UNIT 1: Introduction to Environment

DEFINATION, SCOPE, IMPORTANCE OF ENVIRONMENTAL STUDIES

Environment is the sum total of all conditions and influences that affect the development and life of all organisms on earth. The functions of the environment in relation to man have been analysed: (1) recreation; (2) source of natural resources— agricultural, mineral and forestry which man consumes directly or indirectly; (3) "sink" for receiving wastes produced by man and his activities. The capacity of the environment to carry out these functions is damaged by human activities which imposes four stresses on the environment: (i) "eutrophic", i.e. the task of decomposing wastes produced by consumption and production activities; (ii) "exploitative", i.e. cropping of plants, extraction of minerals and hunting of animals; (iii) disruptive— brought about by activities like deforestation, construction of highways and towns; and (iv) "chemical" and "industrial" stress which results from industrial development.

For the sake of his own survival on earth, man is now concerned about the environment. The need of the hour is environmental education and awareness for all so that they learn how to handle environmental issues, how to lead a better life with less pollution and make this earth a better place to live in for the present and future generations. That is why environmental education and awareness are essential among the student community so that the latter can spread the message among the common people.

COMPONENTS OF THE EARTH/ ENVIRONMENTAL SEGMENTS

1 Lithosphere: The earth's crust, made of the mantle of rocks, is the lithosphere. It includes the soil which covers the rock's crust in many places. Rocks are subjected to continuous weathering forces—rain, wind, chemical and biological. The resulting primitive soil is suitable for the growth of plants—after death and decay, plant debris returns to soil. The mineral component of soil comes from the parent rocks by weathering processes while the organic component is due to plant biomass as well as populations of bacteria, fungi and insects (earthworms). A typical soil, suitable for agriculture, contains about 5 per cent organic matter and 95 per cent inorganic matter. Soil has an important role as it produces food for us and animals. Good soil and good climate for agriculture are valuable assets for a nation. Soil is an important component of natural cycles (see subsequent section of this Chapter). But due to human activities soil becomes the dumping ground for many pollutants including pesticides, fertilizers, industrial effluents and particulate matter from smoke chimneys of factories, etc. In general, soil has a loose structure consisting of solid mineral and organic matter, air spaces. It shows broadly three zones as its depth increases. The top layer, upto several inches thick, is known as the top soil which is an index of the soil quality. This is the layer of maximum biological productivity and it contains bulk of the organic matter. Hence it is very important for vegetation cover and agricultural crops. Reckless deforestation causes loss of top soil which also means loss of agricultural production. The underlying layer is the sub-soil which receives organic matter, salts and clay particles leached from the top soil. The third layer (zone) consists of weathered parent rocks from which the soil was formed. Plants draw water and nutrients from soil—they transport water into the plant body (roots and leaves) and then

excess water into the atmosphere through leaves by the process of transpiration. Soils have an important function, i.e. exchange of cations whereby essential trace metals are made available to plants as nutrients.

Soil, however, receives large quantities of waste products— domestic, human, animal and industrial. Fertilizers and pesticides applied to crops are retained by the soil and spread into the environment, namely, water bodies by leaching. Pesticide residues in crops and food get into the human food chain causing long-time health hazards. Thus it may be concluded that soil has direct effect on public health and wellbeing of a nation.

2 **Hydrosphere** The hydrosphere consists of all types of water resources— oceans, seas, rivers, lakes, streams, reservoirs, glaciers, polar ice caps and ground water (i.e. water below the earth's surface). The history of ancient civilizations—their growth and decline— is closely linked with the quantum of water supply. Several cities and civilizations disappeared from earth due to water scarcity. The major uses of water are for irrigation (30 per cent) and thermal power plants (50 per cent) while other uses are domestic (7 per cent) and industrial consumption (12 per cent). Surface water gets polluted by domestic sewage, industrial waste and agricultural run-off including pesticides and fertilizers. Water-borne diseases from sewage alone kill millions of people in developing countries.

3 **Atmosphere** The major components of the atmosphere are nitrogen and oxygen while the minor components are argon, carbon dioxide and some trace gases. The atmosphere plays an important role in maintaining the heat balance of the earth through absorption of infra-red radiation emitted by the sun and re-emitted from the earth. It protects life on earth and saves it from the hostile environment of outer space. It absorbs bulk of the cosmic rays from outer space and major portion of electromagnetic radiation from the sun. It filters out the harmful ultraviolet radiation below 300 nanometers (1 nm or nanometer = 10–9 meter) and thereby protects the living species on earth. Man has polluted the atmosphere by dumping harmful waste aerosols, gases and fumes into it. This has affected the world climate and the future of mankind.

4 **Biosphere** Broadly speaking, the biosphere consists of the earth's crust, hydrosphere, atmosphere and various living species (microorganisms to man) which exist in the zone 600 meters above earth's surface and 10,000 meters below sea level. Both biosphere and environment have close interactions with each other. Thus oxygen and carbon dioxide levels of the atmosphere depend entirely on the plant world. Green plants alone are responsible for the accumulations of oxygen in the atmosphere through photosynthesis and decay. In the early stages atmosphere was devoid of oxygen and there was no life form on earth. In general, the biological world is closely related with energy flows in the environment and water chemistry.

SUSTAINABILITY

The developing countries face to-day critical situation on economic and environmental fronts. For economic growth they have to give priority to agricultural industrial bases but at the cost of environment. The resource base, once depleted, sets in chain of environmental degradation which finally weakens the economy. Our population explosion remains the core issue. Our development policy should be such that the ecosystem is sustainable, i.e. it contains the element of renewability. This requires sound management strategy which ensures the continuation of socio-economic development in the long run. The important components of sustainable development/ ecosystem are: • Population stabilisation, • Integrated land use planning, • Conservation of bio-diversity, • Air and water pollution control, • Renewable energy resources, • Recycling of wastes and residues, and • Environmental education and awareness at all levels. Sustainability is thus effecting a balance between stability, equity and diversity.

ROLE OF INDIVIDUAL IN ENVIRONMENT CONSERVATION

1. Keep your home and surrounding areas clean and also working places (offices/institutions) clean.

2. Enforce "No Smoking" in as many public places (offices/institutions/banks/post offices/public transports/ public halls, etc.) as possible besides own homes.

3. Promote literacy and environmental campaigns among the masses.

4. Organise environmental brigades in every block consisting of young and old people including girls and women for protection and conservation of environment.

5. In critical situations where environment is on the point being destroyed, organise environmental movement along the lines of the Chipko and Silent Valley Movements involving teachers, students and people.

6. Let us take the solemn pledge in our day-to-day life that we shall do our best to make this world a better place to live in for our next and future generations.

Unit 2: Natural Resources

FOREST RESOURCES

The policy for conservation of natural resources mainly focusses on the policy for conservation of forests. The latter has undergone various processes of legislation over the last two centuries. Some forests have been declared as Reserve Forests, the first being the Corbett National Park (1936). The National Forest Policy was framed in 1988 for forest management in view of the rapidly vanishing forests which now stand at about 15 per cent forest cover. The Forest Policy aims at 33 per cent forest cover. In the hilly regions most of the major rivers originate and the ecosystem is fragile—the new Policy targets at 67 per cent of land under forest cover, encourages massive afforestation and prohibits deforestation. The role of tribals living in the forests and on forest products has been recognised and their symbiotic (i.e. intimate association) relationship with forests since ancient times has been respected.

