scale deforestation in upper course is the most important factor of the river floods.

Effects

Flood damages crops, roads, railways, bridges, houses, loss of lines and creates soil erosion.

Flood Management:

The flood is natural phenomena and one cannot entirely get rid off them, but their impacts can be minimized by man's technological skill, better measures adopted by the government.

Flood control measures include a series of steps to tame the rivers

1. Flood reduction by treating watershed slopes. Large-scale aforestation and forestation in the hilly source of forests delay the return of rainwater to the river.

2. Reduce the volume of water during flood stage. This can be done through the construction of flood control storage reservoirs. Collected water in the reservoir can be used for many purposes, e.g. Irrigation, hydel power, drinking water, in-land fishing etc.

3. Divert the flow of water. Simply diversion of floodwater in low-lying areas, depressions or artificially constructed channels.

4. Embankments, dikes and floodwalls are used to confine the floodwater within the valley.

Tsunami

Tsunamis, or seismic sea waves, are large ocean waves generated by impulses from geophysical even occurring on the ocean floor or along the coastline, such as earthquakes, landslides and volcanic eruptions. Mostly occurring in the Pacific Ocean tsunamis, although hardly noticeable at sea, can reach gigantean proportions as they reach shallow, coastal waters. In Hawaii and Japan, for example Tsunamis have been known to reach 30 m in height. At least 22 countries along bank of the Pacific are estimated to be at risk from potential tsunami (NASA, 1978)

The fact that tsunamis can travel 10,000 km at velocities exceeding 90 km per hour with little loss of energy and are therefore capable of hitting areas not directly affected by the inducing event has led to the establishment of a tsunami early warning service for the whole circum Pacific area (Munich Reinsurance Company 1988). However, only a few of the 22 countries most at risk are considered to have standard. operating procedures for immediate evacuation or reliable rapid communication system capable of receiving real time warnings from the pacific Tsunami Warning Centre.

About 6,000 people have been killed by tsunami in the last decade alone (NASA, 1987). Probably the best documented of these events is the occurrence at Noshiro, Japan in 1983 which caused approximately 100 deaths and extensive property damage and flooding.

Windstorms

Judged by the frequency with which they cause damage and by the surface area of the regions they strike, windstorms can be said to be most significant of all natural hazards (Munich Reinsurance Company, 1988). Windstorms influence precipitation system, floods and most importantly, cause severe destruction to crops and properties. Severe tropical cyclones (called "hurricanes" in the Atlantic, Caribbean and northeastern Pacific. 'Typhoons" in the Indian Ocean and in the sea around Australia). Tornadoes, monsoons and thunderstorms between them affect every country in the world.

Today, increasing attention is being paid to windstorm particularly tropical cyclones as some scientists see their incidence as being a possible indicator of global climatic change and predict an increase in their frequency. Have tropical cyclone frequencies or their intensities increased with global changes throughout the last century? At present, available evidence does not support this idea, perhaps because the warming is not yet large enough to make its impact felt (WMO/UNEP, 1990).

Global information on Kanor windstorms and their impact is collected by organizations such as UNDRO, UNEP and AID/ OFDA. However, global listings of disasters rarely include those which occur in small states such as island states. Caribbean, Indian Ocean and South Pacific, are particularly prone to tropical cyclones (Lewis, 1990). This is because listings often

set criteria based on magnitude o' impact with which small states can not compete against larger countries. However, the proportional impact upon small states is often far greater in terms of population, housing and economics.

Volcanoes

An active volcano occurs where magma (molten rock) reaches the earth's surface through a central vent or a long crack (fissure). Volcanic activity can release eject (debris), liquid lava and gases (Water vapour, Carbon, Sulphur dioxide, Nitrous oxide etc) into the environment.

Land use planning, better prediction of volcanic eruptions and development of effective evacuation plans can reduce the loss of human life from volcanic eruption. The prediction system related to volcanic activity has improved considerably during past few decades.

Natural Environmental Hazards : Concern and Management

Natural events occur suddenly and swiftly and consequently cause severe damage to the society and surrounding environment. Such natural events can't be prevented from occurring but their impacts can be reduced if effective measures are taken to reduce their severity, frequency and possibly size. The hazard coping measure includes planning for disaster preparedness based on appraisal of the magnitude of risks in the past and those anticipated in the future. The preparation of hazard zoning maps is the first prerequisite of these measures. These maps require not only identification of vulnerable zones and sites of past occurrences and of predicted future events, but also an estimation of the actual danger to the settlements, communication systems and essential supply lines. In addition, on the basis of these maps, the geologists investigate ways in which the intensity of the anticipated event could be moderated.

The rising of mountains, their subsequent erosion almost to sea level, the drifting of continents and the continuous motion of the earth's lithosphere plates are among the planet's largest scale phenomena but they usually take place so slowly on the human time scale that they are not generally regarded as threats to society. But much lesser events like earthquakes, volcanic activity, floods, storms and landslides do put people and property at risk, because they usually occur suddenly and often unexpectedly. Earthquakes, storms, or floods of various kinds are the major killers, but volcanoes and landslides are serious hazards too. Earthquakes, volcanic eruptions, landslides, tsunami, hurricanes, tornadoes, floods and wildfires killed more than 2.8 million people over the period 1968 to 1988.

Natural Hazard Management;

The strategy for hazard mitigation embraces measures to reduce if not climate the probability or frequency of occurrence and intensity of impacts. It may be emphasized that individually or severally any one measure taken can never be effective. Only the combination of measures can be undertaken for abatement of Natural hazards.

Table: Some of the major digesters on earth

Hazard	Mitigatory measures
Earthquakes	Reduction of damage by avoiding the earthquake zones for settlement and construction of development structures. Prediction of earthquake ahead of time to reduce the damages of properties. By proper land use planning and good construction, the effect of earthquake may be minimized.
Volcanism	Evacuation of population from volcanic prone areas even after the eruption has just started.
Cyclone and storm surge	Forecasting and warning of possible hazards of probable cyclone hit areas. Temporary evacuation of population from affected sites. Maintain and preserve barrier islands and coastal wetlands. Construct and maintain break waters and flood walls as physical barriers.
Flood	Construction of barrages, dams and also implementation of proper watershed management schemes. Forest denuded areas Manage watershed to minimize erosion. Construct and maintain flood walls as physical barriers. Emergency flood control measures.
Landslides	Curtailment of human activities in landslide zones. Reforest the denuded areas. .educe, prevent or control infiltration and erosion.

Watershed Management

Watershed management is an approach of area planning of natural resources specially land, water and plants for the socio-economic need of human society and community concerned. It provides a systematic way for integrated development in any given area. It involves the exploration and development of the complex interrelationship between the resources of watershed and the people of the area. Watershed would permit maximum possible stability through the process of production, consumption and regeneration. Conservation programs for a natural resource to sub serve primary production on the basis of watershed are being implemented throughout the country. Although watershed has been in existence since long time, it became popular in eighties when large number of model watersheds under the edges of National Watersheds, Ministry of Agriculture, and Government of India in 1987-88 launched National Watershed Development programme for Rain fed Areas (NWDPRA). Since then a massive national watershed programme to improve and stabilize the agricultural

production system for rain fed areas have been taken up in different agro-ecological zones. A total area of 9 million ha has been treated through watershed management programme implementation.

