ENVIRONMENTAL STUDIES

3RD SEMESTER ETC

Due to various aspects of human developments including the demand of different kinds of technological innovations, most people have been forgetting that, the Environment in which they are living is to be maintained under various living standards for the preservation of better health. The degradation of environment due to industrial growth is very much alarming due to environmental pollution beyond permissible limits in respect of air, water industrial waste, noise etc. Therefore, the subject of Environmental Studies to be learnt by every student in order to take care of the environmental aspect in each and every activity in the best possible manner.

CHAPTER 1
The Multidisciplinary nature of environmental studies:

Definition

Environmental studies deals with every issue that affects an organism. It is essentially a multidisciplinary approach that brings about an appreciation of our natural world and human impacts on its integrity.

It is an applied science as its seeks practical answers to making human civilization sustainable on the earth's finite resources. Its components include biology, geology, chemistry, physics, engineering, sociology, health, anthropology, economics, statistics, computers and philosophy.

Scope

As we look around at the area in which we live, we see that our surroundings were originally a natural landscape such as a forest, a river, a mountain, a desert, or a combination of these elements. Most of us live in landscapes that have been heavily modified by human beings, in villages, towns or cities. But even those of us who live in cities get our food supply from surrounding villages and these in turn are dependent on natural landscapes such as forests, grasslands, rivers, seashores, for resources such as water for agriculture, fuel wood, fodder, and fish. Thus our daily lives are linked with our surroundings and inevitably affects them. We use water to drink and for other day-to-day activities. We breathe air, we use resources from which food is made and we depend on the community of living plants and animals which form a web of life, of which we are also a part. Everything around us forms our environment and our lives depend on keeping its vital systems as intact as possible.

The industrial development and intensive agriculture that provides the goods for our increasingly consumer oriented society uses up large amounts of natural resources such as water, minerals, petroleum products, wood, etc.

Non renewable resources, such as minerals and oil are those which will be exhausted in the future if we continue to extract these without a thought for subsequent generations.

Renewable resources, such as timber and water, are those which can be used but can be regenerated by natural processes such as regrowth or rainfall. But these too will be depleted if we continue to use them faster than nature can replace them.

Our natural resources can be compared with money in a bank. If we use it rapidly, the capital will be reduced to zero. On the other hand, if we use only the interest, it can sustain us over the longer term. This is called **sustainable utilisation or development**.

Importance

Environment is not a single subject. It is an integration of several subjects that include both Science and Social Studies. To understand all the different aspects of our environment we need to understand biology, chemistry, physics, geography, resource management, economics and population issues.

Thus the scope of environmental studies is extremely wide and covers some aspects of nearly every major discipline.

NEED FOR PUBLIC AWARENESS

As the earth's natural resources are dwindling and our environment is being increasingly degraded by human activities, it is evident that something needs to be done. We often feel that managing all this is something that the Government should do. But if we go on endangering our environment, there is no way in which the Government can perform all these clean-up functions. It is the prevention of environment degradation in which we must all take part that must become a part of all our lives. Just as for any disease, prevention is better than cure. To prevent ill-effects on our environment by our actions, is economically more viable than cleaning up the environment once it is damaged. Individually we can play a major role in environment management. We can reduce wasting natural resources and we can act as watchdogs that inform the Government about sources that lead to pollution and degradation of our environment.

Suggested further activities for concerned students:

• Join a group to study nature, such as WWFI or BNHS, or another environmental group.

• Begin reading newspaper articles and periodicals such as 'Down to Earth', WWF-I newsletter, BNHS Hornbill, Sanctuary magazine, etc. that will tell you more about our environment. There are also several environmental websites.

• Lobby for conserving resources by taking up the cause of environmental issues during discussions with friends and relatives. Practice and promote issues such as saving paper, saving water, reducing use of plastics, practicing the 3Rs principle of reduce, reuse, recycle, and proper waste disposal.

• Join local movements that support activities such as saving trees in your area, go on nature treks, recycle waste, buy environmentally friendly products.

• Practice and promote good civic sense such as no spitting or tobacco chewing, no throwing garbage on the road, no smoking in public places, no urinating or defecating in public places.

• Take part in events organised on World Environment Day, Wildlife Week, etc.

• Visit a National Park or Sanctuary, or spend time in whatever nature you have near your home.

CHAPTER 2

Natural Resources

The natural resources include, air, water, soil, minerals, along with the climate and solar energy, which form the non-living or '**abiotic**' part of nature.

The '**biotic**' or living parts of nature consist of plants and animals, including microbes.

Plants and animals can only survive as communities of different organisms, all closely linked to each in their own habitat, and requiring specific abiotic conditions. Thus, forests, grasslands, deserts,

mountains, rivers, lakes and the marine environment all form habitats for specialised communities of plants and animals to live in. Interactions between the abiotic aspects of nature and specific living organisms together form ecosystems of various types. Many of these living organisms are used as our food resources. Others are linked to our food less directly, such as pollinators and dispersers of plants, soil animals like worms, which recycle nutrients for plant growth, and fungi and termites that break up dead plant material so that micro-organisms can act on the detritus to reform soil nutrients.

Non renewable resources:

Non-renewable resources include fossil fuels such as oil and coal, which if extracted at the present rate, will soon be totally used up. The end products of fossil fuels are in the form of heat and mechanical energy and chemical compounds, which cannot be reconstituted as a resource.

Renewable resources:

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). We also get renewable energy from burning trees and even garbage as fuel and processing other plants into biofuels.

Natural resources and associated problems

The unequal consumption of natural resources:

A major part of natural resources are today consumed in the technologically advanced or 'developed' world, usually termed 'the North'.

The 'developing nations' of 'the South', including India and China, also over use many resources because of their greater human population.

However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases.

Energy from fossil fuels is consumed in relatively much greater quantities in developed countries. Their per capita consumption of food too is much greater as well as their waste of enormous quantities of food and other products, such as packaging material, used in the food industry. The USA for example with just 4% of the world's population consumes about 25% of the world's resources. Producing animal food for human consumption requires more land than growing crops. Thus countries that are highly dependent on non-vegetarian diets need much larger areas for pastureland than those where the people are mainly vegetarian.

Planning Land use:

Land itself is a major resource, needed for food production, animal husbandry, industry, and for our growing human settlements. These forms of intensive land use are frequently extended at the cost of 'wild lands', our remaining forests, grasslands, wetlands and deserts. Thus it is essential to evolve a rational land-use policy that examines how much land must be made available for different

purposes and where it must be situated. For instance, there are usually alternate sites at which industrial complexes or dams can be built, but a natural wilderness cannot be recreated artificially.

The need for sustainable lifestyles:

The quality of human life and the quality of ecosystems on earth are indicators of the sustainable use of resources. There are clear indicators of sustainable lifestyles in human life.

• Increased longevity

• An increase in knowledge

• An enhancement of income. These three together are known as the 'Human development index'. The quality of the ecosystems has indicators that are more difficult to assess.

• A stabilized population.

• The long term conservation of biodiversity.

• The careful long-term use of natural resources.

• The prevention of degradation and pollution of the environment

Forest Resources

Use and overexploitation:

Scientists estimate that India should ideally have 33 per cent of its land under forests. Today we have only about 12 per cent. Thus we need not only to protect existing forests but also to increase our forest cover. People who live in or near forests know the value of forest resources first hand because their lives and livelihoods depend directly on these resources. However, the rest of us also derive great benefits from the forests which we are rarely aware of.

The water we use depends on the existence of forests on the watersheds around river valleys.

Our homes, furniture and paper are made from wood from the forest.

We use many medicines that are based on forest produce.

And we depend on the oxygen that plants give out and the removal of carbon dioxide we breathe out from the air.

Forests once extended over large tracts of our country. People have used forests in our country for thousands of years. As agriculture spread the forests were left in patches which were controlled mostly by tribal people. They hunted animals and gathered plants and lived entirely on forest resources. Deforestation became a major concern in British times when a large amount of timber was extracted for building their ships. This led the British to develop scientific forestry in India. They however alienated local people by creating Reserved and Protected Forests which curtailed access to the resources. This led to a loss of stake in the conservation of the forests which led to a gradual degradation and fragmentation of forests across the length and breadth of the country. Another period of overutilization and forest degradation occurred in the early period following independence

as people felt that now that the British had gone they had a right to using our forests in any way we pleased.

Deforestation:

Today logging and mining are serious causes of loss of forests in our country and all over the world. Dams built for hydroelectric power or irrigation have submerged forests and have displaced tribal people whose lives are closely knit to the forest. This has become a serious cause of concern in India. One of India's serious environmental problems is forest degradation due to timber extraction and our dependence on fuelwood. A large number of poor rural people are still highly dependent on wood to cook their meals and heat their homes. We have not been able to plant enough trees to support the need for timber and fuelwood. The National Forest Policy of 1988 now gives an added importance to JFM. Another resolution in 1990 provided a formal structure for community participation though the formation of Village Forest Committees. Based on these experiences, new JFM guidelines were issued in 2000. This stipulates that at least 25 per cent of the income from the area must go to the community. From the initiation of the program, until 2002, there were 63,618 JFM Committees managing over 140,953 sq. km of forest under JFM in 27 States in India. The States have tried a variety of approaches to JFM. The share for village forest committees ranges from 25 per cent in Kerala to 100 per cent in Andhra Pradesh, 50 per cent in Gujarat, Maharashtra, Orissa and Tripura. In many States 25 per cent of the revenue is used for village development. In many States non-timber forest products (NTFPs) are available for people free of cost. Some States have stopped grazing completely; some have rotational grazing schemes which have helped in forest regeneration.

Timber extraction, mining and dams are invariably parts of the needs of a developing country. If timber is overharvested the ecological functions of the forest are lost. Unfortunately forests are located in areas where there are rich mineral resources. Forests also cover the steep embankments of river valleys, which are ideally suited to develop hydel and irrigation projects. Thus there is a constant conflict of interests between the conservation interests of environmental scientists and the Mining and Irrigation Departments. What needs to be understood is that long-term ecological gains cannot be sacrificed for short-term economic gains that unfortunately lead to deforestation. These forests where development projects are planned, can displace thousands of tribal people who lose their homes when these plans are executed. This leads to high levels of suffering for which there is rarely a satisfactory answer.

Water resources

The water cycle, through evaporation and precipitation, maintains hydrological systems which form rivers and lakes and support in a variety of aquatic ecosystems. Wetlands are intermediate forms between terrestrial and aquatic ecosystems and contain species of plants and animals that are highly moisture dependent. All aquatic ecosystems are used by a large number of people for their daily needs such as drinking water, washing, cooking, watering animals, and irrigating fields. The world depends on a limited quantity of fresh water. Water covers 70% of the earth's surface but only 3% of

this is fresh water. Of this, 2% is in polar ice caps and only 1% is usable water in rivers, lakes and subsoil aquifers. Only a fraction of this can be actually used. At a global level 70% of water is used for agriculture about 25% for industry and only 5% for domestic use. India uses 90% for agriculture, 7% for industry and 3% for domestic use. The world population has passed the 6 billion mark. Based on the proportion of young people in developing countries, this will continue to increase significantly during the next few decades.

Overutilization and pollution of surface and groundwater: With the growth of human population there is an increasing need for larger amounts of water to fulfill a variety of basic needs. Today in many areas this requirement cannot be met. Overutilization of water occurs at various levels.