(i) Conservation of Reserve Forests: These are areas where our major water resources are located, viz. the Himalayas, Western and Eastern Ghats and areas like reservoirs, National Parks, Sanctuaries, Biosphere Reserves, etc. These must be protected and no commercial exploitation be allowed in these areas. This is an important conservation strategy.

(ii) Limited Production Forests: These are less fertile areas at high altitude (more than 1000 metres) with hilly environment. Here the health of the forests should not be damaged and only limited harvesting with utmost care be allowed.

(iii) Production Forests: These are forests on the plains and their productivity can be enhanced by proper management. These should be maintained to make up for the losing forest cover.

(iv) Social/Commercial Forestry: Such forestry is meant for supplying goods and services to meet the everincreasing demand for firewood, fodder, food, fertiliser, fibre, timber, medicine, etc. or for industrial purposes such as timber, plywood, matchwood, fibre board, paper and pulp, rayon, etc. The main idea is to remove pressure on natural forests for these requirements.

MINES AND MINERAL RESOURCES

Mines Since independence India has seen rapid growth in mineral production to provide raw materials for industrial development. Fossil fuels comprise the bulk of the mining output—coal production tops the list. Iron ore, limestone and bauxite predominate among metallic and non-metallic minerals respectively. Mining has adverse effect on the environment—it damages land, forests, water and air. The loss or pollution of natural resources degrades the quality of human life in these areas. Much agricultural land is lost due to mining. Everymining enterprise means the conversion of land to such purposes as roads, railways and ropeways for mineral transport, housing for miners and staff, land for stockyard, etc. The disposal of mining wastes requires additional area and makes the surrounding land infertile. Much of the mining activity is being carried out in forested regions. The obvious result is deforestation and erosion. Mining wastes pollute streams and rivers. Mineral dust is a source of air pollution causing health hazards in an around-mining area. While mineral production has increased about 50 times in the last 30 years, several million hectares of good crop and forest lands have been destroyed by mining operations and hundreds of villages depopulated. The worst affected are tribals. More than 50 per cent of the national mining output comes from 40 contiguous districts of central and eastern India, the tribal heartland of the country.

WATER RESOURCES

Water has no alternative—it is known as "life". It is essential for the sustenance of all living organisms including plants, animals and man. All plants, insects, animals and men have 60–95 per cent water in their bodies. This water is partly released in the form of sweat, excreta, urine and vapour. So all these species require lot of water daily. Besides much water is also needed for body growth, nutrition, etc. So it is absurd to think of life without water. But our usable water resources like any other natural resource is finite and is likely to be exhausted within a century. Moreover, it is getting polluted by man-made activities and unfit for use sooner than expected. Water crisis is more serious than food or population crisis since food production or population problems are irrelevant without water supply. Use of polluted water itself takes toll of 25,000 people all over the world every day. In India out of 6 lakh villages, one third or about 2 lakh villages are without access to water. In these villages women have to walk daily about 1–14 km. to collect water for cooking and drinking. The United Nations Food and Agriculture department estimate that if the present day practices of wasting and polluting water are not stopped, then within less than a century the world's biosphere including man will disappear.

We have a very limited stock of usable water, 0.03 per cent surface water (rivers, streams and ponds) and 0.66 per cent ground water. The quantity of water vapour arising from evaporation of sea water and river water returns by the same volume to the earth's surface by rainfall and back to the water sources. The hydrological cycle in nature is more or less balanced in terms of charge (cloud formation) and discharge (rainfall). But we are drawing large quantities of ground water for agriculture and industries while the waste water from these is much polluted and on mixing with rivers is polluting the rivers also. The mass balance of annual rainfall shows that about 70 per cent is lost by evaporation and transpiration by plants, while the remaining 30 per cent goes into the stream flow. The approximate break-up of this stream flow, as consumed by man is—8 per cent for irrigation, 2 per cent for domestic use, 4 per cent for industries and 12 per cent for electrical utilities. Irrigation for agriculture and electric power plants are the major consumers of water.

DAMS

Narmada is the largest west flowing river arising from the Amar Kantaka Plateau in Shahdol district of Madhya Pradesh 190 Environmental Studies and travels 1300 km. draining 9.88 million hectares between the Vindhya and Satpura ranges. This vast basin—average annual flow is 41 billion cubic metres—is mostly untapped because of inter-state (Gujrat, MP) water disputes. The MP Government undertook a gigantic plan—Narmada Basin Development Programme—which involves construction of 31 large dams for Narmada and its tributaries, 450 medium-sized projects and several thousand minor structures at a cost of about Rs 25,000 crores. The benefits were projected—several million hectares of land irrigated; water supply to thousands of industries; several thousand megawatts of power, etc. But according to environmentalists and environment action groups massive damming of the Narmada river could be a blueprint for disaster. The basin is one of the most densely forested in India. The project would imply displacement of over 1 million people, mostly tribals, submerging of over 1000 villages and over 50,000 hectares of agricultural land and also loss of forests in the region. The damage to environment and people far outweighs the projected benefits. The environmental action groups, led by the environmentalist, Smt. Medha Patekar, organised sustained movement to stall the projects of Sardar Sarobar and Narmada Sagar dams and partly succeeded.

PEST CONTROL AND MANAGEMENT (IPM) IN AGRICULTURE

In an agricultural field crops are susceptible to attack by insects, nematodes, pathogens, mites, birds and mammals which together form a complicated interacting pest complex. The control of a pest complex requires careful assessment of the pests and integration of several methods for control/management (Integrated Pest Management, IPM).

Pesticides In the early period of human civilisation it was realised that pests harm crops and transmit diseases to both animals and men. The first use of chemicals to kill pests was in 70 AD when arsenic was recommended to kill insects. In the 16th century the Chinese used arsenic sulphide as an insecticide. During the 20th century lead arsenate was used as insecticide. Paris green (copper acetoarsenite) was used extensively in pools in the tropics for controlling malaria transmitting mosquitoes. However, it is known that arsenical pesticides can persist in the soil for 40 years and damage crops. Pesticide is the general term for insecticides, rodentitides, molluscides, herbicides, fungicides, etc. The era of synthetic-organic pesticides started around 1940. At present there are more than 10,000 different pesticides. They are classified as:

Insecticides Organophosphorus group (e.g. malathion); Organochlorine group (e.g. DDT); Carbamate group (e.g. Carbaryl) Herbicides Chlorophenoxy acid group (designed to kill weeds or undesirable vegetation) Fungicides Dithiocarbamate group; (designed to Organometallic group kill fungi and (e.g. phenyl mercury acetate) check plant disease) The uses of pesticides helped in the eradication of diseases such as malaria (by DDT) and typhus and also in boosting crop production.

FOOD RESOURCES

From the standpoint of recovery from the war, the problem of the food resources of the world is one of special interest. With full recognition of the importance of agricultural raw materials for industrial use, attention is here confined to foodstuffs, feeding stuffs, and farm animals. It seems simplest to proceed with the discussion topically rather than chronologically. Wherever comparisons are made between pre-war and present positions, allowance for change in population has been made in accordance with the somewhat fragmentary data available in official records.

The definition of the food resources of the world must include terms both of statics and dynamics. The food resources are a composite of the goods (the foodstuffs) and the services in commerce and distribution through which these are made available for consumption. It is easy to overemphasize the goods, to undervalue the services. The Great War effected a decline of production in Europe and Russia, a distortion of production elsewhere. The services in commerce were directly perverted in Europe and less directly, though still effectually, elsewhere. Post-war reconstruction includes recovery from direct and indirect effects on production and restoration of the appropriate services in commerce. The purpose of this article is to sketch in broad outlines the war injuries and the post-war recoveries, and to indicate that the processes of production have made relatively more rapid recovery than the processes of commerce.