Important flood control measures include maintenance of watershed, construction of embankments (levees) and dams, diversion of flow, dredging of river basin, and preventing human encroachment of flood plains. Watershed should have sufficient vegetation cover, which will impede the flow velocity and hence will help in flood and erosion control. Construction of embankments is the cheapest of any of protection from floods. These are the dikes constructed earths, stone, or mortar that are built at some distance from the river bank so as to protect valuable residential, industrial, and agricultural property from flood-water. Earthen embankments should be spaced sufficiently away from the river margin, as they cannot stand the velocity adjacent to the banks. Dams have been used to check surging river waters and make efficient use of it since long before the Christian era. The ruins of many concrete dams built by Romans in N. Africa and Italy many centuries ago may still be seen. Dams, in addition to providing flood control, are also useful in generation of hydropower, and providing irrigation, navigation, and recreation facilities. However, for effective flood control it is necessary to frequently discharge the water from such reservoirs so that it retains a greater capacity to accommodate floodwaters. In addition to high cost of construction, the negative features of dam construction include their siltation-abbreviated life span and inundation of acres of once fertile agricultural land. Scientists are of view that several smaller dams on headwater tributaries would be less expensive than one big dam downstream and equally effective in flood control. Diversion and floodways take a part of floodwaters to another basin or to a depression where it could be stored for use or disposal, and consequently reduce the flood discharge in the main river. Some areas in Gurgaon district of Haryana, northen part of Bharatpur district of Rajasthan, and part of Mathura district of Uttar Pradesh used to be flooded for long periods in the monsoon months due to inadequate drainage system. A drainage improvement project completed in the year 1967 benefited 29,000 ha areas in these regions. River channels tends to accumulate huge deposits of soil that are washed into it from the surrounding watershed. Mississippi river, for instance, transports about 2 million tons of silt daily. To correct this problem it is necessary to dredge the river channel periodically, which will reduce the probability of flood and provide better navigation.

It is true that man cannot prevent all floods but at least can prevent lesser ones and reduce the magnitude and damaging powers of others.

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CHAPTER 6

SOCIAL ISSUES AND THE ENVIRONMENT

SOCIAL ISSUES

From birth to death of man on earth, his activities are related to social issues. Social issues incorporate family, associations, institutions and communities. The society is the web of social, relations and man is a social animal. Man can't detach himself from social issues of life. While living in a society, he has to perform many socio-economic activities such as industry, agriculture, transport, building of roads and houses. These activities bring about environmental degradation of water, soil, air, etc. Therefore, the protection of the environment is an important issue of the day. There should be development without causing pollution of the environment. Both these cannot be achieved simultaneously. However, the real aim of socio-economic development should be not only in producing and amassing (collecting) material and non material things bui in having things along with a clean and pollution free environment.

Urban Problems Related to Energy :

Energy use particularly the use of energy from fossil fuels v has the most significant impact on environmental quality both xy'and beyond city borders. It can deplete non renewable resources and produce emissions that contribute to smog and other local environmental problems, such as climate change.

The production of energy namely, fossil fuel production and power generation consumes a significant amount of energy. One quarter of all energy used and produced more than one third of green house gases {GHG) emissions. This emission can be reduced, however, through the adoption of more sustainable forms of energy production suited to an urban environment, such as community energy systems. Because there are little or no data to indicate what share of energy is produced in cities, point source emissions from energy production are not considered to be a characteristically urban environmental issue, and therefore did not fall within the scope of the Task Force's work. Industrial use (including both building related energy uses and energy used for industrial processes) accounts for the largest share of energy use.

Transportation is the next most significant sector, accounting for 22% of primary energy use and 29% of GHG emissions. The residential and commercial sectors (the latter includes offices and institutions) accounts for 13% and 9% respectively of energy use, and 9% and 5% respectively of GHG emissions.

Water Conservation

Water serves not only to quench the thirst but also to meet the food requirements because it is an essential raw material in the process of photosynthesis through which green plants make food that is used by all trophic levels directly or indirectly. Ambient humidity which is indeed the invisible form of water that surrounds us is necessary to prevent desiccation of terrestrial life forms. Thus, it can be said that water is a biological essential and it serves as milieu internal as well as milieu external.

Flood plains of rivers have been the cradle of civilization and centres of population since ancient times. The reasons being their high fertility and easy accessibility to water for various uses like drinking, washing, and transport. Egypt was developed on the flood plains of the Nile, Babylon on the flood plains of the Tigris, and north India on the flood plains of the Ganges. Even today the Mississippi plain is the most densely populated area in USA as well as flood plains of the Rhine in Europe, and the Yellow river in China.

Water influences the global ecology. Covering about 70% of land surface and circulating in hydrologic cycle water influences weather and climate of any region and thus its flora and fauna. Agriculture has come up as a very potent industry. It requires rainfall, surface or ground water irrigation. It eventually is more important commodity in a country like India because of her largely agrarian economy which depends critically on water. Huge amount of protein rich food in the form of fish, shell fish, and prawn is obtained from inland as well as sea waters world over.

The kinetic energy due to the gravitational flow of water is tapped and transformed into electricity, known as 'hydropower'. This concept of electricity generation is one of the oldest and cheapest tricks largely used world over. Moreover, there is no pollution burden on nature as in the case of thermal or nuclear power generation.

Hardly any industry can do without water. It has multifarious applications in industrial processes viz., used with a raw material, solvent, chemical reactant, coolent and as cleaning agent.

Water everywhere but not any drop to drink is the situation not only found amidst sea but also at places where industrial and domestic refuse make the benevolent water sources so severely contaminated with pathogens and or toxins that they are left un potable. Being the best dilution medium, it is frequently used as the cheapest and convenient way for liquid and solid waste disposal. Further it is practically impossible to maintain sanitary conditions without water as it is needed in all common cleaning and washing practices.

Water being unevenly distributed over the land, influences interstate and international relations and thus is the cause of what is known as hydro politics.

In can, therefore, be said that while water is essential for life it is significantly linked with social, economic, political, and ecological intricacies.

Management of Ground Water Resources

The degradation of ground water quality and depletion of ground water resources are emerging as major problems. The ground water resources in arid region have four major problems.

1. 65 per cent area has saline ground water with total soluble salt content over 3200 ppm.
2. Deep static water level.
3. Poor yield from wells.

4. Due to over exploitation of ground water resources, in any parts of the re9'on the static water level started declining, soluble salt contents have increased and yield reduced.

Replenishment of ground water can overcome these problems to a considerable extent and should form the vital component of any management plan. This requires harvesting wasteful runoff by large scale water conservation measures and artificial recharging the over exploited aquifers. Following methods are available for artificially recharging the aquifers :

1. Water spreading
2. Recharging through pits
3. Wells and shafts
4. Pumping to induce recharge from surface water bodies.

The concept of recharge (donor) and recharged (receptor) zone for development of ground water resources has been introduced. The recharge zones are hills, upper rocky or gravelly sediments, riverbeds, sand dunes and undulating sandy alluvial plains. The recharged zones are younger alluvial plains, older alluvial plains, filled valleys, interdune plains, lower rocky or gravelly sediments. But these should not be utilized for ground water exploitation but should be used for recharging the adjoining recharged area using the methods like trenching, pitting, bunding and flooding.