- Most people use more water than they really need. Most of us waste water during a bath by using a shower or during washing of clothes. Many agriculturists use more water than necessary to grow crops. There are many ways in which farmers can use less water without reducing yields such as the use of drip irrigation systems.
- Agriculture also pollutes surface water and underground water stores by the excessive use of chemical fertilizers and pesticides. Methods such as the use of biomass as fertilizer and non toxic pesticides such as neem products and using integrated pest management systems reduces the agricultural pollution of surface and ground water.
- Industry tends to maximise short-term economic gains by not bothering about its liquid waste and releasing it into streams, rivers and the sea. In the longer term, as people become more conscious of using 'green products' made by ecosensitive industries, the polluter's products may not be used. The polluting industry that does not care for the environment and pays off bribes to get away from the cost needed to use effluent treatment plants may eventually be caught, punished and even closed down.

Floods:

Floods have been a serious environmental hazard for centuries. However, the havoc raised by rivers overflowing their banks has become progressively more damaging, as people have deforested catchments and intensified use of river flood plains that once acted as safety valves. Wetlands in flood plains are nature's flood control systems into which overfilled rivers could spill and act like a temporary sponge holding the water, and preventing fast flowing water from damaging surrounding land.

Drought:

Drought has been a major problem in our country especially in arid regions. It is an unpredictable climatic condition and occurs due to the failure of one or more monsoons. It varies in frequency in different parts of our country

In most arid regions of the world the rains are unpredictable. This leads to periods when there is a serious scarcity of water to drink, use in farms, or provide for urban and industrial use.

Drought prone areas are thus faced with irregular periods of famine. Agriculturists have no income in these bad years, and as they have no steady income, they have a constant fear of droughts.

India has 'Drought Prone Areas Development Programs', which are used in such areas to buffer the effects of droughts. Under these schemes, people are given wages in bad years to build roads, minor irrigation works and plantation programs.

Sustainable water management:

'Save water' campaigns are essential to make people everywhere aware of the dangers of water scarcity. A number of measures need to be taken for the better management of the world's water resources. These include measures such as:

• Building several small reservoirs instead of few mega projects.

• Develop small catchment dams and protect wetlands.

• Soil management, micro catchment development and afforestation permits recharging of underground aquifers thus reducing the need for large dams.

• Treating and recycling municipal waste water for agricultural use.

• Preventing leakages from dams and canals.

• Preventing loss in Municipal pipes.

• Effective rain water harvesting in urban environments.

• Water conservation measures in agriculture such as using drip irrigation.

• Pricing water at its real value makes people use it more responsibly and efficiently and reduces water wasting.

• In deforested areas where land has been degraded, soil management by bunding along the hill slopes and making 'nala' plugs, can help retain moisture and make it possible to re-vegetate degraded areas.

Dams:

Today there are more than 45,000 large dams around the world, which play an important role in communities and economies that harness these water resources for their economic development. Current estimates suggest some 30-40% of irrigated land worldwide relies on dams. Hydropower, another contender for the use of stored water, currently supplies 19% of the world's total electric power supply and is used in over 150 countries.

Dams problems

• Fragmentation and physical transformation of rivers.

• Serious impacts on riverine ecosystems.

• Social consequences of large dams due to displacement of people.

• Water logging and salinisation of surrounding lands.

• Dislodging animal populations, damaging their habitat and cutting off their migration routes.

• Fishing and travel by boat disrupted.

• The emission of green house gases from reservoirs due to rotting vegetation and carbon inflows from the catchment is a recently identified impact.

Mineral Resources

A mineral is a naturally occurring substance of definite chemical composition and identifiable physical properties.

An ore is a mineral or combination of minerals from which a useful substance, such as a metal, can be extracted and used to manufacture a useful product.

Minerals are formed over a period of millions of years in the earth's crust. Iron, aluminum, zinc, manganese and copper are important raw materials for industrial use. Important non-metal resources include coal, salt, clay, cement and silica. Stone used for building material, such as granite, marble, limestone, constitute another category of minerals. Minerals with special properties that humans value for their aesthetic and ornamental value are gems such as diamonds, emeralds, rubies. The luster of gold, silver and platinum is used for ornaments. Minerals in the form of oil, gas and coal were formed when ancient plants and animals were converted into underground fossil fuels.

Minerals and their ores need to be extracted from the earth's interior so that they can be used. This process is known as mining.

Mining operations generally progress through four stages:

(1) Prospecting: Searching for minerals.

(2) Exploration: Assessing the size, shape, location, and economic value of the deposit.

(3) Development: Work of preparing access to the deposit so that the minerals can be extracted from it.

(4) Exploitation: Extracting the minerals from the mines.

Mine safety: Mining is a hazardous occupation, and the safety of mine workers is an important environmental consideration of the industry. Surface mining is less hazardous than underground mining. Metal mining is less hazardous than coal mining. In all underground mines, rock and roof falls, flooding, and inadequate ventilation are the greatest hazards. Large explosions have

occured in coal mines, killing many miners. More miners have suffered from disasters due to the use of explosives in metal mines.

Environmental problems: Mining operations are considered one of the main sources of environmental degradation. The extraction of all these products from the lithosphere has a variety of side effects. Depletion of available land due to mining, waste from industries, conversion of land to industry and pollution of land, water and air by industrial wastes, are environmental side effects of the use of these non-renewable resources. Public awareness of this problem is of a global nature and government actions to stem the damage to the natural environment have led to numerous international agreements and laws directed toward the prevention of activities and events that may adversely affect the environment.

Food resources

Today our food comes almost entirely from agriculture, animal husbandry and fishing. Although India is self-sufficient in food production, it is only because of modern patterns of agriculture that are unsustainable and which pollute our environment with excessive use of fertilizers and pesticides.

The FAO defines sustainable agriculture as that which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable. Most of our large farms grow single crops (monoculture). If this crop is hit by a pest, the entire crop can be devastated, leaving the farmer with no income during the year. On the other hand, if the farmer uses traditional varieties and grows several different crops, the chance of complete failure is lowered considerably. Many studies have shown that one can use alternatives to inorganic fertilizers and pesticides. **This is known as Integrated Crop Management**.

World food problems:

In many developing countries where populations are expanding rapidly, the production of food is unable to keep pace with the growing demand. Food production in 64 of the 105 developing countries is lagging behind their population growth levels. These countries are unable to produce more food, or do not have the financial means to import it. India is one of the countries that have been able to produce enough food by cultivating a large proportion of its arable land through irrigation. The Green Revolution of the 60's reduced starvation in the country.

However many of the technologies we have used to achieve this are now being questioned.

• Our fertile soils are being exploited faster than they can recuperate.

• Forests, grasslands and wetlands have been converted to agricultural use, which has led to serious ecological questions.

• Our fish resources, both marine and inland, show evidence of exhaustion.

• There are great disparities in the availability of nutritious food. Some communities such as tribal people still face serious food problems leading to malnutrition especially among women and children.

Energy resources

The sun is the primary energy source in our lives. We use it directly for its warmth and through various natural processes that provide us with food, water, fuel and shelter.

The sun's rays power the growth of plants, which form our food material, give off oxygen which we breathe in and take up carbon dioxide that we breathe out.

Energy from the sun evaporates water from oceans, rivers and lakes, to form clouds that turn into rain. Today's fossil fuels were once the forests that grew in prehistoric times due to the energy of the sun.

- Chemical energy, contained in chemical compounds is released when they are broken down by animals in the presence of oxygen.
- In India, manual labour is still extensively used to get work done in agricultural systems, and domestic animals used to pull carts and ploughs.
- Electrical energy produced in several ways, powers transport, artificial lighting, agriculture and industry. This comes from hydel power based on the water cycle that is powered by the sun's energy that supports evaporation, or from thermal power stations powered by fossil fuels.
- Nuclear energy is held in the nucleus of an atom and is now harnessed to develop electrical energy.

We use energy for **household use, agriculture, production of industrial goods and for running transport**. Modern agriculture uses chemical fertilizers, which require large amounts of energy during their manufacture. Industry uses energy to power manufacturing units and the urban complexes that support it. Energy-demanding roads and railway lines are built to transport products from place to place and to reach raw materials in mines and forests.

Growing energy needs:

Energy has always been closely linked to man's economic growth and development. Present strategies for development that have focused on rapid economic growth have used energy utilization as an index of economic development. This index however, does not take into account the long-term ill effects on society of excessive energy utilisation.

Types of energy:

There are three main types of energy; those classified **as non-renewable**; those that are said to be **renewable**; and **nuclear energy**, which uses such small quantities of raw material (uranium) that supplies are to all effect, limitless.

However, this classification is inaccurate because several of the renewable sources, if not used 'sustainably', can be depleted more quickly than they can be renewed.

Non-Renewable Energy:

- These consist of the mineral based hydrocarbon fuels coal, oil and natural gas, that were formed from ancient prehistoric forests.
- These are called 'fossil fuels' because they are formed after plant life is fossilized.
- At the present rate of extraction there is enough coal for a long time to come.
- Oil and gas resources however are likely to be used up within the next 50 years.
- When these fuels are burnt, they produce waste products that are released into the atmosphere as gases such as carbon dioxide, oxides of sulphur, nitrogen, and carbon monoxide, all causes of air pollution.
- These have led to lung problems in an enormous number of people all over the world, and have also affected buildings like the Taj Mahal and killed many forests and lakes due to acid rain.
- Many of these gases also act like a green house letting sunlight in and trapping the heat inside. This is leading to global warming, a raise in global temperature, increased drought in some areas, floods in other regions, the melting of icecaps, and a rise in sea levels, which is slowly submerging coastal belts all over the world.

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).
- We also get renewable energy from burning trees and even garbage as fuel and processing other plants into biofuels.
- One day, all our homes may get their energy from the sun or the wind. Your car's gas tank will use biofuel. Your garbage might contribute to your city's energy supply.
- Renewable energy technologies will improve the efficiency and cost of energy systems. We may reach the point when we may no longer rely mostly on fossil fuel energy.

Nuclear Power

- In 1938 two German scientists Otto Hahn and Fritz Strassman demonstrated nuclear fission.
- They found they could split the nucleus of a uranium atom by bombarding it with neutrons. As the nucleus split, some mass was converted to energy.
- The nuclear power industry however was born in the late 1950s. The first large-scale nuclear power plant in the world became operational in 1957 in Pennsylvania, US. Dr. Homi Bhabha was the father of Nuclear Power development in India.
- The nuclear reactors use Uranium 235 to produce electricity.
- Energy released from 1kg of Uranium 235 is equivalent to that produced by burning 3,000 tons of coal. U235 is made into rods which are fitted into a nuclear reactor.
- The control rods absorb neutrons and thus adjust the fission which releases energy due to the chain reaction in a reactor unit.

- The heat energy produced in the reaction is used to heat water and produce steam, which drives turbines that produce electricity.
- The drawback is that the rods need to be changed periodically. This has impacts on the environment due to disposal of nuclear waste.
- The reaction releases very hot waste water that damages aquatic ecosystems, even though it is cooled by a water system before it is released.

The disposal of nuclear waste is becoming an increasingly serious issue. The cost of Nuclear Power generation must include the high cost of disposal of its waste and the decommissioning of old plants. These have high economic as well as ecological costs that are not taken into account when developing new nuclear installations. For environmental reasons, Sweden has decided to become a Nuclear Free Country by 2010.

Land resources:

Landforms such as hills, valleys, plains, river basins and wetlands include different resource generating areas that the people living in them depend on. Many traditional farming societies had ways of preserving areas from which they used resources. Eg. In the 'sacred groves' of the Western Ghats, requests to the spirit of the Grove for permission to cut a tree, or extract a resource, were accompanied by simple rituals. The outcome of a chance fall on one side or the other of a stone balanced on a rock gave or withheld permission. The request could not be repeated for a specified period.