Agriculture is a complex operation; The results depend not only upon technical considerations but upon the non-agrarian conditions as well -- the monetary situation, fiscal policy, transportation and trade restrictions. Broadly considered, in any decade the position of agricultural production is as much dependent upon external factors as upon the factor of agricultural potential. By the term agricultural potential is meant the productive force corresponding to maximum outturn representative of soil and

climate under intensive operation. One may say that agricultural potential is a driving force that is continuously modified by factors outside of climate and agricultural technique. World agriculture is a part of world division of labor; both within countries and between countries, agriculture competes with itself and with urban industries. One must endeavor to appraise both world-wide and local circumstances, but without overemphasis on either.

ENERGY RESOURCES

The conventional energy resources are fossil fuel (coal, petroleum and diesel), wood, natural gas, hydroelectricity and nuclear energy. The energy, as consumed by man, is: 33 per cent from petroleum and diesel, 27 per cent from coal and 5 per cent from nuclear fuels. Examples include: coal, thermal power, methanol, petroleum, hydroelectricity, nuclear power, wood, natural gas. Non conventional energy resources include solar energy, biogas, wind energy, ocean and tidal energy, geothermal energy and energy plantation.

Biogas: Gas (energy source), usually methane mixed with carbon dioxide, produced from animal dung e.g. gobar gas from cowdung. This non-conventional energy resource is useful fuel for rural areas.

Conventional Energy Resources: Usually traditional energy resources such as fossil fuel (coal, petroleum and diesel), wood, natural gas, hydroelectricity and nuclear energy. Energy Plantation: Trees are natural renewable energy resources. Plantation of trees (afforestation) on land is known as energy plantation. This is necessary for raising a new forest cover to make up for deforestation. The major important products of energy plantation are wood, paper, cellophone, rayon, plywood, plastic, etc.

Geothermal Energy: The heat energy coming out of the very hot earth's core e.g. hot springs. Harnessing geothermal energy would save fossil fuels and has been tried in several developed countries.

Hydroelectricity: Electricity generation from water dam of reservoir. It is a conventional, clean energy resources, which accounts for 21 per cent of total electricity generation.

Methanol: Conventional liquid fuel which can be produced from coal. It is manufactured from carbon monoxide and hydrogen, which, in turn, are obtained from coal, oxygen and steam.

Non-conventional Energy Resource: Solar energy, wind energy, ocean and tidal energy, geothermal energy and biogas belong to the category of non-conventional energy resources. Solar energy is the most promising non-conventional energy resource for India. It is lean, pollution-free and inexpensive.

Natural Gas: Cleaner fuel than fossil fuel as it produces less carbon dioxide on burning than fossil fuel (coal, petroleum, etc.)

Nuclear Power: Electricity (power) generated from nuclear fission i.e. splitting of nucleus (plutonium) into two or more fragments with liberation of tremendous amount of energy.

Petroleum (mineral oil): An important fossil fuel (underground reserve) used as conventional energy resource, mostly in the developed countries since 1950. USA is the largest consumer of petroleum at present in the world. The world reserve at the present rate of consumption is likely to last less than 100 years.

Solar Energy: The most abundant and clean source of energy (non-conventional) for India. Sunlight is directly converted into electricity through photovoltaic cell (device for conversion of light energy into

electrical energy). Solar energy can be used as solar cooker, solar heater, solar lanterns, solar pumps, etc. in remote rural areas and thereby save wooden fuel.

Thermal power: Coal, on combustion in a furnace, generates steam at high temperature and pressure which is then used to run steam turbine and generate electricity. This is the basis of thermal power production which, however, causes severe air pollution.

Tidal Energy: Energy associated with tidal wave (3–5 metres high) can be tapped for generating electricity. On the ocean shore 1-metre high tidal wave can generate 25–70 kilowatts of energy.

Wind Energy: This is cheap and clean energy resource in India. Wind power mills can be set up along coastlines (in Gujarat, Western Ghats) where wind velocity 6.5 metres per second gives optimum conditions for running wind mills. The technology for harnessing wind energy has become commercial in developed countries (Denmark, Holland, Sweden, etc.).

LAND RESOURCE AND LAND USE PLANNING

Land is one of the most important components of life support system which has been exploited and abused over centuries. Our ancestors regarded land as the Mother Earth which should be handled with care and respect. In fact, ancient kings used to be called as "Bhoomipal", i.e. custodian of land. In a predominantly agricultural country like India, land is the top priority. Good soil forms the basis of good farming and good living. An understanding of soil is the key to good farming. Due to exploding population, more and more agricultural land is being sacrificed for housing. This poses threat to food production. Careless use of soil can damage soil which results in loss of soil quality and quantity of grassland and cropland. This is associated with soil erosion and degradation of water sheds and catchments, deforestation, desertification, etc. The recent Ethiopian experience of mass starvation and deaths due to acute famine should be a lesson for India. It must be remembered by all that land is a finite source with finite carrying capacity and only by integrated land use planning we can be saved from disaster. There is need of a National Policy on land/soil with short and long range objectives. As indicated above, the land is subjected to demographic (population) pressures due to demands of agriculture, industries and urbanisation including construction of railways, highways, etc. Another important aspect is that cropland is fast losing fertile top soil (25 billion tons each year world-wise and 5 billion tons in India). This puts limitation on long-term crop production. Land Use Planning is in essence the determination of optimum use of every hectare of land of the country. Utilisation of land is important for satisfying the needs of people. Primary use of land is for agriculture in developing countries where farming is the occupation of majority of people. In the developed and also in developing countries other occupations based on land are industries, mining, commerce, etc. The roadways and railways also demand considerable land. In recent years pressure on land has increased due to demand for communication and this has in turn led to degradation of land. Industrial uses of land have led to the growth of towns and hence urbanisation. Even in ancient time riverine civilizations flourished e.g. Indus, Egyptian, Babylonian, etc. India has one of the lowest man-land ratio—hardly 0.48 ha. per capita. It has continuously decreased since the sixties. As we have limited land, we must take urgent measures for landuse planning in an integrated manner. 1. The concerned departments—Agriculture, Forest and Revenue should in a co-ordinated manner prepare soil maps of the country. 2. At the district or the village level, a nation-wide survey of landuse planning should be undertaken. This would enable to allocate land for short-term and long-term requirements for agriculture, forestry, vegetation, grassland, fisheries, water bodies, water sheds and water resources, human settlements, roads, transport, industries, mining, ports, harbour, etc. The planning process should take into account the requirements in relation to population explosion.