Problems of Water Management

Management of water implies making the best use of available water resources for human benefit. While not only preventing and controlling its depletion and degradation but also developing it in view of the present and future needs. Water, like forest, is a multipurpose resource and it is as important to see that its various uses should not conflict with each other and can be enjoyed in its totality by man and others. Thus, right allocation, and quantitative and qualitative conservation are the primary tasks before water managers. Floods, droughts, improper use, pollution and disease transmission are the important problem related to water.

Similarly, an increasing demand of water to meet the basic needs of the people for drinking, irrigation and industries have risen. Over exploitation of water resources has caused continuous threat of desertification to the fragile arid ecosystem. To avert this problem the measures for management of surface and groundwater resources such as prevention of seepage losses from canals and field channels, runoff water harvesting in reservoirs, khadins, nadis, cisterns (tanks), insitu surface water management, suppression of evaporation losses of ground water have been suggested for management of water resources. Water from roof tops, courtyard, and natural or artificial catchments areas can be collected in permanent constructed areas using stones, bricks, cement, and iron sheets with tops cover. This will not only replenish ground water level but control desertification also.

Watershed Management

Watershed is the area of land that catches rain, snow and drains or seeps into a marsh, stream, river, lake or groundwater.

Watershed comes in all shapes and sizes. Some are millions of square miles, others are just a few acres. Just as creeks drain into rivers, watersheds are nearly always part of a larger watershed.

Homes, farms, ranches, forests, small towns, big cities and more can make up watersheds. Some cross country, state, and even international borders can become watersheds.

A watershed consists of all the land that drains water, sediment, and other material to a common point. It is the land elevation that defines a watershed boundary and not the political border. Watersheds are important as the viability of the watershed directly affects the health of the communities within that watershed. Water for human consumption, wildlife, industry and recreation are all impacted by activities that occur within the watershed. Watershed management planning works to protect water resources by empowering local people to provide for the environmental, social, and economic health of the community.

A watershed is a geo hydrological unit, which drains into a common point. It is a project based, ridge to valley approach for in situ oil, water conservation, aforestation etc. and it includes;

a) Focus on village common lands

b) Institutionalized community participation

c) Emphasis on sustainable rural livelihood support system

d) Capacity building as a vital component

e) Committee Systems at the State and District level.

GREENHOUSE GASES AND GLOBAL WARMING

The atmosphere, like the air we breathe, belongs to everyone. When it becomes a limited quantity, such as the extent to which it can be polluted, the only enduring basis on which the limitation be shared is on the principle of an equal share per person on this earth (however the basic assumption here is that development cannot happen devoid of pollution) Any other method that iniquitous (immoral) established on the strength of present power relations, may work for a while, but cannot be sustained for long.

It is this realization that makes several far sighted statement including the environment ministers of Denmarks, Holland and the UK, Britain's Royal Commission on Environmental Pollution and the Chartered Insurance institute of the UK- support the strategy of Contraction and Convergence, by which all countries will be allotted entitlements to pollute based on a single per capita allowance. Here one important fact to be noted is that the per capita energy use is just one tenth of that in the US and one seventh of that in Europe. Every individual (rich, medium and poor) owns a car in America. If these entitlements are permitted to be traded, the developing countries can get substantial resources to expose themselves to cleaner technologies for power and transport and for overall development as well. There would still be the question of ecological debt by way of the past emission of the rich countries that would need to be accommodated to maintain equity.

Emission of 'greenhouse gases' into the atmosphere at the current level, will lead to an unprecedented increase in mean global temperature over the next few decades. To predict

potential increases in mortality due to global warming, the quality, magnitude, frequency, and location of the climatic changes associated with global warming must be known. A World Health Organization Task Group (1990a) admits in the report Potential Health Effects of Climatic Change, however, that the extent and distribution of these changes are not well understood at the present.

The **'Green House"** effect was first described by the French Mathematician. J. Fourier in 1827. It is also called the carbon dioxide problem or the **'global warming'."** The CO2 is considered the most dominant factor responsible for the GH effect.

The Carbon dioxide (CO2) is the major product of combustion and is not particularly harmful. In fact, C02 is a necessary ingredient when it comes to the photosynthetic process (preparation of food by green plants) which as we know is one of the prime factors that sustains life on earth. The problem comes when the balance between CO2 and O2 is not favourable to life. When there is too much CO2 there is a possibility of the so called 'greenhouse effect". This effect maintains that if the CO2 levels on the earth are allowed to are above what is necessary for balance, the extra CO2 'n II form a blanket around the earth and trap infra red radiation Tom escaping the earth's surface in order to cool off the earth after having absorbed the suns rays. The CO2 is a green house g. i.e. it remains transparent for the incoming solar radiation and' absorbs the outgoing light wave infrared radiation. This property of carbon dioxide to absorb the heat energy in the form of infrared rays prevents the heat radiation being emitted to the outer atmospheric layers. This has become an obstacle for the easier 'way out' of these heat waves into the outer atmospheres, instead they are trapped in the surface atmosphere. This phenomenon results in creating 'warming effect' on the surface of the earth with an increase in its temperature. This has been termed as **'blanket' or 'green house'** effect.

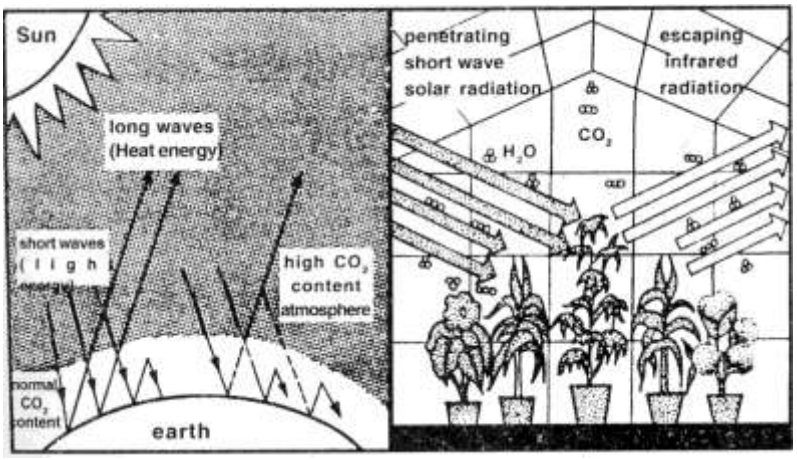

Fig 24: Diagrammatic respiration of green house effect

The effect of global warming has been observed recently to be accelerating. The troposphere or the lower atmosphere contains only 0.033 percent CO2 (by volume) and its amount 18 controlled by a cycle often called the carbon cycle. The major contributors of the carbon dioxide into the atmosphere are the fossil fuels. It was estimated in 1976 that the world consumption about 5000 million tons of fossil fuels per year was contributing the equivalent of 2.37 ppm of carbon dioxide additionally to the atmosphere. A continued increase in world

fossil fuel combustion of future can be expected to produce a further increase of CO2 in the atmosphere (about 340 ppm in 1981). It has been 20% higher in 2000 and in this century it will be still higher given the consumption rate remain the same.