If land is utilized carefully it can be considered a renewable resource.

Land on earth is as finite as any of our other natural resources. While mankind has learnt to adapt his lifestyle to various ecosystems world over, he cannot live comfortably for instance on polar ice caps, on under the sea, or in space in the foreseeable future.

Man needs land for building homes, cultivating food, maintaining pastures for domestic animals, developing industries to provide goods, and supporting the industry by creating towns and cities. Equally importantly, man needs to protect wilderness area in forests, grasslands, wetlands, mountains, coasts, etc. to protect our vitally valuable biodiversity.

Thus a rational use of land needs careful planning. One can develop most of these different types of land uses almost anywhere, but Protected Areas (National Park's and Wildlife Sanctuaries) can only be situated where some of the natural ecosystems are still undisturbed. These Protected Areas are important aspects of good landuse planning.

Land Degradation:

- Farmland is under threat due to more and more intense utilisation.
- Every year, between 5 to 7 million hectares of land worldwide is added to the existing degraded farmland.

- When soil is used more intensively by farming, it is eroded more rapidly by wind and rain. Over irrigating farmland leads to salinisation, as evaporation of water brings the salts to the surface of the soil on which crops cannot grow.
- Over irrigation also creates water logging of the topsoil so that crop roots are affected and the crop deteriorates.
- The use of more and more chemical fertilizers poisons the soil so that eventually the land becomes unproductive.
- As urban centers grow and industrial expansion occurs, the agricultural land and forests shrink. This is a serious loss and has long term ill effects on human civilisation.

Soil erosion:

The characteristics of natural ecosystems such as forests and grasslands depend on the type of soil. Soils of various types support a wide variety of crops. The misuse of an ecosystem leads to loss of valuable soil through erosion by the monsoon rains and, to a smaller extent, by wind. The roots of the trees in the forest hold the soil. Deforestation thus leads to rapid soil erosion. Soil is washed into streams and is transported into rivers and finally lost to the sea. The process is more evident in areas where deforestation has led to erosion on steep hill slopes as in the Himalayas and in the Western Ghats. These areas are called '**ecologically sensitive areas'** or ESAs. To prevent the loss of millions of tons of valuable soil every year, it is essential to preserve what remains of our natural forest cover. It is equally important to reforest denuded areas. The linkage between the existence of forests and the presence of soil is greater than the forest's physical soil binding function alone. The soil is enriched by the leaflitter of the forest. This detritus is broken down by soil micro-organisms, fungi, worms and insects, which help to recycle nutrients in the system. Further losses of our soil wealth will impoverish our country and reduce its capacity to grow enough food in future.

ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES

The two most damaging factors leading to the current rapid depletion of all forms of natural resources are increasing 'consumerism' on the part of the affluent sections of society, and rapid population growth. Both factors are the results of choices we make as individuals. As individuals we need to decide;

- What will we leave to our children? (Are we thinking of short-term or long-term gain?)
- Is my material gain someone else's loss?

What can you do to save electricity?

• Turn off lights and fans as soon as you leave the room.

• Use tube lights and energy efficient bulbs that save energy rather than bulbs. A 40- watt tube light gives as much light as a 100 watt bulb.

• Keep the bulbs and tubes clean. Dust on tubes and bulbs decreases lighting levels by 20 to 30 percent.

• Switch off the television or radio as soon as the program of interest is over.

• A pressure cooker can save up to 75 percent of energy required for cooking. It is also faster.

• Keeping the vessel covered with a lid during cooking, helps to cook faster, thus saving energy.

EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFESTYLES

Reduction of the unsustainable and unequal use of resources, and control of our population growth are essential for the survival of our nation and indeed of human kind everywhere. Our environment provides us with a variety of goods and services necessary for our day-to-day lives, but the soil, water, climate and solar energy which form the 'abiotic' support that we derive from nature, are in themselves not distributed evenly throughout the world or within countries. A new economic order at the global and at national levels must be based on the ability to distribute benefits of natural resources by sharing them more equally among the countries as well as among communities within countries such as our own. It is at the local level where people subsist by the sale of locally collected resources, that the disparity is greatest. 'Development' has not reached them and they are often unjustly accused of 'exploiting' natural resources. They must be adequately compensated for the removal of the sources to distant regions and thus develop a greater stake in protecting natural resources.

CHAPTER 3
SYSTEMS

CONCEPT OF AN ECOSYSTEM

An 'Ecosystem' is a region with a specific and recognizable landscape form such as forest, grassland, desert, wetland or coastal area.

The nature of the ecosystem is based on its geographical features such as hills, mountains, plains, rivers, lakes, coastal areas or islands.

It is also controlled by climatic conditions such as the amount of sunlight, the temperature and the rainfall in the region.

The geographical, climatic and soil characteristics form its **non-living (abiotic)** component. These features create conditions that support a community of plants and animals that evolution has produced to live in these specific conditions.

The living part of the ecosystem is referred to as its **biotic** component.

Ecosystems are divided into

- **Terrestrial or Landbased ecosystems**
- **Aquatic ecosystems in water**

These form the two major habitat conditions for the Earth's living organisms.

Definition:

The living community of plants and animals in any area together with the non-living components of the environment such as soil, air and water, constitute the ecosystem.

STRUCTURE AND FUNCTIONS OF AN ECOSYSTEM

Structural aspects

Components that make up the structural aspects of an ecosystem include:

1) Inorganic aspects – C, N, CO_2 , H_2O.

2) Organic compounds – Protein, Carbohydrates, Lipids – link abiotic to biotic aspects.

3) Climatic regimes – Temperature, Moisture, Light & Topography.

4) Producers – Plants.

5) Macro consumers – Phagotrophs – Large animals.

6) Micro consumers – Saprotrophs, absorbers – fungi.

Functional aspects

1) Energy cycles.

2) Food chains.

3) Diversity-interlinkages between organisms.

4) Nutrient cycles-biogeochemical cycles.

5) Evolution.

PRODUCERS, CONSUMERS AND DECOMPOSERS

Every living organism is in some way dependent on other organisms. Plants are food for herbivorous animals which are in turn food for carnivorous animals. Thus there are different tropic levels in the ecosystem. Some organisms such as fungi live only on dead material and inorganic matter.

- Plants are the **'producers'** in producers the ecosystem as they manufacture their food by using energy from the sun. In the forest these form communities of plant life. In the sea these include tiny algal forms to large seaweed.
- The herbivorous animals are **primary consumers** as they live on the producers. In a forest, these are the insects, amphibia, reptiles, birds and mammals. The herbivorous animals include for example hare, deer and elephants that live on plant life. They graze on grass or feed on the foliage from trees. In grasslands, there are herbivores such as the blackbuck that feed on grass.
- At a higher tropic level, there are carnivorous animals, or **secondary consumers**, which live on herbivorous animals. In our forests, the carnivorous animals are tigers, leopards, jackals, foxes and small wild cats.

- **Decomposers or detrivores** are a group of organisms consisting of small animals like worms, insects, bacteria and fungi, which break down dead organic material into smaller particles and finally into simpler substances that are used by plants as nutrition.

Decomposition thus is a vital function in nature, as without this, all the nutrients would be tied up in dead matter and no new life could be produced.

ENERGY FLOW IN THE ECOSYSTEM

Every ecosystem has several interrelated mechanisms that affect human life. These are the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle. While every ecosystem is controlled by these cycles, in each ecosystem its abiotic and biotic features are distinct from each other.

- All the functions of the ecosystem are in some way related to the growth and regeneration of its plant and animal species.
- These linked processes can be depicted as the various cycles. These processes depend on energy from sunlight.
- During photosynthesis carbon dioxide is taken up by plants and oxygen is released. Animals depend on this oxygen for their respiration.
- The water cycle depends on the rainfall, which is necessary for plants and animals to live.
- The energy cycle recycles nutrients into the soil on which plant life grows. Our own lives are closely linked to the proper functioning of these cycles of life. If human activities go on altering them, humanity cannot survive on our earth.

ECOLOGICAL SUCCESSION

Ecological succession is a process through which ecosystems tend to change over a period of time.

Succession can be related to seasonal environmental changes, which create changes in the community of plants and animals living in the ecosystem. Other successional events may take much longer periods of time extending to several decades. If a forest is cleared, it is initially colonized by a certain group of species of plants and animals, which gradually change through an orderly process of community development.

The most frequent example of successional changes occur in a pond ecosystem where it fluctuates from a dry terrestrial habitat to the early colonisation stage by small aquatic species after the monsoon, which gradually passes through to a mature aquatic ecosystem, and then reverts back to its dry stage in summer where its aquatic life remains dormant.

FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

The food chains

The most obvious aspect of nature is that energy must pass from one living organism to another. When herbivorous animals feed on plants, energy is transferred from plants to animals. In an ecosystem, some of the animals feed on other living organisms, while some feed on dead organic

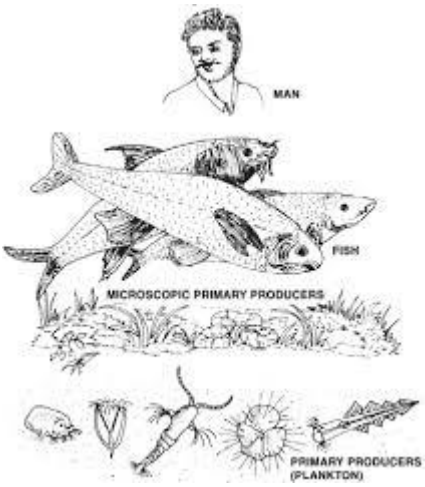
matter. The latter form the 'detritus' food chain. At each linkage in the chain, a major part of the energy from the food is lost for daily activities. Each chain usually has only four to five such links. However a single species may be linked to a large number of species.

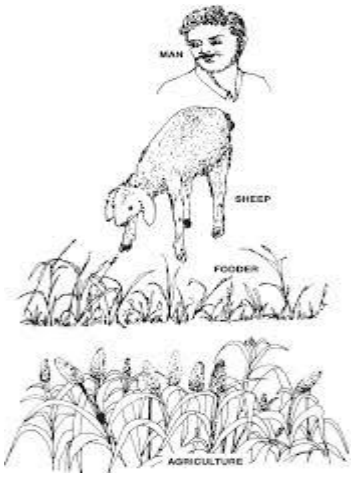
The food webs

In an ecosystem there are a very large number of interlinked chains. This forms a food web. If the linkages in the chains that make up the web of life are disrupted due to human activities that lead to the loss or extinction of species, the web breaks down.

The ecological pyramids

In an ecosystem, green plants – the producers, utilize energy directly from sunlight and convert it into matter. A large number of these organisms form the most basic, or first 'trophic level' of the food pyramid. The herbivorous animals that eat plants are at the second trophic level and are called primary consumers. The predators that feed on them form the third trophic level and are known as secondary consumers. Only a few animals form the third trophic level consisting of carnivores at the apex of the food pyramid. This is how energy is used by living creatures and flows through the ecosystem from its base to the apex. Much of the energy is used up in activities of each living organism.





Forest ecosystem

Forests are formed by a community of plants which is predominantly structurally defined by its trees, shrubs, climbers and ground cover. Natural vegetation looks vastly different from a group of planted trees, which are in orderly rows. The most 'natural' undisturbed forests are located mainly in our National Parks and Wildlife Sanctuaries. The landscapes that make up various types of forests look very different from each other. Their distinctive appearance is a fascinating aspect of nature. Each forest type forms a habitat for a specific community of animals that are adapted to live in it.