UNIT 3: Ecosystems and Biodiversity

ECOLOGY AND ECOSYSTEM

The word "Ecology" was coined by a German biologist in 1869 and is derived from the Greek word, "Oikos" meaning "House". Ecology is the branch of Science that deals with the study of interactions between living organisms and their physical environment. The latter are closely inter-related and they have continuous interaction so that any change in the environment has an effect on the living organisms and viceversa. Any unit or biosystem that includes all the organisms which function together (biotic community) in a given area where they interact with the physical environment is known as ecosystem. The ecosystem is the functional unit in ecology as it consists of both the biotic community (living organisms) and abiotic environment. The latter have close interaction, essential for maintenance of life processes. The interaction is conducted by energy flow (solar energy) in the system and cycling of materials (natural cycles). From biological points of view, the ecosystem has the following constituents:

(i) inorganic substances (carbon, nitrogen, carbon dioxide, water, etc.) involved in natural cycles;

(ii) organic compounds (proteins, carbohydrates, humic substances, etc.;

(iii) air, water and substrate environment including the climatic regime and other physical factors;

(iv) producers, autotrophic (i.e. self-sustaining organisms, main) green plants that can manufacture food from simple inorganic substances;

(v) heterotrophic (i.e. depending on others for nourishment) organisms, mainly bacteria, fungi and animals which live on other organisms or particulate organic matter;

(vi) micro-consumers, decomposers, mainly, bacteria, fungi which obtain their energy by breaking down dead tissues or by absorbing dissolved organic matter extracted from plants or other organisms. The decomposers release inorganic nutrients that are utilised by producers. They also supply food for macroconsumers or heterotrophic organisms bacteria, fungi and (animals) and often excrete hormone-like substances that inhibit or stimulate other biotic components of the ecosystem. The common features of all ecosystems—terrestrial, freshwater, marine and agricultural—are the interactions of the autotrophic and heterotrophiic components. The major autotrophic metabolism occurs in the upper "green belt" stratum where solar energy is available while the intense heterotrophic metabolism occurs in the lower "brown belt" where organic matter accumulates in soils and sediments.

The Biome is a very large land community unit where the plant species is more or less uniform. It provides a basis of natural ecological classification. The main Biomes of the world are the Tundra, Temperate, Coniferous forest, Deciduous forest, Temperate grassland, Tropical Savanna, Desert and Tropical Rain Forest.

Land-based Ecosystem Land (terrestrial) ecosystems depend largely on the climate and soil. Higher plants and animals have evolved on land. For example, seed plants, insects, warm-blooded vertebrates and micro-organisms dominate on land now. The major terrestrial communities consist of herbaceous plants, shrubs, grass and also woody trees besides numerous insects, anthropods, birds, etc.

Marine Ecosystem Oceans occupy 70 per cent of earth's surface, offering habitat to numerous plants, (mainly algae), animals like zoo plankton, shrimps, oysters, fishes, reptiles, birds and mammals. They

serve as the sink of a large quantity of run-off and wastes from land. Marine water has a high salt content (about 3.5% by weight) and poor fertility due to lack of nitrates and phosphates as compared to fresh water. Marine life is abundant near the shore and in the continental shelf. The species include commercial fishes, large sea mammals like whales and seals.

Freshwater Ecosystem Freshwater bodies (ponds, lakes, rivers, springs) are rich in nutrients (nitrates, phosphates) and provide good habitat for phytoplankton, zooplankton, aquatic plants and fishes.

Wetland Ecosystems Wetlands are transitional lands between terrestrial and ecosystems where water stands at 2.5 to 300 cm during most of the year. They include valuable natural ecosystem harbouring a wide variety of plants, animals, fishes and micro-organisms. They are at present in danger due to increasing urbanization as in case of eastern part of Calcutta.

Mangroves (Forest between Land and Sea) Mangroves are important forest communities in tidal zones or equatorial and tropical coasts. For example, the Sunderbans in the Gangetic estuarine delta touching the Bay of Bengal offer important mangroves, habitat of wild animals including Royal Bengal Tiger and of interesting plant species.

The important components of sustainable development/ ecosystem are:

- Population stabilisation
- Integrated land use planning
- Conservation of bio-diversity
- Air and water pollution control
- Renewable energy resources
- Recycling of wastes and residues
- Environmental education and awareness at all levels.

BIODIVERSITY

Biodiversity There may be about 10 million species of plants, microorganisms and animals on earth while only about 1.5 million species are on record, i.e. identified so far. Among these the majority are insects (7,50,000), 41,000 are vertebrates (i.e. those having backbones or spinal columns), 2,50,000 are plants, 1,00,000 are fungi and the rest are invertebrates and microorganisms. Biological diversity or biodiversity involves genetic diversity among species as also between individuals and ecological diversity, i.e. number of species in a community of organisms. The existing species of plants and animals are the product of 3 billion years of evolution involving mutation, recombination and natural selection. Changes in environment, e.g. warm and cool periods exerted selection pressures and have been responsible for evolution of new species and extinction of others who could not survive in the struggle for survival. The dinosaur era is an example. These giant-sized animals dominated the earth for 130 million years and became extinct before the Ice Age.

Natural extinction, part of evolutionary process, has been accelerated by man-made extinction wave due to constant greed and need of man. By this time, 1 out of 10 million species has become extinct and each day we are losing one plant and one animal species. At this rate of extinction, the survival of man himself is threatened. The specide (extinction of species) in which man is involved in more serious a crime than geliocide (mass murder). In this context we may note our tradition. Charaks, the well-known ancient physician, was asked by his teacher to get a plant that was useless. He returned after

a few days and reported that there was no such plant. One cannot imagine a situation if Penicillium was extinct before man could make use of it as an antibiotics or if Cinchona became extinct before quinine was discovered as a cure for malaria. It is, therefore, in our own interest that we should conserve our plant as well as animal and micro-organism (fungus and bacteria) wealth. There is a growing realisation all over the world about the urgent need to conserve the biological diversity. The United Nations Earth Summit (Rio de Janeiro, 1992) adopted the Treaty on Biodiversity whereby countries agreed to conserve the Biodiversity—the living natural resources (plants, animals, microbes) for the welfare of mankind.

FLORA AND FAUNA

The total area under mangroves in India is about 6750 sq. km. which is about 7 per cent of world's mangroves. Among these the Sunderbans of West Bengal has the largest area under mangroves, 4200 sq. km., the next being Andaman and Nicobar islands, 1190 sq. km. together accounting for 80 per cent of the total mangroves in the country. The mangroves have suffered severe deforestation, which must be checked. India is rich in biodiversity with about 75,000 species of animals and 45,000 species of plants.

The fauna (animals) include 340 species of mammals, 1200 species of birds, 420 species of reptiles, 140 species of amphibians, 2000 of fishes., 4000 of molluscs and 5000 of insects besides other invertebrates (those without backbones/spines). The flora include 15000 species of flowering plants, 5000 algae, 1600 lichens, 20,000 fungi, 2700 bryophytes, etc. Rich biodiversity is also observed in wetlands and mangroves which serve as treasurehouses of genetic resources and also as active protective systems. There is cause for alarm when we notice overexploitation of biodiversity and continued habitat (shelter) destruction (deforestation). Extinction of species is on the increase—everyday we are losing one animal and one plant species. Already a large number of plant and animal species are in the list of the endangered species.

CONSERVATION

Forests

1927, Indian Forest Act—Forests were classified as

- Reserve Forest
- Protected Forest
- Village Forest
- Restriction on hunting and authorised establishments of Sanctuaries.

1976, 42nd Amendment to the Constitution of India—Forests were transferred from State list to the Concurrent list (i.e. all India Basis).

1980, Indian Forest Act—National Forest Policy

- Prohibits State Governments for declaring any portion of forest as non-reserved without approval of Central Government.
- Prohibits State Government for allotting any forest land or any portion thereof for any non-forest purpose.

1988, Indian Forest Act—Welfare of forest-dwellers is the major objective

- Prohibits lease of forest land to anybody other than Government.
- Conservation, planting and increase of forest cover to an average of 30 per cent across the country.