Thus it is widely accepted that during the last couple of decades the fossil fuels may have contributed more C02 to the atmosphere than the terrestrial biosphere and the oceans absorb which is building up in the atmosphere. Forests consume a tremendous amount of carbon dioxide, and thus help control the concentration of the gas in the atmosphere. Clearance of forests is another cause for the increase of this. Thus carbon dioxide acts as a green house gas. Besides this there are three other gases, which account for the global green house warming trend. They are

Nitrous Oxide.(laughing gas): From automobile exhausts and chemical fertilizers.

Chlorofluorocarbons_(CFC's): From spray bottle, propellants and refrigerants and

Methane Gas: From decaying organic matter.

But Carbon dioxide plays the dominant role in producing the new GH effects since its role in the evolution of earth's climate in the past billions years has been identified as crucial. The major greenhouse gases (GHGs), their composition, sources of emission and percentage contribution are shown in Table 1, and pre industrial and 1992 concentrations in Table 2.

Carbon dioxide (C02); The single largest contributor to the global greenhouse effect, is produced wherever fossil fuel /burns. It has been estimated that by mid 1700 the average 7 CO2 level in the earth's atmosphere was 280 ppmv that stood *355* ppmv in 1992 **(IPCC WGI Report, 1994),** and by the middle of 2050, if the current rate of fossil fuel burning continues, it is likely to reach 600 pmmv **(Bach, 1984).** The present growth rate of C02 is 0.5% and its concentration has reached around 370 ppmv by 1998. Carbon dioxide, as a GHG, by trapping heat from the atmosphere warms the earth.

Industrial countries are responsible for this increase of CO2 in the atmosphere. In 1997, the 29 industrialized member nations of OECD countries contributed 53,2% of the total CO2 emission of the world.

Methane (CH4): Is another important greenhouse gas, which C0uld affect the climate of the earth, the level of which is rising alarmingly. It is significant to note that the gas is only about 5% of that of CO2- but is 25 times more effective than CO in producing greenhouse effect. Most methane is produced by natural biological processes such as bacterial action in the gut of cattle and other ruminants, in water logged rice paddies, marshlands and garbage dumps and landfills.

Chlorofluorocarbons (CFCs) constitute the third major greenhouse gas. These versatile chemicals came on the scene only in the 1960s. Since then they have been indiscriminately used as refrigerants, plastic foaming agents, aerosol propellants and cleaning agent. As a greenhouse gas, the CFCs (CFC-11 and CFC12) are thousand times (4000 and £5,000, respectively) more powerful than CO2 but their /atmospheric concentrations are extremely low. CFCs emissions contribute global warming through two different routes: i) firstly, as greenhouse gas like CO2 can trap heat resulting in rise in temperatures, and ii)

secondly, with the destruction of ozone more solar radiations enter and heat the troposphere. Ozone depletion potential and global warming potential of different CFCs is shown in Table 3.

Source: World Meteorological Organizational - Global Ozone Research Monitoring Project Report No. 20: Scientific Assessment of Stratospheric Ozone (Vol. I) 1989. OOP based on 1-D models from AER, LINL, Univ. Oslo and DuPont; GWP based on AER and Duppont Results.

Nitrous oxide (N20): Is yet another greenhouse gas. It is produced by burning of coal, oil and biomass, along with C02. It is also given out by nitrogen based fertilizers in agriculture soil. During the pre industrial period, the atmospheric level of it was 280 ppbv, which stood to 311 ppbv in 1992. The present level is around 330 ppbv and rising at average 0.3 to 0,4% a year. As a GHG, it is 320 times as powerful as CO2.

Some of the measures that can help reduce the production of greenhouse gas:

1. Use of energy source that does not produce CO2 like solar and wind energy.
2. Replanting of forest.
3. Adopting means of transport which do not use fossil fuel etc.

Global Warming

Contribution of different GHGs on global warming has been evaluated very recently. CO2 shares is as high as 61 %, methane 15% CFCs 11 % Nitrous oxide (N2O) 4% and others 9%. There 15 been continuous build up of greenhouse gases in the has cohere This caused rise in global temperature that increased from 13.84°C in 1950 to 14.57°C in 1998. Given current trend of increase in concentration of GHGs, CO2 in particular, it may warm the earth by another 1°C to 3.5'C by 2080.

The threat to developing countries in the tropics and sub tropics is apparent. Rising sea levels will displace tens of million people in small and low lying delta areas of Bangladesh, Egypt and China. Coastal wetlands are sensitive to climatic changes. Wetlands in the western coasts of Central and North America may be lost.

Climate Change:

The changing climate poses the greatest challenge facing 'humanity today. There is certainly a limit for our ability to adapt ourselves to the fast changing climate. This change in climate is the obvious result of our intervention with the environment. The question who is (which nation) responsible for this harmful effect, is unwanted when effort is to be made for a way out. The increase in the global temperature is no joke. It becomes still more serious when awareness is developed that the developed countries have contributed the most. Every where there are only "Devel's alternatives". Nations must find a way to work with each other, sharing the resources equitably and quickly to make a sustainable selection of these alternatives. Andrew Kerr of the World Wildlife Fund has made genuine analysis that "the United States is responsible for almost half of the increase in world carbon dioxide in the past decade. It is greater than the increase in China, India, Africa and the whole of Latin America." This fact probably directs us to decide our future actions to be taken. The world has reason to be worried. Climate Change is the most serious and most difficult environmental challenge that faces

humanity today, and USA, with just 4% of the world population is responsible for 25% of the current release and close to 35% of the historic release '" the last 150 years, of the major pollutant, carbon dioxide (CO2) which is the principal among all the Greenhouse Gases

(GHGs) that cause global warming in the atmosphere. It js a fact that the developed industrialized countries accounted f0 80% of all man made GHG emission till they reached their present 'luxury zone'. But this was not the case with developing countries. They needed to increase their 'survival emissions" which was needed to achieve economic growth and to reduce poverty. To keep pace with the developed countries was no joke. Even to reduce the gap between themselves & the industrial countries (let alone close the gap), there was no other go but to ride on the back of the carbon economy. Even though the UN Framework Convention of Climate Change (UNFCCC), Conference decided that the developed countries "should take the lead" by "aiming" to return to the 1990 levels of GHG emissions by year 2000 (has not in the absolute sense happened even after 2000+++). It was a landmark conference that took place in 1997 at Kyoto in Japan' that finally decided on binding commitments for the industrial countries to reduce their GHGs. The non industrial countries were exempted at this first stage, Even this was like an eyewash because of major loophole called 'flexibility mechanisms' by which industrial countries could trade in emission with each other and implement emission reduction projects in developing countries, to claim against their own emission targets. It is a pity that the focus here is on trading emissions and claiming credits, not on curing the emission, which is the real need for environmental safety. It is obvious that the earth can take only so much more C02 into the atmosphere for safety and this limit would largely be used up by the industrial country 'entitlements' leaving very little to the developing countries when it becomes their turn to take on binding commitments.

Effects of Global Warming on the Global Climate

Weather has an extraordinary influence on human health and well being. Climatic parameters historically have been a major determinant in the survival and development of human populations. To cope with harsh climatic conditions people have modified their exposure through behavioral changes and adaptations, in some places, such as high altitude regions, people have developed advantageous physiological changes over long periods of time, Whether or how quickly populations might also acclimate to increased temperatures from global warming, however, is unclear. Several studies examine the excess mortality associates with seasonal temperature variations and prolonged periods of high temperatures, referred to as ‘heat waves'.