The forest ecosystem has two parts:

- **The non-living or abiotic aspects of the forest**: The type of forest depends upon the abiotic conditions at the site. Forests on mountains and hills differ from those along river valleys. Vegetation is specific to the amount of rainfall and the local temperature which varies

according to latitude and altitude. Forests also vary in their plant communities in response to the type of soil.

- **The living or the biotic aspects of the forest:** The plants and animals form communities that are specific to each forest type. For instance coniferous trees occur in the Himalayas. Mangrove trees occur in river deltas. Thorn trees grow in arid areas. The snow leopard lives in the Himalayas while the leopard and tiger live in the forests of the rest of India. Wild sheep and goats live high up in the Himalayas. Many of the birds of the Himalayan forests are different from the rest of India. Evergreen forests of the Western Ghats and North East India are most rich in plant and animal species.

The biotic component includes both the large (macrophytes) and the microscopic plants and animals.

Forest types in India:

Forests in India can be broadly divided into **Coniferous forests** and **Broadleaved forests**.

They can also be classified according to the nature of their tree species – **evergreen, deciduous, xerophytic or thorn trees, mangroves,** etc.

They can also be classified according to the most abundant species of trees such as **Sal or Teak** forests.

Coniferous forests

- They grow in the Himalayan mountain region, where the temperatures are low.
- These forests have tall stately trees with needle like leaves and downward sloping branches so that the snow can slip off the branches.
- They have cones instead of seeds and are called gymnosperms.

Broadleaved forests

- They have several types, such as evergreen forests, deciduous forests, thorn forests, and mangrove forests.
- Broadleaved forests have large leaves of various shapes.

Evergreen forests

- They grow in the high rainfall areas of the Western Ghats, North Eastern India and the Andaman and Nicobar Islands.
- These forests grow in areas where the monsoon lasts for several months.
- Evergreen plants shed a few of their leaves throughout the year.
- There is no dry leafless phase as in a deciduous forest.
- An evergreen forest thus looks green throughout the year.
- The trees overlap with each other to form a continuous canopy. Thus very little light penetrates down to the forest floor. Only a few shade loving plants can grow in the ground layer in areas where some light filters down from the closed canopy.

- The forest is rich in orchids and ferns.
- The barks of the trees are covered in moss.
- The forest abounds in animal life and is most rich in insect life.

Deciduous forests

- They are found in regions with a moderate amount of seasonal rainfall that lasts for only a few months.
- Most of the forests in which Teak trees grow are of this type.
- The deciduous trees shed their leaves during the winter and hot summer months.
- In March or April they regain their fresh leaves just before the monsoon, when they grow vigorously in response to the rains.
- Thus there are periods of leaf fall and canopy regrowth.
- The forest frequently has a thick undergrowth as light can penetrate easily onto the forest floor.

Thorn forests

- They are found in the semi- arid regions of India.
- The trees, which are sparsely distributed, are surrounded by open grassy areas.
- Thorny plants are called xerophytic species and are able to conserve water.
- Some of these trees have small leaves, while other species have thick, waxy leaves to reduce water losses during transpiration.
- Thorn forest trees have long or fibrous roots to reach water at great depths.
- Many of these plants have thorns, which reduce water loss and protect them from herbivores.

Mangrove forests

- They grow along the coast especially in the river deltas.
- These plants are able to grow in a mix of saline and fresh water.
- They grow luxuriantly in muddy areas covered with silt that the rivers have brought down.
- The mangrove trees have breathing roots that emerge from the mudbanks.

Forest utilisation:

Natural forests provide local people with a variety of products if the forest is used carefully. Over-exploitation for fuel wood or timber, and conversion to monoculture plantations for timber or other products, impoverishes local people as the economic benefit goes to people who live elsewhere. The entire resource base on which local people have traditionally survived for generations, is rapidly destroyed. Eventually the forest is completely degraded. Natural forest ecosystems play an important role in controlling local climate and water regimes. It is well-known that under the canopy of a natural forest, it is cooler than outside the forest.

Forest products:

- Forest products that are collected by people include food such as fruit, roots, herbs and medicinal plants.

- People depend on fuelwood to cook food, collect fodder for domestic animals, cut building material for housing, collect medicinal plants that have been known for generations for several ailments and use a variety of non timer forest products such as fiber, cane, gum, to make household articles.
- Wood from different species of trees have special uses.

Grassland ecosystems

A wide range of landscapes in which the vegetation is mainly formed by grasses and small annual plants are adapted to India's various climatic conditions. These form a variety of grassland ecosystems with their specific plants and animals.

- Grasslands cover areas where rainfall is usually low and/or the soil depth and quality is poor. The low rainfall prevents the growth of a large number of trees and shrubs, but is sufficient to support the growth of grass cover during the monsoon.
- Many of the grasses and other small herbs become dry and the part above the ground dies during the summer months.
- In the next monsoon the grass cover grows back from the root stock and the seeds of the previous year. This change gives grasslands a highly seasonal appearance with periods of increased growth followed by a dormant phase.
- A variety of grasses, herbs, and several species of insects, birds and mammals have evolved so that they are adapted to these wide-open grass covered areas.
- These animals are able to live in conditions where food is plentiful after the rains, so that they can store this as fat that they use during the dry period when there is very little to eat.
- Man began to use these grasslands as pastures to feed his livestock when he began to domesticate animals and became a pastoralist in ancient times.

Grassland Types in India:

1. The **Himalayan pasture belt** extends upto the snowline. The grasslands at a lower level form patches along with coniferous or broadleaved forests. Himalayan wildlife require both the forest and the grassland ecosystem as important parts of their habitat. The animals migrate up into the high altitude grasslands in summer and move down into the forest in winter when the snow covers the grassland. These Himalayan pastures have a large variety of grasses and herbs. Himalayan hill slopes are covered with thousands of colourful flowering plants.
2. The **Terai** consists of patches of tall grasslands interspersed with a Sal forest ecosystem. The patches of tall elephant grass, which grows to a height of about five meters, are located in the low-lying waterlogged areas. The Sal forest patches cover the elevated regions and the Himalayan foothills. The Terai also includes marshes in low-lying depressions. This ecosystem extends as a belt south of the Himalayan foothills.
3. The Semi-arid plains of **Western India, Central India and the Deccan** are covered by grassland tracts with patches of thorn forest. Several mammals such as the wolf, the blackbuck, the chinkara, and birds such as the bustards and floricans are adapted to these arid conditions. The Scrublands of the Deccan Plateau are covered with seasonal grasses and

herbs on which its fauna is dependent. It is teaming with insect life on which the insectivorous birds feed.

4. The **Shola grasslands** consist of patches on hillslopes along with the Shola forests on the Western Ghats, Nilgiri and Annamalai ranges. This forms a patchwork of grassland on the slopes and forest habitats along the streams and lowlying areas.

Desert ecosystem

- Deserts and semi arid areas are located in Western India and the Deccan Plateau. The climate in these vast tracts is extremely dry.
- There are also cold deserts such as in Ladakh, which are located in the high plateaus of the Himalayas.
- The most typical desert landscape that is seen in Rajasthan is in the Thar Desert. This has sand dunes.
- There are also areas covered with sparse grasses and a few shrubs, which grow if it rains.
- In most areas of the Thar the rainfall is scanty and sporadic. In an area it may rain only once every few years. In the adjoining semi arid tract the vegetation consists of a few shrubs and thorny trees such as kher and babul.
- The Great and Little Rann of Kutch are highly specialised arid ecosystems.
- Desert and semi arid regions have a number of highly specialized insects and reptiles. The rare animals include the Indian wolf, desert cat, desert fox and birds such as the Great Indian Bustard and the Florican. Some of the commoner birds include partridges, quails and sandgrouse.

Aquatic ecosystems

The aquatic ecosystems constitute the marine environments of the seas and the fresh water systems in lakes, rivers, ponds and wetlands. These ecosystems provide human beings with a wealth of natural resources. They provide goods that people collect for food such as fish and crustaceans. Natural aquatic systems such as rivers and seas break down chemical and organic wastes created by man. However, this function has limitations, as the aquatic ecosystem cannot handle great quantities of waste. Beyond a certain limit, pollution destroys this natural function.

- In aquatic ecosystems, plants and animals live in water. These species are adapted to live in different types of aquatic habitats.
- The special abiotic features are its physical aspects such as the quality of the water, which includes its clarity, salinity, oxygen content and rate of flow.
- Aquatic ecosystems may be classified as being **stagnant ecosystems**, or **running water ecosystems**.
- The mud gravel or rocks that form the bed of the aquatic ecosystem alter its characteristics and influence its plant and animal species composition.
- The aquatic ecosystems are classified into **freshwater, brackish and marine ecosystems**, which are based on the salinity levels.

- The fresh water ecosystems that have running water are streams and rivers. Ponds, tanks and lakes are ecosystems where water does not flow. Wetlands are special ecosystems in which the water level fluctuates dramatically in different seasons. They have expanses of shallow water with aquatic vegetation, which forms an ideal habitat for fish, crustacea and water birds.

The Pond ecosystem

- The pond is the simplest aquatic ecosystem to observe.
- There are differences in a pond that is temporary and has water only in the monsoon, and a larger tank or lake that is an aquatic ecosystem throughout the year.
- Most ponds become dry after the rains are over and are covered by terrestrial plants for the rest of the year. When a pond begins to fill during the rains, its life forms such as the algae and microscopic animals, aquatic insects, snails, and worms come out of the floor of the pond where they have remained dormant in the dry phase.
- Gradually more complex animals such as crabs frogs and fish return to the pond.
- The vegetation in the water consists of floating weeds and rooted vegetation on the periphery which grow on the muddy floor under water and emerge out of the surface of the water.
- As the pond fills in the monsoon a large number of food chains are formed. Algae is eaten by microscopic animals, which are in turn eaten by small fish on which larger carnivorous fish depend.
- These are in turn eaten by birds such as kingfishers, herons and birds of prey. Aquatic insects, worms and snails feed on the waste material excreted by animals and the dead or decaying plant and animal matter.
- They act on the detritus, which is broken down into nutrients which aquatic plants can absorb, thus completing the nutrient cycle in the pond.
- The temporary ponds begin to dry after the rains and the surrounding grasses and terrestrial plants spread into the moist mud that is exposed.
- Animals such as frogs, snails and worms remain dormant in the mud, awaiting the next monsoon.

Lake ecosystem

- A lake ecosystem functions like a giant permanent pond. A large amount of its plant material is the algae, which derives energy from the sun.
- This is transferred to the microscopic animals, which feed on the algae. There are fish that are herbivorous and are dependent on algae and aquatic weeds.
- The small animals such as snails are used as food by small carnivorous fish, which in turn are eaten by larger carnivorous fish. Some specialised fish, such as catfish, feed on the detritus on the muddy bed of the lake.
- Energy cycles through the lake ecosystem from the sunlight that penetrates the water surface to the plants.
- From plants energy is transferred to herbivorous animals and carnivores. Animals excrete waste products, which settle on the bottom of the lake.

- This is broken down by small animals that live in the mud in the floor of the lake. This acts as the nutrient material that is used by aquatic plants for their growth.
- During this process plants use Carbon from CO_2 for their growth and in the process release Oxygen. This Oxygen is then used by aquatic animals, which filter water through their respiratory system.