Wildlife

1927, Indian Forest Act—Restriction on hunting

- establishment of sanctuaries.

1936, Corbett National Park—First wild life National Park Act

- establishment of Sanctuary—Tiger reserve.

1972, Wildlife Protection Act—Action Plan for wild life objectives

- management of protected areas and habitat
- rehabilitation of endangered and threatened species
- National Conservation Strategy
- collaboration with voluntary bodies and NGOs.

Unit 4: Environmental Pollution

AIR POLLUTION

Pure air is colourless and odourless. But various pollutants from natural and man-made sources are entering the atmosphere daily and these disturb the dynamic equilibrium in the atmosphere. This leads to air pollution when the normal properties of air are upset and both man and environment suffer.

Natural sources of air pollution are: • Volcanic activity, vegetation decay, forest fires emitting carbon monoxide, sulphur dioxide and hydrogen sulphide and tiny particles of solids or liquids sprayed from the seas and land by wind.

Man-made sources are: • Gases, mists, particulates and aerosols emitted by industries and other chemical and biological processes used by man.

There are five primary pollutants which together contribute more than 90 per cent of global air pollution: Carbon monoxide, CO Nitrogen oxides, NOX Hydrocarbons, HC Sulphur oxides, SOX and Particulates.

Carbon Monoxide, CO It is a colourless, odourless and tasteless gas which is injurious to our health. Each year 350 million tons of CO (275 million tons from human sources and 75 million tons from natural sources) are emitted all over the world in which USA alone shares 100 million tons. Transportation accounts for 70 per cent of CO emission. That is to say, diesel and petroleum engines in automobiles are primarily responsible for about 70 per cent of CO emissions.

Control of CO Pollution The petroleum and diesel-fed automobiles account for major share of carbon monoxide emission. Hence efforts for carbon monoxide pollution control are mainly aimed at automobiles. Use of catalytic converters in the internal combustion engines of automobiles helps in cleaning up the exhaust emissions. Such converters built into the automobile engines promote oxidation-reduction cycles and ensure complete combustion of carbon monoxide, nitrogen oxides and hydrocarbons. The following figure and flow-sheet illustrate the action of catalytic converters: Use of catalytic converters in two stages helps in elimination of pollutants from exhaust gases before they are discharged into the atmosphere.

In the first converter nitrogen oxides are reduced to nitrogen (+ ammonia) in presence of finely divided catalyst platinum, and the reducing gases, carbon monoxide and hydrocarbons. The production of ammonia is kept at a minimum under carefully controlled conditions. In the second converter, air is introduced to provide an oxidizing atmosphere for complete oxidation of carbon monoxide and hydrocarbon into carbon dioxide and water in presence of finely divided platinum catalyst.

ACID RAIN

It has been described above that much of nitrogen oxides, NOX and sulphur oxides, SOX entering the atmosphere are transformed into nitric acid (HNO_3) and sulphuric acid (H_2SO_4) respectively. These combine with hydrogen chloride, HCl from HCl emissions (both by man-made and natural sources) and generate acidic precipitation, known as acid rain.

Acid rain is a major environmental issue as it badly damages the environment. It damages buildings and structural materials of marble, limestones, slate and mortar. These materials become structurally

hearing, has audio range between 20 Hz and 20,000 Hz. The audio sense is sharpest in the frequency range 2000–8500 Hz.

WATER POLLUTION CONTROL AND WATER MANAGEMENT—WATER RECYCLING

Clean water is essential for healthy environment to support life systems on this planet. The task of delicately balancing the ratio of available and exploitable water resources and sustaining their quality is most important for India as rainfall distribution is confined to 3–4 months in a year. Moreover, man-made global and local climatic distortions due to global warming (see Chapter 6), deforestation, loss of top soil, etc. have adverse effect on the monsoon pattern in India. India is blessed with good rainfall (average 200 cm in a year) but 70 per cent of it is wasted. The country faces recurring problems of floods, and droughts and highly polluted water resources. It is necessary to do rain harvesting, i.e. build large tanks and reservoirs all over the country to store rain water, flood water and excess water from the Ganga, Brahmaputra and other rivers. The rivers, the lifelines of our culture and economy, are dying because of severe pollution. This water pollution abatement and resource management should be at the top of our national agenda.

The river water pollution has three dimensions—agricultural run-off, industrial effluents and domestic sewage. A typical example is that of the Ganga pollution. The total quantity of fresh water used in the Ganga basin is 150 billion cubic meters out of which 26 per cent is discharged as waste water. Agricultural run-off is 27 billion cubic metre compared to 1530 million cubic metre from industrial and domestic sewage.

Ground water is relatively clean because of its location below the land surface where it gets filtered through layers of soil and rocks but it gets polluted due to leaching of minerals from above. (See Arsenic pollution). Land Use Planning: Land, an important component of our lifesupport system, requires careful utilisation to satisfy the needs of the people. The uses of land include agriculture, forestry, housing, urbanisation, industrialisation, roadways, railways, etc. The welfare of a country depends on land use planning by the government.

Waste Water Treatment: Both domestic sewage (84%) and industrial sewage (16%) are responsible for water pollution. Municipal waste water is handled by sewage treatment plants. The processes are screening, sedimentation, biological decomposition, chlorination, etc. of effluent. The resulting clean water is fit for domestic use. Industrial wastes are treated by activated charcoal filtration or ion exchange resins.

Water Pollution: Man-made activities disturb the biological and physico-chemical properties of water and lead to water pollution. The common sources of water pollution are sewage (pathogenic), chemical salts, organic matter, etc., industrial chemicals including fertilisers, pesticides, etc. which are directly or indirectly discharged into water bodies. Water pollution must be controlled to ensure good quality of water which is essential for the welfare of mankind. Water Pollutants: Consist of organic pollutants (domestic sewage, pesticides, synthetic organic compounds, etc.), sediments, radioactive materials, inorganic pollutants, (inorganic salts, acids, metals, etc.).

Water Quality: The extent of purity of water for drinking, domestic and other purposes is called the water quality. Good water quality is essential for sound public health. The World Health Organization (WHO), US Public Health and Indian Standards Institution have laid down standards for water quality parameters.

with sulphuric acid to form soluble sulphate, which is leached out

$CaSO_4 + CO_2 + H_2O$

troposphere and lower stratosphere. The ground air, 1–100 highly polluted in urban and industrial areas. Some pollutants are absorbed on surfaces. The primary pollutants discharged into the atmosphere, changes in presence of water vapour, oxygen and solar ultra-violet radiation and secondary pollutants. Carbon dioxide Carbonic acid Hydrogen sulphide Sulphuric acid Sulphur dioxide Sulphuric acid Nitrogen oxides Nitric acid These pollutants (secondary) have harmful effects on soil, vegetation, crops, animals, men and materials. Plants are affected both by gaseous pollutants and by particulates deposited on soil. Acid rain over a period of time tends to reduce the soil pH (= log 1/n i.e. negative logarithm of hydrogen ion concentration which is an index of acidity, alkalinity or neutrality) and renders it acidic and less fertile. Moreover, deposition of toxic metals on soil in industrial areas makes the soil unsuitable for growth of plants.

AIR QUALITY STANDARDS

Each pollutant, present in air, has a threshold limit value (TLV) which, if exceeded, causes public health hazards. Table 6.4 gives a list of typical pollutants with their threshold limits (TLV). For factory workers TLV sets the limit of exposure for 40-hour week (8 hours a day) without adverse effects. These TLV values are determined mainly by experiments on animals.