Many authors agree that the primary impact of global warming on human health will not be direct. The impacts are likely to be the result. In addition to frequently mentioned effects, others include heat stress and vector borne diseases, allergic diseases, developmental effects, malnutrition and associated infectious disease, and health problem related to overcrowding.

In the Greenhouse Effect, scientist have predicted that, as result of this increase in\ temperature, an array of environmental changes, such\as sea level rise, flooding, U9ht, and increased frequency and intensity of some weather extremes may occur. The potential for

direct and indirect health effects from global warming will depend upon how, where, and when such weather events will take place.

The increase of the earth's surface of just a few degrees could result in the melting of the polar ice caps resulting in a significant increase in the coastal sea levels. Coastal cities like New York, Los Angeles, and San Francisco would be inundated with water. Weather patterns could undergo significant change converting temperate climates to tropical ones. This would have an adverse effect on growing areas and could result in the increase in the rate of the desertization process (the creation of desert). The Great Sahara Desert was at one time a lush green valley. The food chain would be severally disrupted.

The infrared absorption properties of carbon dioxide have tremendous importance in deciding global temperature. The air today contains about 25% more of the CO2 than it did in 1958. Environmentalists predict that by the middle of this century, the resulting warming could boost global mean temperature from 3 (in 1958) to 90° F.

Such a global rise in the temperature is rightly termed as 'global warming'

Causes of Global Warming:

- Summers which are hotter, drier?
- Deserts getting expanded while the increased temperature shrinking rivers and lakes, (due to evaporation)
- The partial melting of polar ice caps causing an increase in sea level from 1 to 6 feet. Thousand square mites of coastal land would be flooded. The homes of an estimated 25 to 40 million people worldwide would be threatened with inundation. By AD 2050, 15% of the arable land in the Nile delta in Egypt would be lost. Beaches, estuaries would also be destroyed.
- Higher water temperatures contribute to the swelling of the world's oceans, since water expands as it gets warmer.
- Unmitigated climate change due to increasing greenhouse gases would have global consequences such as adverse impact on crop yields and water resources.
- International food insecurity triggered by drought, flooding of land caused by Sea level rise.
- Migration of peoples due to environmental changes etc. become inevitable

Climate change due to global warming may also result in the spread of vector borne disease. Here is a brief description of the disease and how it is a consequence of the global warming. Vector borne disease is one in which the pathogenic microorganism is transmitted from an infected individual to another individual by an arthropod or other agent, sometimes with other animals serving as intermediary hosts. The transmission depends upon the attributed and requirements of at least three different living organisms: the pathogenic agent, either, a virus, protozoa, bacteria, or helminthes (worm); the vector, which are commonly arthropods such as ticks or mosquitoes, and the human host. In addition, intermediary host such as domesticated or wild animals often serve as a reservoir for the pathogen until susceptible human populations are exposed. Weather affects vector population dynamics and disease

transmission. Temperature and humidity are considered as key variables. Only recently researchers have attempted to predict how climate change might affect the distribution of vector-borne diseases. A comprehensive model should consider both the direct impacts (such as changes in temperature or rainfall) and indirect impacts (such as changes in hydrology or agriculture) of global warming on the agent, vector, intermediary host, and the human host.

ACID RAIN

Sulphuric and nitric acids are the two main acid principles evolved in acid rains. It is already seen that smelting plants and motor vehicle exhaust produces the oxides of sulphur and nitrogen. These oxides are swept up into the atmosphere through tall chimneys, which may be 400 meters high and can travel thousands of kilometers before returning to the earth. The longer they stay in the atmosphere the more likely they are to be oxidized into sulphuric and nitric acids, which then dissolve in water in;-the atmosphere and fall on the ground as acid rain (or snow), or I may remain in the atmosphere as clouds and fogs

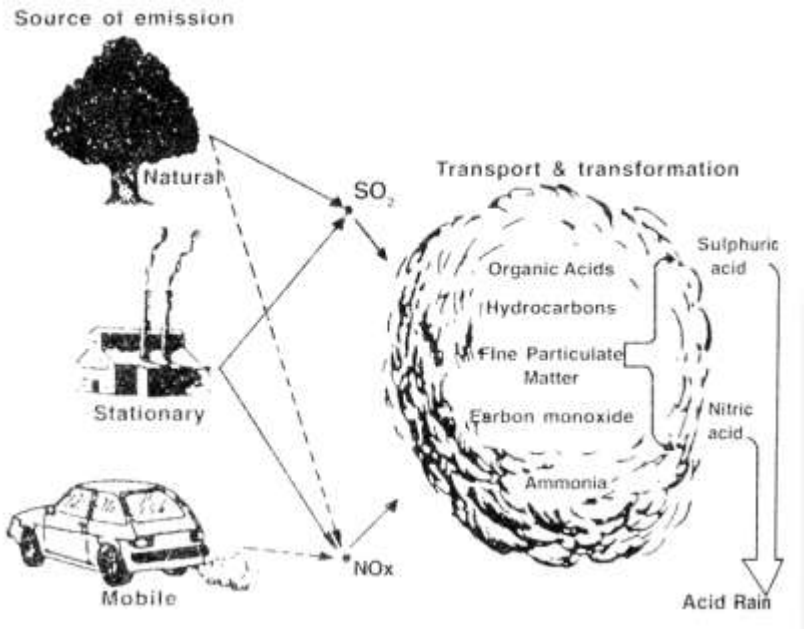

Fig. 25 Showing the Acid rain formation

Acid rain has been observed to cause a number of adverse implications. It increases acidity in the soil, threatens human and aquatic life and destroys forests and crops reducing agricultural productivity. Besides, it also corrodes buildings, monuments, statues, bridges, fences and railings that cost the world 1,450 million dollars a year.

Acid rain was first noted in Sweden and Norway in 1960's.

Ozone Layer Depletion

Ozone deplete is a chemical that destroys the ozone in the tratosphere. Most ozone depletes are chemically stable compounds containing chlorine or bromine, which remain unchanged for long enough to drift up to the upper atmosphere m a cocktail of more active substances which then react with ozone, causing its depletion. The best known are chlorofluorocarbons (CFCs) but many other ozone depletes are known, including halons used in some fire extinguishers, methyl chloroform, and carbon tetrachloride, both solvents, some

CFG substitutes, and the pesticide methyl bromide. Most research into alternatives to ozone depletes seeks chemical alternatives, which will break up before they get into the upper atmosphere, but still have a useful working life as a refrigerant or propellant.

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CHAPTER 7

HUMAN POPULATION & ENVIRONMENT

"Humanity's impact on the earth has increased extinction rates to levels rivaling the five mass extinction of past geologic history, transformed nearly half of Earth's land and created 50 dead zones in the world's oceans" Environment News Service.

Human Population is a factor in any society, which has the potential to lay its impact strongly on all other systems in the society. In this unit, you will be learning the growth of population, how it varies with different nations, the impact of population explosion on the welfare of the families, how the population affects the environment and human health along with the role of Information Technology in environment and human health. The unit also deal with the role of human rights, value education, and prevention of HIV/AIDS. Women and child welfare programmes etc on controlling population explosion.