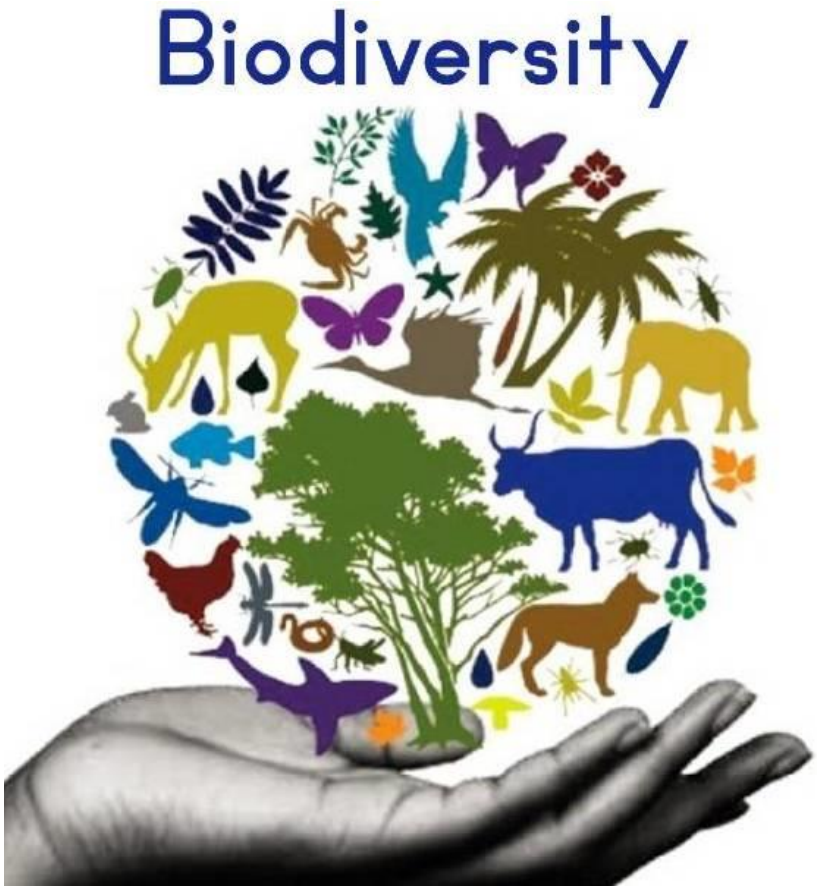
Stream and River ecosystems

- Streams and rivers are flowing water ecosystems in which all the living forms are specially adapted to different rates of flow.
- Some plants and animals such as snails and other burrowing animals can withstand the rapid flow of the hill streams.
- Other species of plants and animals such as water beetles and skaters can live only in slower moving water.
- Some species of fish, such as Mahseer, go upstream from rivers to hill streams for breeding. They need crystal clear water to be able to breed. They lay eggs only in clear water so that their young can grow successfully.
- As deforestation occurs in the hills the water in the streams that once flowed throughout the year become seasonal. This leads to flash floods in the rains and a shortage of water once the streams dry up after the monsoon.
- The community of flora and fauna of streams and rivers depends on the clarity, flow and oxygen content as well as the nature of their beds.
- The stream or river can have a sandy, rocky or muddy bed, each type having its own species of plants and animals

Marine ecosystems

- The Indian Ocean, the Arabian Sea and the Bay of Bengal constitute the marine ecosystems around peninsular India.
- In the coastal area the sea is shallow while further away, it is deep. Both these are different ecosystems.
- The producers in this ecosystem vary from microscopic algae to large seaweeds. There are millions of zooplankton and a large variety of invertebrates on which live fish, turtles and marine mammals.
- The shallow areas near Kutch and around the Andaman and Nicobar Islands are some of the most incredible coral reefs in the world.
- Coral reefs are only second to tropical evergreen forests in their richness of species. Fish, crustacea, starfish, jellyfish and the polyps that deposit the coral are a few of the thousands of species that form this incredible world under the shallow sea.
- The marine ecosystem is used by coastal fisherfolk for fishing which forms their livelihood. In the past, fishing was done at a sustainable level. The marine ecosystem continued to maintain its abundant supply of fish over many generations. Now with intensive fishing by using giant nets and mechanised boats, fish catch in the Indian Ocean has dropped significantly.

CHAPTER 4
Biodiversity And Its Conservation



What is biodiversity?

Biological diversity deals with the degree of nature's variety in the biosphere.

This variety can be observed at three levels;

- The genetic variability within a species
- The variety of species within a community
- The organisation of species in an area into distinctive plant and animal communities constitutes ecosystem diversity.

Genetic diversity

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

Species diversity

- The number of species of plants and animals that are present in a region constitutes its species diversity.
- This diversity is seen both in natural ecosystems and in agricultural ecosystems. Some areas are more rich in species than others.
- Natural undisturbed tropical forests have a much greater species richness than plantations developed by the Forest Department for timber production.
- A natural forest ecosystem provides a large number of non-wood products that local people depend on such as fruit, fuel wood, fodder, fiber, gum, resin and medicines.
- Timber plantations do not provide the large variety of goods that are essential for local consumption. In the long-term the economic sustainable returns from non-wood forest products is said to be greater than the returns from felling a forest for its timber.

- Thus the value of a natural forest, with all its species richness is much greater than a plantation.
- Modern intensive agricultural ecosystems have a relatively lower diversity of crops than traditional agropastoral farming systems where multiple crops were planted.
- At present conservation scientists have been able to identify and categorise about 1.8 million species on earth. However, many new species are being identified, especially in the flowering plants and insects.
- **Areas that are rich in species diversity are called 'hotspots' of diversity**.
- India is among the world's 15 nations that are exceptionally rich in species diversity

Ecosystem diversity

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

BIOGEOGRAPHIC CLASSIFICATION OF INDIA

India's Biogeographic Zones

1. The cold mountainous snow covered Trans Himalayan region of Ladakh.

2. The Himalayan ranges and valleys of Kashmir, Himachal Pradesh, Uttarakhand, Assam and other North Eastern States.

3. The Terai, the lowland where the Himalayan rivers flow into the plains.

4. The Gangetic and Bhramaputra plains.

5. The Thar Desert of Rajasthan.

6. The semi arid grassland region of the Deccan plateau Gujarat, Maharashtra, Andra Pradesh, Karnataka and Tamil Nadu.

7. The Northeast States of India,

8. The Western Ghats in Maharashtra, Karnataka and Kerala.

9. The Andaman and Nicobar Islands.

10. The long western and eastern coastal belt with sandy beaches, forests and mangroves.

VALUE OF BIODIVERSITY

- Environmental services from species and ecosystems are essential at global, regional and local levels.
- Production of oxygen, reducing carbon dioxide, maintaining the water cycle, protecting soil are important services.
- The world now acknowledges that the loss of biodiversity contributes to global climatic changes.
- Forests are the main mechanism for the conversion of carbon dioxide into carbon and oxygen.
- The loss of forest cover, coupled with the increasing release of carbon dioxide and other gases through industrialization contributes to the 'greenhouse effect'.
- Global warming is melting ice caps, resulting in a rise in the sea level which will submerge the low lying areas in the world.
- It is causing major atmospheric changes, leading to increased temperatures, serious droughts in some areas and unexpected floods in other areas.
- Biological diversity is also essential for preserving ecological processes, such as fixing and recycling of nutrients, soil formation, circulation and cleansing of air and water, global life support (plants absorb CO_2 , give out O_2), maintaining the water balance within ecosystems, watershed protection, maintaining stream and river flows throughout the year, erosion control and local flood reduction.

Consumptive use value

- The direct utilisation of timber, food, fuelwood, fodder by local communities.
- The biodiversity held in the ecosystem provides forest dwellers with all their daily needs, food, building material, fodder, medicines and a variety of other products.
- They know the qualities and different uses of wood from different species of trees, and collect a large number of local fruits, roots and plant material that they use as food, construction material or medicines.
- Fisherfolk are highly dependent on fish and know where and how to catch fish and other edible aquatic animals and plants.

Productive use value

Marketable goods.

- The biotechnologist uses biorich areas to 'prospect' and search for potential genetic properties in plants or animals that can be used to develop better varieties of crops that are used in farming and plantation programs or to develop better livestock.
- To the pharmacist, biological diversity is the raw material from which new drugs can be identified from plant or animal products.
- To industrialists, biodiversity is a rich store-house from which to develop new products.
- For the agricultural scientist the biodiversity in the wild relatives of crop plants is the basis for developing better crops.
- Genetic diversity enables scientists and farmers to develop better crops and domestic animals through careful breeding.
- Even today, species of plants and animals are being constantly discovered in the wild.
- Thus these wild species are the building blocks for the betterment of human life and their loss is a great economic loss to mankind.
- Preservation of biodiversity has now become essential for industrial growth and economic development.
- A variety of industries such as pharmaceuticals are highly dependent on identifying compounds of great economic value from the wide variety of wild species of plants located in undisturbed natural forests. This is called **biological prospecting.**

Social values

- While traditional societies which had a small population and required less resources had preserved their biodiversity as a life supporting resource, modern man has rapidly depleted it even to the extent of leading to the irrecoverable loss due to extinction of several species.
- Thus apart from the local use or sale of products of biodiversity there is the social aspect in which more and more resources are used by affluent societies.
- The biodiversity has to a great extent been preserved by traditional societies that valued it as a resource and appreciated that its depletion would be a great loss to their society.
- The consumptive and productive value of biodiversity is closely linked to social concerns in traditional communities.
- 'Ecosystem people' value biodiversity as a part of their livelihood as well as through cultural and religious sentiments.
- A great variety of crops have been cultivated in traditional agricultural systems and this permitted a wide range of produce to be grown and marketed throughout the year and acted as an insurance against the failure of one crop.
- In recent years farmers have begun to receive economic incentives to grow cash crops for national or international markets, rather than to supply local needs.

- This has resulted in local food shortages, unemployment (cash crops are usually mechanised), landlessness and increased vulnerability to drought and floods.

Ethical and moral values

- Ethical values related to biodiversity conservation are based on the importance of protecting all forms of life.
- All forms of life have the right to exist on earth.
- Man is only a small part of the Earth's great family of species.
- Apart from the economic importance of conserving biodiversity, there are several cultural, moral and ethical values which are associated with the sanctity of all forms of life.
- Indian civilization has over several generations preserved nature through local traditions. This has been an important part of the ancient philosophy of many of our cultures.
- We have in our country a large number of sacred groves or 'deorais' preserved by tribal people in several States.
- These sacred groves around ancient sacred sites and temples act as gene banks of wild plants.

Aesthetic value

Knowledge and an appreciation of the presence of biodiversity for its own sake is another reason to preserve it. Quite apart from killing wildlife for food, it is important as a tourist attraction. Biodiversity is a beautiful and wonderful aspect of nature. Sit in a forest and listen to the birds. Watch a spider weave its complex web. Observe a fish feeding. It is magnificent and fascinating. Symbols from wild species such as the lion of Hinduism, the elephant of Buddhism and deities such as Lord Ganesh, and the vehicles of several deities that are animals, have been venerated for thousands of years. Valmiki begins his epic story with a couplet on the unfortunate killing of a crane by a hunter. The 'Tulsi' has been placed at our doorsteps for centuries.

Option value

Keeping future possibilities open for their use is called option value. It is impossible to predict which of our species or traditional varieties of crops and domestic animals will be of great use in the future. To continue to improve cultivars and domestic livestock, we need to return to wild relatives of crop plants and animals. Thus the preservation of biodiversity must also include traditionally used strains already in existence in crops and domestic animals.

BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVELS

There are at present 1.8 million species known and documented by scientists in the world. However, scientists have estimated that the number of species of plants and animals on earth could vary from 1.5 to 20 billion! Thus the majority of species are yet to be discovered.

- Most of the world's bio-rich nations are in the South, which are the developing nations. In contrast, the majority of the countries capable of exploiting biodiversity are Northern nations, in the economically developed world. These nations however have low levels of biodiversity.
- Thus the developed world has come to support the concept that biodiversity must be considered to be a 'global resource'.
- However, if biodiversity should form a 'common property resource' to be shared by all nations, there is no reason to exclude oil, or uranium, or even intellectual and technological expertise as global assets.
- India's sovereignty over its biological diversity cannot be compromised without a revolutionary change in world thinking about sharing of all types of natural resources.
- Throughout the world, the value of biologically rich natural areas is now being increasingly appreciated as being of unimaginable value.
- International agreements such as the **World Heritage Convention** attempt to protect and support such areas. India is a signatory to the convention and has included several protected Areas as World Heritage sites. These include Manas on the border between Bhutan and India, Kaziranga in Assam, Bharatpur in U.P., Nandadevi in the Himalayas, and the Sunderbans in the Ganges delta in West Bengal.
- India has also signed the **Convention in the Trade of Endangered Species** (CITES) which is intended to reduce the utilization of endangered plants and animals by controlling trade in their products and in the pet trade.

THREATS TO BIODIVERSITY: HABITAT LOSS, POACHING OF WILDLIFE, MAN-WILDLIFE CONFLICTS

Man has begun to overuse or misuse most of these natural ecosystems. Due to this 'unsustainable' resource-use, once productive forests and grasslands have been turned into deserts and wasteland have increased all over the world. Mangroves have been cleared for fuelwood and prawn farming, which has led to a decrease in the habitat essential for breeding of marine fish. Wetlands have been drained to increase agricultural land. These changes have grave economic implications in the longer term.

The current destruction of the remaining large areas of wilderness habitats, especially in the super diverse tropical forests and coral reefs, is the most important threat worldwide to biodiversity. Scientists have estimated that human activities are likely to eliminate approximately 10 million species by the year 2050.

- There are about 1.8 million species of plants and animals, both large and microscopic, known to science in the world at present.
- The number of species however is likely to be greater by a factor of at least 10. Plants and insects as well as other forms of life not known to science are continually being identified in the worlds' 'hotspots' of diversity.
- Unfortunately at the present rate of extinction about 25% of the worlds' species will undergo extinction fairly rapidly. This may occur at the rate of 10 to 20 thousand species per

year, a thousand to ten thousand times faster than the expected natural rate! Human actions could well exterminate 25% of the world's species within the next twenty or thirty years.

- Much of this mega extinction spasm is related to human population growth, industrialization and changes in land-use patterns.
- A major part of these extinctions will occur in 'biorich' areas such as tropical forests, wetlands, and coral reefs.
- The loss of wild habitats due to rapid human population growth and short term economic development are major contributors to the rapid global destruction of biodiversity.

Poaching:

Specific threats to certain animals are related to large economic benefits. Skin and bones from tigers, ivory from elephants, horns from rhinos and the perfume from the must deer are extensively used abroad. Bears are killed for their gall bladders. Corals and shells are also collected for export or sold on the beaches of Chennai and Kanyakumari. A variety of wild plants with real or at times dubious medicinal value are being over harvested. The commonly collected plants include Rauvolfia, Nuxvomica, Datura, etc. Collection of garden plants includes orchids, ferns and moss.

CHAPTER 5
Environmental Pollution

DEFINITION

Pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings.

This occurs when only short-term economic gains are made at the cost of the long-term ecological benefits for humanity. No natural phenomenon has led to greater ecological changes than have been made by mankind. During the last few decades we have contaminated our air, water and land on which life itself depends with a variety of waste products.

Air Pollution

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment. Air may get polluted by natural causes such as volcanoes, which release ash, dust, sulphur and other gases, or by forest fires that are occasionally naturally caused by lightning. However, unlike pollutants from human activity, naturally occurring pollutants tend to remain in the atmosphere for a short time and do not lead to permanent atmospheric change.

Primary pollutants

Pollutants that are emitted directly from identifiable sources are produced both by natural events (for example, dust storms and volcanic eruptions) and human activities (emission from vehicles, industries, etc.). These are called primary pollutants.

There are five primary pollutants that together contribute about 90 percent of the global air pollution.

These are

- Carbon oxides (CO and CO2)
- Nitrogen oxides

- Sulfur oxides
- volatile organic compounds (mostly hydrocarbons)
- Suspended particulate matter.

Secondary Pollutants

Pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called secondary pollutants. Eg: sulfuric acid, nitric acid, carbonic acid, etc.

Effects of air pollution on living organisms

- Prolonged smoking or exposure to air pollutants can overload or breakdown the natural defenses causing or contributing to diseases such as lung cancer, asthma, chronic bronchitis and emphysema.
- Exposure to air containing even 0.001 percent of carbon monoxide for several hours can cause collapse, coma and even death.
- Carbon monoxide in heavy traffic causes headaches, drowsiness and blurred vision.
- Sulfur dioxide irritates respiratory tissues. Chronic exposure causes a condition similar to bronchitis.
- Nitrogen oxides especially NO2 can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds.
- Suspended particles aggravate bronchitis and asthma. Exposure to these particles over a long period of time damages lung tissue and contributes to the development of chronic respiratory disease and cancer.
- Many volatile organic compounds such as (benzene and formaldehyde) and toxic particulates (such as lead, cadmium) can cause mutations, reproductive problems or cancer.
- Inhaling ozone, a component of photochemical smog causes coughing, chest pain, breathlessness and irritation of the eye, nose and the throat.

Effects on plants

- When some gaseous pollutants enter leaf pores they damage the leaves of crop plants.
- Chronic exposure of the leaves to air pollutants can break down the waxy coating that helps prevent excessive water loss and leads to damage from diseases, pests, drought and frost. Such exposure interferes with photosynthesis and plant growth, reduces nutrient uptake and causes leaves to turn yellow, brown or drop off altogether.
- At a higher concentration of sulphur dioxide majority of the flower buds become stiff and hard. They eventually fall from the plants, as they are unable to flower.

- Prolonged exposure to high levels of several air pollutants from smelters, coal burning power plants and industrial units as well as from cars and trucks can damage trees and other plants.

Effects of air pollution on materials

Every year air pollutants cause damage worth billions of rupees. Air pollutants break down exterior paint on cars and houses. All around the world air pollutants have discoloured irreplaceable monuments, historic buildings, marble statues, etc.

Effects of air pollution on the stratosphere

- The upper stratosphere consists of considerable amounts of ozone, which works as an effective screen for ultraviolet light.
- This region called the ozone layer extends up to 60 kms above the surface of the earth.
- Ozone is a form of oxygen with three atoms instead of two.
- It is produced naturally from the photodissociation of oxygen gas molecules in the atmosphere.
- The ozone thus formed is constantly broken down by naturally occurring processes that maintain its balance in the ozone layer.
- In the absence of pollutants the creation and breakdown of ozone are purely governed by natural forces, but the presence of certain pollutants can accelerate the breakdown of ozone.
- Though it was known earlier that ozone shows fluctuations in its concentrations which may be accompanied sometimes with a little ozone depletion, it was only in 1985 that the large scale destruction of the ozone also called the Ozone Hole came into limelight when some British researchers published measurements about the ozone layer.

Ozone depletion-What does it do?

Effects on human health:

- Sunburn, cataract, aging of the skin and skin cancer are caused by increased ultra-violet radiation.
- It weakens the immune system by suppressing the resistance of the whole body to certain infections like measles, chicken pox and other viral diseases that elicit rash and parasitic diseases such as malaria introduced through the skin.

Effects on Food production:

- Ultra violet radiation affects the ability of plants to capture light energy during the process of photosynthesis.
- This reduces the nutrient content and the growth of plants. This is seen especially in legumes and cabbage. Plant and animal planktons are damaged by ultra-violet radiation.
- In zooplanktons (microscopic animals) the breeding period is shortened by changes in radiation. As planktons form the basis of the marine food chain a change in their number and species composition influences fish and shell fish production.

Effect on materials:

Increased UV radiation damages paints and fabrics, causing them to fade faster.

Effect on climate:

- Atmospheric changes induced by pollution contribute to global warming, a phenomenon which is caused due to the increase in concentration of certain gases like carbon dioxide, nitrogen oxides, methane and CFCs.
- Observations of the earth have shown beyond doubt that atmospheric constituents such as water vapour, carbon dioxide, methane, nitrogen oxides and Chloro Fluro Carbons trap heat in the form of infra-red radiation near the earth's surface. This is known as the '**Greenhouse Effect'**.
- The phenomenon is similar to what happens in a greenhouse. The glass in a greenhouse allows solar radiation to enter which is absorbed by the objects inside. These objects radiate heat in the form of terrestrial radiation, which does not pass out through the glass.
- The heat is therefore trapped in the greenhouse increasing the temperature inside and ensuring the luxuriant growth of plants.

There could be several adverse effects of global warming.

• With a warmer earth the polar ice caps will melt causing a rise in ocean levels and flooding of coastal areas.

• In countries like Bangladesh or the Maldives this would be catastrophic. If the sea level rises by 3m., Maldives will disappear completely beneath the waves.

• The rise in temperature will bring about a fall in agricultural produce.

• Changes in the distribution of solar energy can bring about changes in habitats. A previously productive agricultural area will suffer severe droughts while rains will fall in locations that were once deserts. This could bring about changes in the species of natural plants, agricultural crops, insects, livestock and micro-organisms.

• In the polar regions temperature rises caused by global warming would have disastrous effects. Vast quantities of meth ane are trapped beneath the frozen soil of Alaska. When the permafrost melts the methane that will be released can accelerate the process of global warming.

Control measures for air pollution

Air pollution can be controlled by two fundamental approaches:

- preventive techniques
- Effluent control.

- One of the effective means of controlling air pollution is to have proper equipment in place.
- This includes devices for removal of pollutants from the flue gases though scrubbers, closed collection recovery systems through which it is possible to collect the pollutants before they escape, use of dry and wet collectors, filters, electrostatic precipitators, etc.

- Providing a greater height to the stacks can help in facilitating the discharge of pollutants as far away from the ground as possible.
- Industries should be located in places so as to minimize the effects of pollution after considering the topography and the wind directions. Substitution of raw material that causes more pollution with those that cause less pollution can be done.

Water Pollution

Water is the essential element that makes life on earth possible. Without water there would be no life. We usually take water for granted. It flows from our taps when they are turned on. Most of us are able to bathe when we want to, swim when we choose and water our gardens.

Although 71% of the earth's surface is covered by water only a tiny fraction of this water is available to us as fresh water. About 97% of the total water available on earth is found in oceans and is too salty for drinking or irrigation. The remaining 3% is fresh water. Of this 2.997% is locked in ice caps or glaciers. Thus only 0.003% of the earth' total volume of water is easily available to us as soil moisture, groundwater, water vapour and water in lakes, streams, rivers and wetlands. In short if the world's water supply were only 100 litres our usable supply of fresh water would be only about 0.003 litres (one-half teaspoon). This makes water a very precious resource.

When the quality or composition of water changes directly or indirectly as a result of man's activities such that it becomes unfit for any purpose it is said to be polluted.