NOISE POLLUTION AND HEALTH

Noise is part of our environment. With progress in industrialisation, the noise level has been rising continuously. In the 19th century the development of the steam engines, petrol engine and machines in factories resulted in increasingly noisy environment. In the 20th century this was further accelerated by introduction of diesel engine, jet engines, turboprop, high tech machineries, construction site machineries and automobile traffic. Noise has been recognised as one of the dimensions of pollution which brings about degradation of the environment and creates health and communication hazards.

Sound and Human Acoustics Sound consists of wave motion in an elastic medium such as air, water or solids (e.g. metals, plastics, wood, bricks, etc.). Sound waves travel through the medium from the source to the recipient or listener. The rate of the oscillation of the medium is known as the frequency of the sound, the unit being Hertz (Hz) or cycles per second. The frequency is a measure of the pitch of the sound received by the listener. High frequencies mean high pitched sounds which are more irritating to the individual than low frequencies. The second parameter of sound in sound pressure which is measured in Newtons per sq. metre (N/m^2). The third parameter on sound is its intensity, expressed in watts per sq. metre, i.e. the quantum of sound energy that flows through unit area of the medium in unit time.

The human ear receives sound waves which set up oscillations in the ear drum (tympanic membrane). These oscillations cause movement of three small bones in the middle ear behind the ear drum. These then pass through the fluid in the inner ear to the auditory nerve and finally transmitted to the brain. The oscillations or sound are intensified and interpreted in the brain, which can select sounds into different categories—speech, music, noises, etc. The sensitivity of the ear varies from person to person. With ageing, people lose hearing power gradually. A young person, 18 years old, with normal

Water Recycling: Polluted waste water, after treatment and purification, can be reused for domestic and industrial purposes and for irrigation.

Water Resources: Consist of seas and oceans (97%), polar ice-caps (2.3%) and fresh water in rivers, lakes and streams and ground water (0.66%). Water is essential for the sustenance of all living organisms including plants, animals and man. The water resources are limited and are not likely to last for more than a century. Water pollution by man-made activities will lead to water famine and crisis in future.

SOIL POLLUTION

Soil contamination or soil pollution is caused by the presence of xenobiotic (human-made) chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals, or improper disposal of waste. The most common chemicals involved are petroleum hydrocarbons, polynuclear aromatic hydrocarbons (such as naphthalene and benzopyrene), solvents, pesticides, lead, and other heavy metals. Contamination is correlated with the degree of industrialization and intensity of chemical usage.

The concern over soil contamination stems primarily from health risks, from direct contact with the contaminated soil, vapors from the contaminants, and from secondary contamination of water supplies within and underlying the soil. Mapping of contaminated soil sites and the resulting cleanup are time consuming and expensive tasks, requiring extensive amounts of geology, hydrology, chemistry, computer modeling skills, and GIS in Environmental Contamination, as well as an appreciation of the history of industrial chemistry. The waste from factory is also a cause of soil pollution.

Soil pollution can be caused by the following: Accidental Spills, Acid rain (Which is caused by air pollution), Intensive farming, Deforestation, Genetically modified plants, Nuclear wastes, Industrial Accidents, Landfill and illegal dumping, Land Erosion, Agricultural practices, such as application of pesticides, herbicides and fertilizers, Mining and other industries, Oil and fuel dumping, Buried wastes, Disposal of coal ash, Disposal of ammunitions and agents of war, Drainage of contaminated surface water into the soil, Electronic waste.

THERMAL POLLUTANTS

Coal-fired or nuclear fuel-fired thermal power plants are sources of thermal pollution. The hot water from these plants is dumped as waste into nearby lake or river where its temperature rises by about 10° C. This has harmful effect on aquatic life in the water body whose D.O. is reduced and as a result, fish kill is quite common.

SOLID WASTE MANAGEMENT

According to biologists, bacteria and fungi are capable of decomposing organic waste and it may be possible to recover resources by this process. Natural micro-organisms can do this job—it is also possible to produce such micro-organisms by genetic engineering. The promising development is the isolation of bacteria which can break down polychlorinated biphenyls (PCBs). New biodegradable plastics are important step towards solving our solid waste problems in respect of plastic wastes. On exposure to micro-organisms which metabolise glucose, biodegradable polymers break down into short carbon chains that decomposers can metabolise. Photodegradable plastics have been developed, which break down on exposure to sunlight.

DISASTER MANAGEMENT

Disaster management (or emergency management) is the creation of plans through which communities reduce vulnerability to hazards and cope with disasters. Disaster management does not avert or eliminate the threats, instead it focuses on creating plans to decrease the impact of disasters. Failure to create a plan could lead to damage to assets, human mortality, and lost revenue. Currently in the United States 60% businesses do not have emergency management plans. Events covered by disaster management include acts of terrorism, industrial sabotage, fire, natural disasters (such as earthquakes, hurricanes, etc.), public disorder, industrial accidents, and communication failures.

If possible, emergency planning should aim to prevent emergencies from occurring, and failing that, should develop a good action plan to mitigate the results and effects of any emergencies. As time goes on, and more data becomes available, usually through the study of emergencies as they occur, a plan should evolve. The development of emergency plans is a cyclical process, common to many risk management disciplines, such as Business Continuity and Security Risk Management, as set out below:

1. Recognition or identification of risks,
2. Ranking or evaluation of risks,
3. Responding to significant risks.
4. Tolerate, Treat, Transfer, Terminate
5. Resourcing controls,
6. Reaction Planning
7. Reporting & monitoring risk performance
8. Reviewing the Risk Management framework

There are a number of guidelines and publications regarding Emergency Planning, published by various professional organisations such as ASIS, FEMA and the Emergency Planning College. There are very few Emergency Management specific standards, and emergency management as a discipline tends to fall under business resilience standards.

In order to avoid or reduce significant losses to a business, emergency managers should work to identify and anticipate potential risks, hopefully to reduce their probability of occurring. In the event that an emergency does occur, managers should have a plan prepared to mitigate the effects of that emergency, as well as to ensure Business Continuity of critical operations post-incident. It is essential for an organisation to include procedures for determining whether an emergency situation has occurred and at what point an emergency management plan should be activated.

Flood is an overflow of water that "submerges" land. The EU Floods Directive defines a flood as a temporary covering by water of land not normally covered by water. In the sense of "flowing water", the word may also be applied to the inflow of the tides. Flooding may result from the volume of water within a body of water, such as a river or lake, which overflows causing the result that some of the water escapes its usual boundaries. While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, it is not a significant flood unless the water covers land used by man like a village, city or other inhabited area, roads, expanses of farmland, etc.

Earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves. At the Earth's surface, earthquakes manifest themselves by vibration, shaking and sometimes displacement of the ground. The vibrations may vary in magnitude. Earthquakes are caused mostly by slippage within geological faults, but also by other events such as volcanic activity, landslides, mine blasts, and nuclear tests. The underground point of origin of the earthquake is called the focus. The point directly above the focus on the surface is called the epicenter. Earthquakes by themselves rarely

kill people or wildlife. It is usually the secondary events that they trigger, such as building collapse, fires, tsunamis (seismic sea waves) and volcanoes, that are actually the human disaster. Many of these could possibly be avoided by better construction, safety systems, early warning and planning.

Cyclone, tropical cyclone, hurricane, and typhoon are different names for the same phenomenon, which is a cyclonic storm system that forms over the oceans. The deadliest hurricane ever was the 1970 Bhola cyclone; the deadliest Atlantic hurricane was the Great Hurricane of 1780 which devastated Martinique, St. Eustatius and Barbados.