Population Growth and Variation

Population is a term referring to the total human inhabitants of a specified area, such as a city, country, or continent, at a given time. Population study as a discipline is known as demography. It is concerned with the size, composition, and distribution of populations; their patterns of change over time through births, and migration; and the determinants and consequences of such changes. Population studies yield knowledge important for planning, particularly by governments, in fields such as health, education, housing, social security, employment, and environmental preservation. Such studies also provide information needed to formulate government population policies, which seek to modify demographic trends in order to achieve economic and social objectives. Demography is an interdisciplinary field involving mathematics and statistics, biology, medicine, sociology, economics, history, geography and anthropology.

Having reached 6 billion in 1999, human population continues to grow by more than 75 million people annually According to the United Nations Population Fund's projection world population could grow to between 7.9 billion and 10.9 billion by 2050- a range that suggests broad possibilities influencing population growth.

However any educated person in any developing countries if asked to make a list of the top 5 or 10 problems facing (the world, in developed countries would include "over population on the list. It indeed sounds like a bomb threat. The glob population has silently crossed the 6-billion mark in the year 2000. Is the population growing at a faster rate? What is actually happening?

In reality the rate of global population growth is slowing steadily. In the year 2000 it was expected that 78 million persons will be added to the global population, compared to 86 million at the peak of population growth a few years ago. More than 60 nations in the world, including Russia, Canada, Australia, Japan, all of Europe, and elsewhere have fertility rates which have fallen below the rate needed to maintain a steady state population. Current demographic trends offer hope, however. Over the past 40 years the average number of children born to each woman has fallen from five to less than three. Young people increasingly

want to wait to have children and to have smaller families. This rate is 2.1 children per woman. Only four nations in the world have seen their fertility rate increase since 19SO - Denmark, Norway, Sweden, and Ethiopia and among these only Ethiopia has a fertility rate greater than 2.1. In fact, the best bet is that the world population will peak by 2025, at something around 7.8 billion, and decline after that. When we speak of population growth of a nation, what're we speaking about? Whom are we speaking about? Does population only mean humans? Not necessarily! Even though the term population in this unit refers to number of humans. population is defined as a group of organisms that breed with one another and live in the same space. Any population has natality (birth rate), mortality (death rate), growth form, density structure. We know that no population stays the same in size. It is important to study the trends in order to plan for the future. We know that a population has certain needs. It appears e population density, i.e. the number of individuals in a space, is more important for population survival than just the number of individuals. The density of a population is size of a population in relation to a definite unit of space. Its generally expressed as the number of individuals per unit 5rL of volume. Population density depends upon the number of individuals added to population and the number living or dying. The difference between the immigration (coming) and emigration (going) determines the number of organisms in a given place. The higher the population density, the more competition for resources comes into play. Every population can reach their limit. This is not due to the availability of space but due to the availability of resources. The amount of resources affects the birth rate, death rate, immigration and emigration.

The above discussion may help us arrive at a conventional formula for its growth.

The formula for population growth is:

Population Growth = (births + immigration) - (deaths + emigration).

This is true for the population of any species.

Given that the rest of the things remain the same, a population should not exceed a certain limit. This is because any abnormal increase in the population is taken care of by the nature through its natural processes such as diseases, floods, earthquakes, and cyclones etc. The Earth's population reached ° billion in September, 1999 (Updated total), It will increase this decade by another billion, the fastest population growth in history. It was only 2 billion in 1930, so today's older generation was the first in history to see a tripling of the Earth's population during their lifetimes! Every second, three people are added to of the world; every day quarter of a million (2 times the population city of Irvine) are added. Every year. About 87 million (about the population of Mexico, or 3 multiplied the ion of California, or the combined populations of the Philippines and South Korea) are added to the world n the next 2.5 years, the equivalent of the U.S. population wii^9 added to the planet. During the coming decade the increased population of one billion people is the equivalent of adding extra China to the world's population. A recent joint statement by the U.S. National Academy of Sciences and the British Royal Society finds that population is growing at a rate that will lead to doubling by 2050. (The World Watch Report; shifting views of population.) Human population growth has increased for a variety of reason such as: i) Developed the ability to survive and live in new

habitats, ii) Increased the carrying capacity of the environment iii) removed a series of limiting factors. However according to an announcement made by the researchers at the world watch Institute (Washington, DC- based environmental research organization), many countries have experienced rapid population growth for several decades are showing signs of demographic fatigue. The anticipated population growth of the globe between 1750 and 2150. The difference in the growth of population between the industrialized and developing countries, Although population has grown silently across the globe, the impact of such a growth is not
silent. Very strangely the increased growth of population itself has affected negatively and has made the population to decrease. For e.g. Due to the growth in population, countries struggling with the simultaneous challenge of educating growing numbers of children, creating jobs for swelling ranks
of young job seekers, and dealing with the environmental effects of population growth, such as deforestation, soil erosion, and falling water tables, are stretched to the limit. In addition to this when a major new threat arises-such as AIDS or aquifer depletion-governments often cannot cope.

We find the humanitarian crisis in industrial societies o many developing countries where such problems are routinely and superficially managed. This has led to the increase of aerates in those countries. As a result, some developing countries with rapidly growing populations are headed for population stability in a matter of just few years, not because of falling 3h rates, but because of rapidly rising death rates. This reversal in the death rate trend has made some of the re demographers to feel as marks of a tragic new development in world of demography. A study on this concludes that in the in absence of a concerted effort by national governments and international community to quickly shift to smaller families, events in many countries could spiral out of control, leading to ^reading political instability and economic decline.

Measure of Population

The numbers of births, deaths, immigrants and emigrants over a specified time interval determine the change in population size. For comparative purposes, these components of change are expressed as proportions of the total population, to yield the birth rate, death rate, migration rates, and the population (Birth and death rates are stated as numbers per 1,000 populations per year). These rates are affected by the age-composition of the population; for example, a very healthy population, which, as a result, has a relatively large proportion of old people, might have a death rate similar to that of a poor population made up of predominantly younger members. Demographers, therefore, often use measures that are free of this age-distribution influence. Two such widely used measures are the total fertility rate (TFR) and the life expectancy at birth.

The total fertility rate is the number of children a woman would have during her reproductive life if she experienced the prevailing rates of fertility at each age. High-fertility countries may have birth rates of 40 or even 50 per 1,000 populations (per year); corresponding levels of the TFR would be 5 to 7 children per woman. Low-fertility countries have birth rates of J5 to 20 per 1,000 and TFRs of about 2. "Replacement level" fertility is the level at which

each person on average has a single successor in the next generation. Corresponds to a TFR about 2.1 under low-mortality conditions.

The life expectancy at birth is the average length of life that be observed in a population in which the currently prevailing mortality risks at each age continued indefinitely Preindustrial populations were characterized by large fluctuations in mortality; long-run averages, however, would probably have shown death rates of 30 to 40 per 1,000 and life expectancies of 25 to 35 years. Under modern health conditions, death rates below 10 per 1,000 and life expectancies about 70 years are common.