Point sources of pollution:

When a source of pollution can be readily identified because it has a definite source and place where it enters the water it is said to come from a point source. Eg. Municipal and Industrial Discharge Pipes.

Non-point sources of pollution:

When a source of pollution cannot be readily identified, such as agricultural runoff, acid rain, etc, they are said to be non-point sources of pollution.

Causes of water pollution

Disease-causing agents

There are several classes of common water pollutants. These are **disease-causing agents** (pathogens) which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes. Human wastes contain concentrated populations of coliform bacteria such as Escherichia coli and Streptococcus faecalis. These bacteria normally grow in the large intestine of humans where they are responsible for some food digestion and for the production of vitamin K. These bacteria are not harmful in low numbers. Large amounts of human waste in water, increases the number of these bacteria which cause gastrointestinal diseases. Other potentially harmful bacteria from human wastes may also be present in smaller numbers. Thus the greater the amount of wastes in the water the greater are the chances of contracting diseases from them.

Oxygen depleting wastes

Another category of water pollutants is oxygen depleting wastes. These are organic wastes that can be decomposed by aerobic (oxygen requiring) bacteria. Large populations of bacteria use up the oxygen present in water to degrade these wastes. In the process this degrades water quality. The amount of oxygen required to break down a certain amount of organic matter is called the biological oxygen demand (BOD). The amount of BOD in the water is an indicator of the level of pollution. If too much organic matter is added to the water all the available oxygen is used up. This causes fish and other forms of oxygen dependent aquatic life to die. Thus anaerobic bacteria (those that do not require oxygen) begin to break down the wastes. Their anaerobic respiration produces chemicals that have a foul odour and an un pleasant taste that is harmful to human health.

Inorganic plant nutrients

A third class of pollutants are inorganic plant nutrients. These are water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication. They may interfere with the use of the water by clogging water intake pipes, changing the taste and odour of water and cause a buildup of organic matter. As the organic matter decays, oxygen levels decrease and fish and other aquatic species die.

Water soluble inorganic chemicals

A fourth class of water pollutants is water soluble inorganic chemicals which are acids, salts and compounds of toxic metals such as mercury and lead. High levels of these chemicals can make the water unfit to drink, harm fish and other aquatic life, reduce crop yields and accelerate corrosion of equipment that use this water.

Variety of organic chemicals

Another cause of water pollution is a variety of organic chemicals, which include oil, gasoline, plastics, pesticides, cleaning solvents, detergent and many other chemicals. These are harmful to aquatic life and human health. They get into the water directly from industrial activity either from improper handling of the chemicals in industries and more often from improper and illegal disposal of chemical wastes.

Sediment of suspended matter

Sediment of suspended matter is another class of water pollutants. These are insoluble particles of soil and other solids that become suspended in water. This occurs when soil is eroded from the land. High levels of soil particles suspended in water, interferes with the penetration of sunlight. This reduces the photosynthetic activity of aquatic plants and algae disrupting the ecological balance of the aquatic bodies.

Water soluble radioactive isotopes

Water soluble radioactive isotopes are yet another source of water pollution. These can be concentrated in various tissues and organs as they pass through food chains and food webs. Ionizing radiation emitted by such isotopes can cause birth defects, cancer and genetic damage.

Control measures for preventing water pollution

While the foremost necessity is prevention, setting up effluent treatment plants and treating waste through these can reduce the pollution load in the recipient water. The treated effluent can be reused for either gardening or cooling purposes wherever possible. A few years ago a new technology called the Root Zone Process has been developed by Thermax. This system involves running contaminated water through the root zones of specially designed reed beds. The reeds, which are essentially wetland plants have the capacity to absorb oxygen from the surrounding air through their stomatal openings. The oxygen is pushed through the porous stem of the reeds into the hollow roots where it enters the root zone and creates conditions suitable for the growth of numerous bacteria and fungi. These micro-organisms oxidize impurities in the wastewaters, so that the water which finally comes out is clean.

Soil Pollution

Soil is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life.

Mature soils are arranged in a series of zones called soil horizons. Each horizon has a distinct texture and composition that varies with different types of soils. A cross sectional view of the horizons in a soil is called a soil profile.

- O horizon
- A horizon
- B horizon
- C horizon

O horizon

The top layer or the surface litter layer called the **O horizon** consists mostly of freshly fallen and partially decomposed leaves, twigs, animal waste, fungi and other organic materials. Normally it is brown or black.

A horizon

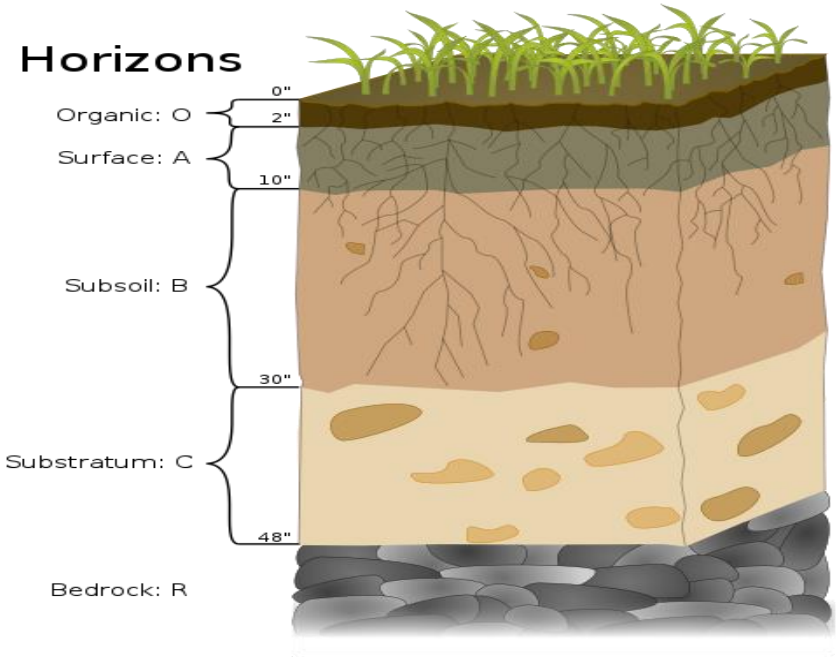
The uppermost layer of the soil called the **A horizon** consists of partially decomposed organic matter (humus) and some inorganic mineral particles. It is usually darker and looser than the deeper layers. The roots of most plants are found in these two upper layers. As long as these layers are anchored by vegetation soil stores water and releases it in a trickle throughout the year instead of in a force like a flood. These two top layers also contain a large amount of bacteria, fungi, earthworms and other small insects that form complex food webs in the soil that help recycle soil nutrients and contribute to soil fertility.

B horizon

The **B horizon** often called the subsoil contains less organic material and fewer organisms than the A horizon.

C horizon

The area below the subsoil is called the **C horizon** and consists of weathered parent material. This parent material does not contain any organic materials. The chemical composition of the C-horizon helps to determine the pH of the soil and also influences the soil's rate of water absorption and retention. Soils vary in their content of clay (very fine particles), silt (fine particles), sand (medium size particles) and gravel (coarse to very coarse particles). The relative amounts of the different sizes and types of mineral particles determine soil texture. Soils with approximately equal mixtures of clay, sand, silt and humus are called **loams**.



<u>Causes of soil degradation</u>

Erosion

Soil erosion can be defined as the movement of surface litter and topsoil from one place to another.

- While erosion is a natural process often caused by wind and flowing water it is greatly accelerated by human activities such as farming, construction, overgrazing by livestock, burning of grass cover and deforestation. Loss of the topsoil makes a soil less fertile and reduces its water holding capacity.
- The topsoil, which is washed away, also contributes to water pollution clogging lakes, increasing turbidity of the water and also leads to loss of aquatic life.
- For one inch of topsoil to be formed it normally requires 200-1000 years depending upon the climate and soil type.
- Thus if the topsoil erodes faster than it is formed the soil becomes a non-renewable resource

Excess use of fertilizers:

- Approximately 25 percent of the world's crop yield is estimated to be directly attributed to the use of chemical fertilizers.
- The use of chemical fertilizes has increased significantly over the last few decades and is expected to rise even higher.
- Fertilizers are very valuable as they replace the soil nutrients used up by plants. The three primary soil nutrients often in short supply are potassium, phosphorus and nitrogen compounds.
- These are commonly referred to as macronutrients.
- Certain other elements like boron, zinc and manganese are necessary in extremely small amounts and are known as micronutrients.
- When crops are harvested a large amount of macronutrients and a small amount of micronutrients are removed with the crops. If the same crop is grown again depleted levels of three nutrients can result in decreased yields.
- These necessary nutrients can be returned to the soil through the application of fertilizers. In addition to fertilizers a large amount of pesticides (chemicals used to kill or control populations of unwanted fungi, animals or plants often called pests) are also used to ensure a good yield.
- Pesticides can be subdivided into several categories based on the kinds of organisms they are used to control. Insecticides are used to control insect populations while fungicides are used to control unwanted fungal growth.
- Mice and rats are killed by rodenticides while plant pests are controlled by herbicides.

Problems with pesticide use

- Pesticides not only kill the pests but also a large variety of living things including humans. They may be persistent or non-persistent.
- Persistent pesticides once applied are effective for a long time.
- However as they do not break down easily they tend to accumulate in the soil and in the bodies of animals in the food chain.

Excess salts and water

- Irrigated lands can produce crop yields much higher than those that only use rainwater.
- However this has its own set of ill effects.
- Irrigation water contains dissolved salts and in dry climates much of the water in the saline solution evaporates leaving its salts such as sodium chloride in the topsoil.
- The accumulation of these salts is called **salinization**, which can stunt plant growth, lower yields and eventually kill the crop and render the land useless for agriculture.
- These salts can be flushed out of the soil by using more water.
- This practice however increases the cost of crop production and also wastes enormous amounts of water.
- Flushing salts can also make the downstream irrigation water saltier. Another problem with irrigation is water logging. **This occurs when large amounts of water is used to leach the salts deeper into the soil.** However if the drainage is poor this water accumulates underground gradually raising the water table. The roots of the plants then get enveloped in this saline water and eventually die.

- Thus in the long run it is better for us to adopt sustainable farming practices so as to prevent the degradation of soil.

Marine Pollution

Marine pollution can be defined as the introduction of substances to the marine environment directly or indirectly by man resulting in adverse effects such as hazards to human health, obstruction of marine activities and lowering the quality of sea water.

While the causes of marine pollution may be similar to that of general water pollution there are some very specific causes that pollute marine waters.

- The most obvious inputs of waste is through pipes directly discharging wastes into the sea. Very often municipal waste and sewage from residences and hotels in coastal towns are directly discharged into the sea.
- Pesticides and fertilizers from agriculture which are washed off the land by rain, enter water courses and eventually reach the sea.
- Petroleum and oils washed off from the roads normally enter the sewage system but stormwater overflows carry these materials into rivers and eventually into the seas.
- Ships carry many toxic substances such as oil, liquefied natural gas, pesticides, industrial chemicals, etc. in huge quantities sometimes to the capacity of 350,000 tonnes. Ship accidents and accidental spillages at sea therefore can be very damaging to the marine environment. Shipping channels in estuaries and at the entrances to ports often require frequent dredging to keep them open. This dredged material that may contain heavy metals and other contaminants are often dumped out to sea.
- Offshore oil exploration and extraction also pollute the seawater to a large extent.