Extratropical cyclones, sometimes called mid-latitude cyclones, are a group of cyclones defined as synoptic scale low pressure weather systems that occur in the middle latitudes of the Earth (outside the tropics) not having tropical characteristics, and are connected with fronts and horizontal gradients in temperature and dew point otherwise known as "baroclinic zones".

Drought is unusual dryness of soil, resulting in crop failure and shortage of water for other uses, caused by significantly lower rainfall than average over a prolonged period. Hot dry winds, shortage of water, high temperatures and consequent evaporation of moisture from the ground can contribute to conditions of drought.

Unit:5 Social Issues and Environment

SUSTAINABLE DEVELOPMENT (SD) is a process for meeting human development goals while sustaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depend. While the modern concept of sustainable development is derived most strongly from the 1987 Brundtland Report, it is rooted in earlier ideas about sustainable forest management and twentieth century environmental concerns.

The ecological sustainability of human settlements is part of the relationship between humans and their natural, social and built environments. Also termed human ecology, this broadens the focus of sustainable development to include the domain of human health. Fundamental human needs such as the availability and quality of air, water, food and shelter are also the ecological foundations for sustainable development; addressing public health risk through investments in ecosystem services can be a powerful and transformative force for sustainable development which, in this sense, extends to all species.

Sustainable agriculture consists of environmentally-friendly methods of farming that allow the production of crops or livestock without damage to human or natural systems. It involves preventing adverse effects to soil, water, biodiversity, surrounding or downstream resources—as well as to those working or living on the farm or in neighboring areas. The concept of sustainable agriculture extends intergenerationally, passing on a conserved or improved natural resource, biotic, and economic base rather than one which has been depleted or polluted. Elements of sustainable agriculture include permaculture, agroforestry, mixed farming, multiple cropping, and crop rotation.

Sustainable energy is the sustainable provision of energy that is clean and lasts for a long period of time. Unlike the fossil fuel that most of the countries are using, renewable energy only produces little or even no pollution. Household energy consumption can also be improved in a sustainable way, like using electronics with Energy Star logos which conserve water and energy. As renewable energy becomes more common, fossil fuel infrastructures is replaced by renewables, providing better social equity to these community.

URBAN PROBLEMS RELATED TO ENERGY

Urban centers use enormous quantities of energy. In the past, urban housing required relatively smaller amounts of energy than we use at present. Traditional housing in India required very little temperature adjustments as the material used, such as wood and bricks, handled temperature changes better than the current concrete, glass and steel of ultra-modern building.

Cities are the main centres of economic growth, trade, education, innovations and employment. Until recently a big majority of human population lived in rural areas and their economic activities cantered on agriculture, cattle, rearing, fishing, hunting or some cottage industry. It was some two hundred years ago with the dawn of industrial era the cities showed rapid development. Now about 50% of the world population lives in urban areas and- there is increasing movement of rural folk to cities in search of employment.

The urban growth is so fast that it is becoming difficult to accommodate all the industrial, commercial and residential facilities within a limited municipal boundary. As a result there is spreading of the cities into the sub-urban or rural areas too, this phenomenon is known as "urban sprawl". In developing countries too urban growth is very fast and in most of the cases it is uncontrollable and unplanned

growth. In contrast to the rural set up, the urban set up is densely populated, consumes a lot of energy and materials and generates a lot of waste.

Energy use is closely related to development in industry, transport, communication, commercial, household and agricultural activities. The energy requirement of urban population is much higher than that of rural ones. This is because urban people have a higher standard of life and their lifestyle demands more energy inputs in every sphere of life. In urban areas the need of energy is increasing by leaps and bounds. Moreover, countries use energy in an uneven manner in the world. In developed countries the amount of energy used is much more compared to developing countries.

WATERSHED MANAGEMENT

Water is an integral part of land/soil productivity—its use and misuse can cause both soil degradation and soil erosion. Availability of water in a given soil environment is a critical factor and is related to erosion, siltation, less of plant cover and productivity. Both control measures and production from land imply management of rainfall and resultant run-off. Such management can best be based on a natural unit called watershed. Watershed is an area bounded by the divide line of water flow so that a distinct drainage basin of a small or big water course of stream can be identified. The Himalayas are one of the most critical watersheds inthe world. The Gangetic basin has high population density—more than 400 million people live in this basin. In the plains of Pakistan, India and Bangladesh more than 460 million people are affected by environmentally unsound developmental projects and land abuses in the mountains by about 46 million people in the Himalayan watershed. There is need for massive afforestation in these hill areas, particularly hilly slopes to make up for the damage already done by deforestation. It is also necessary to safeguard against environment damage caused by developmental projects in the region. With availability of less and less of snow in the Gangetic source, the Ganga will have less quantum of water flow and may dry up in future in the extreme case. That will lead to massacre of the Gangetic basin containing 40 per cent population.

ENVIRONMENTAL ETHICS

Environmental ethics is the part of environmental philosophy which considers extending the traditional boundaries of ethics from solely including humans to including the non-human world. It exerts influence on a large range of disciplines including environmental law, environmental sociology, ecotheology, ecological economics, ecology and environmental geography.

There are many ethical decisions that human beings make with respect to the environment. For example:

- Should we continue to clear cut forests for the sake of human consumption?
- Why should we continue to propagate our species, and life itself?
- Should we continue to make gasoline powered vehicles?
- What environmental obligations do we need to keep for future generations?
- Is it right for humans to knowingly cause the extinction of a species for the convenience of humanity?
- How should we best use and conserve the space environment to secure and expand life?

CLIMATE CHANGE AND GLOBAL WARMING

Global warming and climate change refer to an increase in average global temperatures. Natural events and human activities are believed to be contributing to an increase in average global

temperatures. This is caused primarily by increases in "greenhouse" gases such as Carbon Dioxide (CO_2). A warming planet thus leads to a change in climate which can affect weather in various ways, as discussed further below.

The term greenhouse is used in conjunction with the phenomenon known as the greenhouse effect. Energy from the sun drives the earth's weather and climate, and heats the earth's surface; In turn, the earth radiates energy back into space; Some atmospheric gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse; These gases are therefore known as greenhouse gases; The greenhouse effect is the rise in temperature on Earth as certain gases in the atmosphere trap energy.

Six main greenhouse gases are carbon dioxide (CO_2), methane (CH_4) (which is 20 times as potent a greenhouse gas as carbon dioxide) and nitrous oxide (N_2O), plus three fluorinated industrial gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Water vapor is also considered a greenhouse gas.

Ozone depletion describes two distinct but related phenomena observed since the late 1970s: a steady decline of about 4% in the total volume of ozone in Earth's stratosphere (the ozone layer), and a much larger springtime decrease in stratospheric ozone around Earth's polar regions. The latter phenomenon is referred to as the ozone hole. In addition to these well-known stratospheric phenomena, there are also springtime polar tropospheric ozone depletion events.

CONSUMMERISM AND WASTE PRODUCTS

Consumerism refers to the consumption of resources by the people. While early human society used to consume much less resources, with the dawn of the industrial area, consumerism has shown an exponential rise. It has been related both to the increase in our demands due to change in the life style. Earlier we used to live a simple life and used to have fewer wants. In the modern society our needs have multiplied and so consumerism of resources has also multiplied. We have to face a number of interconnected environmental and resource problems.