Another important mortality measure is the infant mortality rate. This is the probability of death in the first year of life usually stated as number per 1,000 births. Many less' developed countries have infant mortality rates above 100 per 1,000 that is, more than 10 percent of the children die in their first year. In countries with effective health and educational systems, infant mortality rates are about 15 per 1,000, or even lower.

Population Density

Population density can be used as a measurement of any tangible item. However it is most frequently applied to living organisms. Population density is usually expressed in terms of items or organisms per unit area.

Population density, according to this definition, depends on the scale of the sampling area used, and is hard to define as a real-valued continuous function over the area in question. If the items concerned are modeled as discrete points, the population density will jump up and down as the edge of the sampling area passed over individuals. Modelling the individuals as spatially extended objects has other problems, as the scale of the sampling area approaches the scale of an object (for example, a person's scale may be regarded as the size of the grounds of their dwelling place for some people, this will be a large area).

To resolve some of these problems, population density may be regarded, like coastline distance, as a scale-dependent fractal quantity.

Biological Population Densities

Population density is a common biological measurement and is often used by conservationists as a more appropriate than absolute numbers. Low population densities may cause an extinction vortex, where low densities lead to further reduced fertility. This is referred to as the Allee effect, after W. C. Allee, who first identified it. Examples of this may include:

1 Increased problems with locating mates in areas of low density.

2 Increased inbreeding in areas of low population density.

3 Increased susceptibility to catastrophic events in low population densities.

However it should be noted that different species will have different expected densities. For example selected species commonly have high population densities, while k selected species may have lower population densities. Low population densities may be associated with specialized mate location adaptations such as specialized pollinators, as is found in the orchid family, (the Orchidaceae.)

Human Population Density

For human beings, population density is the number of persons per unit of area (which may include or exclude inland water), though it may also be expressed in relation to habitable, inhibited, productive (or potentially productive) or cultivated area. It is frequently measured in persons per square mile or persons per square kilometer or hectare, which can be obtained simply by dividing the number of persons by the land area measured in square miles or in square kilometers or hectares. Commonly this may be calculated for a county, city, country or the entire world. In the country articles the density is based on land area. However, the list of countries by population density is based °n total area, including inland water.

Countries or territories with the highest population densities are:

- Macau
- Monaco
- Hong Kong
- Singapore
- Gibraltar

These territories share a relatively small area a exceptionally high urbanization level, with an economically specialized city population drawing also on rural resources outside the area, illustrating the difference between h°6S population density and overpopulation. The most den populated large state Bangladesh, where 134 million people live in a highly agricultural area around the lower Ganges River, with a national population density in excess of 900 persons per km2. World overall population density presently averages 42 persons per km^2.

Cities with exceptionally high population densities are often considered to be overpopulated, though the extent to which this case is depends on factors like quality of housing and infrastructure or access to resources. Most of the largest densely-populated cities are in southern and eastern Asia though Cairo and Lagos in Africa also fall into the category.

City population is however, heavily dependent on the definition used for the urban area: densities will be far higher for the central municipality than when more recently-developed and as yet administratively unincorporated suburbs are included, as in the concepts of agglomeration or metropolitan area, the later including sometimes neighboring cities.

Variation of Population Growth among Nations

The United Nations (UN), an accepted authority on population levels and trends, estimates that the world population reached 6 billion in 1999, and is increasing annually by more than 77 million persons. The rate of increase, 1.3 percent per year, has fallen below the peak rate of 2 percent per year attained by 1970. By the late 2040s, the UN estimates, the growth rate will have fallen to about 0.64 percent annually, at which time more than 50 countries will experience negative growth.

A. Past and Present Growth

Estimates of world population before 1900 are based on fragmentary data, but scholars agree that, for most of human existence, long-run average population growth approach^ approximately 0.002 percent per year, or 20 per inhabitants. According to UN estimates, the

population of the world was about 300 million in the year AD 1, and it took more 1,500 years to reach the 500 million mark. Growth was not steady but was marked by oscillations dictated by climate, food supply, disease, and war.

Starting in the 17th century, great advances in scientific knowledge, agriculture, industry, medicine, and social organization made possible rapid acceleration in population growth. Machines gradually replaced human and animal labour. People slowly acquired the knowledge and means to control disease. By 1900 the world population had reached 1.65 billion, and by 1960 it stood at 3.04 billion.

Beginning about 1950, a new phase of population growth was ushered in when famine and disease could be controlled even in areas that had not yet attained a high degree of literacy or a technologically developed industrial society. This happened as a result of the modest cost of importing the vaccines, antibiotics, insecticides, and high-yielding varieties of seeds produced since the 1950s. With improvements in water supplies, sewage disposal facilities, and transportation networks, agricultural yields increased, and deaths from infectious and parasitic diseases greatly declined. Life expectancy at birth in most developing countries increased from about 35-40 years in 1950 to 66 years by 2000. The rapid decline in deaths among people who maintained generally high fertility rates led to annual population growth that exceeded 3.1 percent in many developing nations a rate that doubles population size in 23 years.

B. Regional Distribution

As of 2000,1.2 billion people lived in the developed nations of the world, and 4.9 billion people lived in the less developed countries. By region, over half the world's population was in East and South Asia, China, with 1.3 billion inhabitants, and ™a, with some 1 billion, were the dominant contributors, Europe and the countries of the former USSR contained 14 percent, North and South America made up 14 percent. Africa 13 percent, and the Pacific Islands had about percent of world population.

Differences in regional growth rates are altering these percentages over time. Africa's share of the world population is expected to be more than double by the year 2025. The population of South Asia and Latin America is expected to remain nearly constant; in other regions, including East Asia, the population is expected to decline appreciably. The share of the present developed nations in world population 20 percent in 2000 is expected to fall to 15 percent by 2025. Nine out of every ten persons who are now being added to the world's population are living in the less developed countries.

C. Urban Concentration

As a country develops from primarily an agricultural to an industrial economy, large-scale migration of rural residents to towns and cities takes place. During this process, the growth rate of urban areas is typically double the pace of overall population increase. Some 29 percent of the world population was living in urban areas in 1950; this figure was 43 percent in 1990, and is projected to rise to 50 percent by the year 2005.

Urbanization eventually leads to a severe decline in the number of people living in the countryside, with negative population growth rates in rural areas. Rapid growth of overall population has deferred this event in most less-developed countries, but it is projected to occur in the early decades of the 21st century.

Most migrants to the cities can be assumed to have bettered themselves in comparison to their former standard of living, despite the serious problems of overcrowding, substandard housing, and inadequate municipal services that characterize life for many arrivals to urban centers. Dealing with these conditions, especially in very large cities, presents massive difficulties for the governments of less-developed countries.

D. Population Projections

Most of the potential parents of the next two decades have already been born. Population projections over-this interval can, therefore, be made with reasonable confidence, barring catastrophic changes. Beyond two decades, however, uncertainties about demographic magnitudes and other

Population Growth in India

India is the largest democracy in the world. It accounts for more than 16 percent of the world's population around mid-1998. This 16 percent of lives are on less than 2.5 percent of the total land area of the planet Earth. Between 1995 and 2000, the population of the world has been estimated to have increased at the rate of 1.33 percent per year, adding an average of 78 million persons each year. More than one fifth of this increase has been estimated to be accounted by the increase in population in India and this contribution has been the largest, even larger than the contribution of China, the most populous country is the world (United Nations, 1999). Projections prepared by the United Nations suggest that by the year 2050. Population of India will increase to 1529 million which will account for more than 17 percent of the estimated world population of 1909 million. This means that of the projected 2854 more than 18 percent will be confined to India alone. These projections also indicate that by the year 2050, India will become the most populous country of the world, surpassing China. Since nearly one fifth of the population increase in the world during the next 50 years will take place in India, population stabilization in the world as a whole will depend on the pace of demographic transition in India.

During the nineties, the government of India has taken a number of key policy initiatives that have relevance to future population growth in the country. First of these initiatives w as the process of economic reforms that started in continued with varying pace throughout the nineties. The re of these economic reforms was that the performance of the country on the economic front improved and the economy are G at the rate of 6.8 per cent per year during the Eighth Five-ye W Plan compared to 5.8 per cent in the Seventh and 5.6 per cent in the Sixth Five-year Plan (Government of India, 1 998). At the same time, the Child Survival and Safe Motherhood Programme was launched throughout the country in 1990 which was later converted into the Reproductive and Child Health Programme to specifically address issues related to high child and maternal mortality. In 1996, the government abolished the system of allocation of targets for the implementation of the National Family Welfare

Programme, the mainstay of population stabilization efforts and introduced a decentralized, community need based approach of planning and implementing population stabilization activities and programmes. Government has recently adopted a new population policy also which aims at achieving the replacement level fertility by the year 2011 (Government of India, 2000).

These facts explain the special interest with which the results of the 2011 population census in India are awaited. Provisional results of the first population census of the 21st century have now been released. They supply basic information on population size, rates of population growth, population sex ratio and levels of literacy for the country as a whole as well as for its constituent states and Union Territories. This paper analyzes salient features of the demographic situation in the country as revealed by the preliminary results of 2001 population census.

Regional diversity or inequality in growth of population in India is well known. This inequality in population growth has persisted over time. As such, any discussion about the growth of population in India is incomplete without a discussion on the regional differentials in the growth of population. The preliminary results of 2001 population census provide information on population size and growth for all states and Union Territories country. This information is summarized in table 1 which includes data on population, population growth and population density for 1991 and 2001 and for the decade 1991-01. It covers

all constituent states and Union Territories of the country.

Environment and Human Health

Environment-related issues that affect our health have been one of the most important triggers in the increasing awareness of the need for better environmental management. The changes in our environment induced by human activities in nearly every sphere of life have had an influence on our health patterns. The assumption that the only indicator of human progress is economic growth is not true. We expect urbanization and industrialization to bring in prosperity, but on downside, it leads to diseases related to overcrowding and poor quality drinking water, resulting in an increase in water borne diseases like infective diarrhoea and air-borne bacterial diseases like tuberculosis. High-density city traffic leads to an crease in respiratory diseases like asthma. Agricultural pesticides that enhanced food supplies during the green revolution have affected both the farm worker and all of us who consume the produce. Modern medicine promised to solve many health problems, especially associated with infectious diseases through antibiotics, but bacteria have found ways to develop resistant strains, frequently even changing their behaviour in the process, making it necessary to keep on creating newer antibiotics. Many drugs have been found to have serious side-effects. Sometimes, the cure is as damaging as the disease process itself.

Thus, development has created several long-term health problems. While better health care has led to longer life-spans, coupled with lowered infant mortality, it has also led to an unprecedented growth in our population which has negative implications on environmental quality. A better health status of society will bring about a better way of life only if it is coupled with stabilizing population growth.

By healthy, it means disease free body. The state of human health not only depends on the number of doctors and hospitals but also on clean environment. A polluted environment is a threat to human health. The threats of polluted environment to human health can be divided into traditional hazards associated With lack of development and modern hazards with development.

Traditional hazards related to poverty and "insufficient" development are wide-ranging and include: lack of access to a'§ drinking-water; inadequate basic sanitation in the household and the community; indoor air pollution from cooking heating using coal or biomass fuel and inadequate solid Waste disposal.

Modern hazards are related to development that lacks health-and-environment safeguards, and to unsustainable consumption of natural resources. They include: water pollution from populated areas, industry; and intensive agriculture; urban air pollution from motor cars, coal power stations and industry; climate change; stratospheric ozone depletion and transboundary pollution.

The changing pattern of environmental health hazards and associated health risks-moving from "traditional" to "modern" with time and economic development-is known as the "risk transition".

Environmental Health

Environmental health, as defined by WHO, comprises those aspects of human health, including the quality of life, that are determined by physical, chemical, biological, social, and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that adversely affect the health of present and future generations.

Our environment affects health in a variety of ways. Climate and weather affect human health. Public health depends on sufficient amounts of good quality food, safe drinking water, and adequate shelter. Natural disasters such as storms, hurricanes, and floods still kill many people every year. Unprecedented rainfall triggers epidemics of malaria and water-borne diseases.

Global climate change has serious health implications. Many countries will have to adapt to uncertain climatic conditions due to global warming. As our climate is changing, we may no longer know what to expect. There are increasing storms in some countries, drought in others, and a temperature rise throughout the world. The *El Nino* winds affect weather worldwide. The *El Nino* event of 1997-98 had serious impacts on health and well-being of millions of people in many countries. It created serious drought, floods, and triggered epidemics. New strategies must be evolved to reduce our vulnerability to climate variability and changes.

Climate and Health

Centuries of human civilization have helped mankind adapt to living in a wide variety of climates from the hot tropics, to the cold arctic, in deserts, marshlands and in the high mountains. Both climate and weather have a powerful impact on human life and health issues.

Natural disasters (heavy rains, floods, hurricanes) can severely affect the health of a community. Poor people are more vulnerable to the health impacts of climate variability than

the rich. Approximately 80,000 deaths which occur world-wide each year as a result of natural disasters, about 95% are in poor countries. In weather-triggered disasters hundreds of people and animals die, homes are destroyed, crops and other resources are lost. Public health infrastructure, like sewage disposal systems, waste management, hospitals and roads, are damaged. The cyclone in Orissa in 1999 caused 10,000 deaths. The total number of people affected was estimated at 10 to 15 million!

Human physiology can adapt to changes in weather, within certain limits. However, marked short-term fluctuations in weather lead to serious health issues. Heat waves cause heat-related illness and death (e.g., heat stroke). The elderly and persons with existing heart or respiratory diseases are more vulnerable. The heat wave in India in 1998 was associated with many deaths.

Climate plays an important role in vector-borne diseases transmitted by insects like mosquitoes. These disease transmitters are sensitive to the direct effects of climate, such as temperature, rainfall patterns and wind. Climate affects their distribution and abundance through its effects on host plants and animals.

Malaria transmission is particularly sensitive to weather and climate. Unusual weather conditions, for example a heavy downpour, can greatly increase the mosquito population and trigger an epidemic. In the desert and at the highland fringes of malarial areas, malaria transmission is unstable and the human population lacks inherent protective immunity. Thus, weather conditions (rainfall and temperature) favour transmission, serious epidemics occur in such areas. The fluctuations in malaria have also been linked to changes in rainfall associated with the *El Nifto* cycle.

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