In developing countries, population size and the resulting degradation of renewable resources tend to be the key factors in total environmental impact. In such countries per capita resource use is low. But in development countries, high rate of per capita resources use and the resulting high level of pollution and environmental degradation per person usually are the key factors determining overall environmental impact. For example the average U.S. Citizen consumes about 35 times as much as average citizen of India and 100 times as much as the average person is the world's poorest country.

ENVIRONMENTAL LAWS/ACTS

There are more than 200 Central and State Laws to-day that can be interpreted one way or another to protect the environment. Only the more important Laws/Acts are tabulated below.

Forests

1927, Indian Forest Act—Forests were classified as • Reserve Forest • Protected Forest • Village Forest • Restriction on hunting and authorised establishments of Sanctuaries.

1976, 42nd Amendment to the Constitution of India—Forests were transferred from State list to the Concurrent list (i.e. all India Basis).

1980, Indian Forest Act—National Forest Policy • Prohibits State Government's for declaring any portion of forest as non-reserved without approval of Central Government. • Prohibits State Government for allotting any forest land or any portion thereof for any non-forest purpose.

1988, Indian Forest Act—Welfare of forest dwellers is the major objective • Prohibits lease of forest land to anybody other than Government. • Conservation, planting and increase of forest cover to an average of 30 per cent across the country.

Wildlife

1927, Indian Forest Act—Restriction on hunting • establishment of sanctuaries.

1936, Corbett National Park—First wild life National Park Act • establishment of Sanctuary—Tiger reserve.

1972, Wildlife Prptection Act—Action Plan for wild life objectives • management of protected areas and habitat, • rehabilitation of endangered and threatened species, • National Conservation Strategy, • collaboration with voluntary bodies and NGOs.

Water

1927, Indian Forest Act—Prohibits poisoning of water in forests.1948, Indian Factories Act—Restrictions on discharge of effluents into water bodies 1974, Water (Prevention and control of Pollution Act)—Setting up of Pollution Control Boards at Centre and States • Industries required to submit discharge data for effluents, • Penal provision for non-compliance. 1986, Environment Protection Act (EPA) (Act introduced in the wake of Bhopal Disaster, 1984)—Protection and improvement of human environment and prevention of hazards to humans, plants, animals and property The Environment Protection Act (EPA) empowered the Central Government to issue orders for closing down industries for non-compliance, imposing on them heavy penalty, etc. Under the provision of EPA, every State set up "Green Bench" courts to attend to Public Interest Litigation (PIL) cases concerning environmental hazards affecting the quality of life of the citizen. The "Green Bench" courts have been empowered to settle the cases quickly and provide legal redress to the citizens.

Air

1948, Indian Factories Act—Protection to workers against hazardous processes.

1981, Air (Prevention and Control of Pollution Act) Act— Ambient air quality specified. • monitoring stations established.

1987, Air Act—Empowers Government to close down polluting industries and stop their supply line of water and electricity.

1989, Motor Vehicles Act—Emission standards of carbon monoxide and hydrocarbons specified.

HUMAN POPULATION AND DISTRIBUTION

Population is intimately related to environment. The Human population has grown faster in the 20th century than ever before. World population doubled in 40 years between 1950 and 1990 to cross five billion. The developed countries account for 1.5 billion and developing countries 3.5 billion population. By 2010 AD the population has touched 6.3 billion and by 2000 it will grow to 7 billion (one in every seven will be an Indian). World population is growing by 92 million every year, roughly adding population of Mexico. It is interesting to note that it took about 2 million years for the world population to become 1 billion (1830), 100 years for 2 billion (1930), 30 years for 3 billion (1960), 15

years for 4 billion (1986) and 11 years for 5 billion (1987). The population stands at 6.3 billion (2000) and is estimated to be about four the times around 22.5 billion in 2100. In developed countries the population is likely to be less than double while in developing countries like India about four times (2100). The statistics for India is of serious concern. Between 1901 and 1951 India's population grew from 238 million to 361 million an increase of 52 per cent in 50 years. Between 1951 and 1981 it expanded from 361 to 685 million. Post-independent India in 35 years (1947–81) literally added a second India, i.e. doubled its population. In 2000 it has touched 1 billion mark and is the second most populous country, next to China (May 11, 2000). We have been overwhelmed by population explosion since 1980. According to 2001 Census Report, India has joined one billion club, with population of 1.02 billion, ranking second to China (1.265 billion). By 2025 India is likely to overtake China and will be the most populous country in the world. It has to be noted that whereas Chinese population is under control with growth rate of 0.7 per cent, India's population growth rate is 1.8 per cent at present. While China with its strong economy can support its 1 billion plus population, India cannot afford to do so, being one of the poorest countries in the world (400 million people live below the poverty line). We are overwhelmed by the population explosion since 1980 and that remains the core issue of our environment and economy. Indian population statistics 1901 1951 2001 238 million 361 million 1020 million

Distribution For historical and other reasons people are not uniformly distributed. USA and Canada have a population of 250 million; South America and the Soviet Union (CIS) have the same population. Africa and Western Europe have about 500 million people; East Asia, i.e. China, Japan and Korea have more than 1 billion while South Asia is the most populous region, 1.5 billion (India, Bangladesh, Pakistan more than 1 billion). India is adding every year the population of Australia at the current rate.

FAMILY WELFARE SCHEMES

National Family Welfare Programme (External website that opens in a new window) - India launched the National Family Welfare Programme in 1951 with the objective of "reducing the birth rate to the extent necessary to stabilise the population at a level consistent with the requirement of the National economy. The Family Welfare Programme in India is recognised as a priority area, and is being implemented as a 100% centrally sponsored programme.

National Population Policy (External website that opens in a new window) - The National Population Policy, 2000 affirms the commitment of government towards voluntary and informed choice and consent of citizens while availing of reproductive health care services and continuation of the target free approach in administering family planning services.

National Rural Health Mission (File referring to external site opens in a new window) - The National Rural Health Mission (2005-12) seeks to provide effective healthcare to rural population throughout the country with special focus on 18 states, which have weak public health indicators and/or weak infrastructure. The mission aims at effective integration of health concerns with determinants of health like sanitation and hygiene, nutrition and safe drinking water through a District Plan for Health.

Urban Family Welfare Schemes (External website that opens in a new window) - This Scheme was introduced following the recommendation of the Krishnan Committee in 1983. The main focus was to provide services through setting up of Health Posts mainly in slum areas. The services provided are mainly outreach of RCH services, preventive services, First Aid and referral services including distribution of contraceptives.

Sterilization Beds Scheme (External website that opens in a new window) - A Scheme for reservation of Sterilization beds in Hospital sun by Government, Local Bodies and Voluntary Organisations was

introduced as early as in the year 1964 in order to provide immediate facilities for tubectomy operations in hospitals where such cases could not be admitted due to lack of beds etc. But later with the introduction of the Post Partum Programme some of the beds were transferred to Post Partum Programme and thereafter the beds were only sanctioned to hospitals sun by Local Bodies and Voluntary Organisations.

Reproductive and Child Health Programme (External website that opens in a new window) - The Reproductive and Child Health Programme was launched in October 1997 incorporating new approach to population and development issues, as exposed in the International Conference in Population and Development held at Cairo in 1994. The programme integrated and strengthened in services/interventions under the Child Survival and Safe Motherhood Programme and Family Planning Services and added to the basket of services, new areas on Reproductive Tract/Sexually Transmitted infections (RTI/STI).