Pollution due to organic wastes

- The amount of oxygen dissolved in the water is vital for the plants and animals living in it. Wastes, which directly or indirectly affect the oxygen concentration, play an important role in determining the quality of the water.
- Normally the greatest volume of waste discharged to watercourses, estuaries and the sea is sewage, which is primarily organic in nature and is degraded by bacterial activity. Using the oxygen present in the water these wastes are broken down into stable inorganic compounds.
- However as a result of this bacterial activity the oxygen concentration in the water is reduced. When the oxygen concentration falls below 1.5 mg/ lit, the rate of aerobic oxidation is reduced and their place is taken over by the anaerobic bacteria that can oxidize the organic molecules without the use of oxygen.
- This results in end products such as hydrogen sulphide, ammonia and methane, which are toxic to many organisms.
- This process results in the formation of an anoxic zone which is low in its oxygen content from which most life disappears except for anaerobic bacteria, fungi, yeasts and some protozoa. This makes the water foul smelling.

Control measures:

- One way of reducing the pollution load on marine waters is through the introduction of **sewage treatment plants**.
- This will reduce the biological oxygen demand (BOD) of the final product before it is discharged to the receiving waters. Various stages of treatment such as primary, secondary or advanced can be used depending on the quality of the effluent that is required to be treated.

Primary treatment:

- These treatment plants use physical processes such as screening and sedimentation to remove pollutants that will settle, float or, that are too large to pass through simple screening devices.
- This includes, stones, sticks, rags, and all such material that can clog pipes. A screen consists of parallel bars spaced 2 to 7cms apart followed by a wire mesh with smaller openings.
- One way of avoiding the problem of disposal of materials collected on the screens is to use a device called a comminuter which grinds the coarse material into small pieces that can then be left in the waste water.
- After screening the wastewater passes into a grit chamber. The detention time is chosen to be long enough to allow lighter, organic material to settle. From the grit chamber the sewage passes into a primary settling tank (also called as sedimentation tank) where the flow speed is reduced sufficiently to allow most of the suspended solids to settle out by gravity.
- If the waste is to undergo only primary treatment it is then chlorinated to destroy bacteria and control odours after which the effluent is released. Primary treatment normally removes about 35 percent of the BOD and 60 percent of the suspended solids.

Secondary treatment:

- The main objective of secondary treatment is to remove most of the BOD.
- There are three commonly used approaches: **trickling filters**, **activated sludge process** and **oxidation ponds**.
- Secondary treatment can remove at least 85 percent of the BOD.

A trickling filter consists of a rotating distribution arm that sprays liquid wastewater over a circular bed of 'fist size' rocks or other coarse materials.

- The spaces between the rocks allow air to circulate easily so that aerobic conditions can be maintained.
- The individual rocks in the bed are covered with a layer of slime, which consists of bacteria, fungi, algae, etc. which degrade the waste trickling through the bed.
- This slime periodically slides off individual rocks and is collected at the bottom of the filter along with the treated wastewater and is then passed on to the secondary settling tank where it is removed.

Activated sludge process the sewage is pumped into a large tank and mixed for several hours with bacteria rich sludge and air bubbles to facilitate degradation by micro-organisms.

- The water then goes into a sedimentation tank where most of the microorganisms settle out as sludge.
- This sludge is then broken down in an anaerobic digester where methane-forming bacteria slowly convert the organic matter into carbon dioxide, methane and other stable end products.
- The gas produced in the digester is 60 percent methane, which is a valuable fuel and can be put to many uses within the treatment plant itself.
- The digested sludge, which is still liquid, is normally pumped out onto sludge drying beds where evaporation and seepage remove the water.
- This dried sludge is potentially a good source of manure.
- Activated sludge tanks use less land area than trickling filters with equivalent performance.
- They are also less expensive to construct than trickling filters and have fewer problems with flies and odour and can also achieve higher rates of BOD removal.
- Thus although the operating costs are a little higher due to the expenses incurred on energy for running pumps and blowers they are preferred over trickling filters.
- Oxidation ponds are large shallow ponds approximately 1 to 2 metres deep where raw or partially treated sewage is decomposed by microorganisms.
- They are easy to build and manage and accommodate large fluctuations in flow and can provide treatment at a much lower cost.
- They however require a large amount of land and hence can be used where land is not a limitation.

Control measures for oil pollution:

Cleaning oil from surface waters and contaminated beaches is a time consuming labour intensive process. The natural process of emulsification of oil in the water can be accelerated through the use of chemical dispersants which can be sprayed on the oil. A variety of slick-lickers in which a continuous belt of absorbent material dips through the oil slick and is passed through rollers to extract the oil have been designed. Rocks, harbour walls can be cleaned with high pressure steam or dispersants after which the surface must be hosed down.

Effects of marine pollution:

- Apart from causing eutrophication a large amount of organic wastes can also result in the development of red tides.
- These are phytoplankton blooms of such intensity that the area is discolored. Many important commercially important marine species are also killed due to clogging of gills or other structures.
- When liquid oil is spilled on the sea it spreads over the surface of the water to form a thin film called an oil slick.
- The rate of spreading and the thickness of the film depends on the sea temperature and the nature of the oil.

- Oil slicks damage marine life to a large extent. Salt marshes, mangrove swamps are likely to trap oil and the plants, which form the basis for these ecosystems thus suffer.
- For salt marsh plants, oil slicks can affect the flowering, fruiting and germination. If liquid oil contaminates a bird's plumage its water repellent properties are lost.
- Water thus penetrates the plumage and displaces the air trapped between the feathers and the skin.
- This air layer is necessary as it provides buoyancy and thermal insulation. With this loss the plumage becomes water logged and the birds may sink and drown.
- Even if this does not happen loss of thermal insulation results in exhaustion of food reserves in an attempt to maintain body temperature often followed by death.
- Birds often clean their plumage by preening and in the process consume oil which depending on its toxicity can lead to intestinal, renal or liver failure.
- Drill cuttings dumped on the seabed create anoxic conditions and result in the production of toxic sulphides in the bottom sediment thus eliminating the benthic fauna.
- Fish and shellfish production facilities can also be affected by oil slicks. The most important commercial damage can however also come from tainting which imparts an unpleasant flavour to fish and seafood and is detectable at extremely low levels of contamination. This reduces the market value of seafood.

Noise Pollution

- Noise may not seem as harmful as the contamination of air or water but it is a pollution problem that affects human health and can contribute to a general deterioration of environmental quality.
- Noise is undesirable and unwanted sound.
- Not all sound is noise.
- It is not a substance that can accumulate in the environment like most other pollutants. Sound is measured in a unit called the '**Decibel**'.
- There are several sources of noise pollution that contribute to both indoor and outdoor noise pollution.
- Noise emanating from factories, vehicles, playing of loudspeakers during various festivals can contribute to outdoor noise pollution while loudly played radio or music systems, and other electronic gadgets can contribute to indoor noise pollution.
- A study conducted by researchers from the New Delhi based National Physical Laboratory show that noise generated by firecrackers (presently available in the market) is much higher than the prescribed levels.
- The permitted noise level is **125 decibels**, as per the Environment (Protection) (second amendment) Rules, 1999.
- The differences between sound and noise is often subjective and a matter of personal opinion.
- There are however some very harmful effects caused by exposure to high sound levels. These effects can range in severity from being extremely annoying to being extremely painful and hazardous.

Effects of noise pollution on physical health:

The most direct harmful effect of excessive noise is physical damage to the ear and the temporary or permanent hearing loss often called a temporary threshold shift (TTS). People suffering from this condition are unable to detect weak sounds.

Effects of noise pollution on mental health:

Noise can also cause emotional or psychological effects such as irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise. It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of a city and suffer from noise pollution.

Noise Control techniques:

There are four fundamental ways in which noise can be controlled:

- Reduce noise at the source
- Block the path of noise
- Increase the path length
- Protect the recipient.

In general, the best control method is to reduce noise levels at the source.

Thermal Pollution

Sources: The discharge of warm water into a river is usually called a thermal pollution. It occurs when an industry removes water from a source, uses the water for cooling purposes and then returns the heated water to its source. Power plants heat water to convert it into steam, to drive the turbines that generate electricity. For efficient functioning of the steam turbines, the steam is condensed into water after it leaves the turbines. This condensation is done by taking water from a water body to absorb the heat. This heated water, which is at least 15oC higher than the normal is discharged back into the water body

Effects: The warmer temperature decreases the solubility of oxygen and increases the metabolism of fish. This changes the ecological balance of the river. Within certain limits thermal additions can promote the growth of certain fish and the fish catch may be high in the vicinity of a power plant. However sudden changes in temperature caused by periodic plant shutdowns both planned and unintentional can change result in death of these fish that are acclimatized to living in warmer waters.

Control measures: Thermal pollution can be controlled by passing the heated water through a cooling pond or a cooling tower after it leaves the condenser. The heat is dissipated into the air and the water can then be discharged into the river or pumped back to the plant for reuse as cooling water.

There are several ways in which thermal pollution can be reduced.

- One method is to construct a large shallow pond
- A second method is to use a cooling tower.

The disadvantage in both these methods is however that large amounts of water are lost by evaporation.

Nuclear Hazards

Nuclear energy can be both beneficial and harmful depending on the way in which it is used. We routinely use X-rays to examine bones for fractures, treat cancer with radiation and diagnose diseases with the help of radioactive isotopes. Approximately 17 % of the electrical energy generated in the world comes from nuclear power plants.

The radioactive wastes from nuclear energy have caused serious environmental damage. Nuclear fission is the splitting of the nucleus of the atom. The resulting energy can be used for a variety of purposes. Nuclear reactors will produce electricity so cheaply that it will not be necessary to meter it. The users will pay a fee and use as much electricity as they want. Atoms will provide a safe, clean and dependable source of electricity.' Today however though nuclear power is being used as a reliable source of electricity the above statement sounds highly optimistic. Several serious accidents have caused worldwide concern about safety and disposal of radioactive wastes. In order to appreciate the consequences of using nuclear fuels to generate energy it is important to understand how the fuel is processed. Low-grade uranium ore, which contains 0.2 percent uranium by weight, is obtained by surface or underground mining. After it is mined the ore goes through a milling process where it is crushed and treated with a solvent to concentrate the uranium and produces yellow cake a material containing 70 to 90 percent uranium oxide. Naturally occurring uranium contains only 0.7 percent of fissionable U-235, which is not high enough for most types of reactors. Hence it is necessary to increase the amount of U-235 by enrichment though it is a difficult and expensive process.

SOLID WASTE MANAGEEMNT: CAUSES, EFFECTS AND CONTROL MEASURES OF URBAN AND INDUSTRIAL WASTE

- Around most towns and cities in India the approach roads are littered with multi-coloured plastic bags and other garbage. Waste is also burnt to reduce its volume.
- Modern methods of disposal such as incineration and the development of sanitary landfills, etc. are now attempting to solve these problems.
- Lack of space for dumping solid waste has become a serious problem in several cities and towns all over the world.
- Dumping and burning wastes is not an acceptable practice today from either an environmental or a health perspective.
- Today disposal of solid waste should be part of an integrated waste management plan.
- The method of collection, processing, resource recovery and the final disposal should mesh with one another to achieve a common objective.

Control measures of urban and industrial wastes:

An integrated waste management strategy includes three main components:

1. **Source reduction**
2. **Recycling**

3. Disposal

Source reduction

It is one of the fundamental ways to reduce waste. This can be done by using less material when making a product, reuse of products on site, designing products or packaging to reduce their quantity. On an individual level we can reduce the use of unnecessary items while shopping, buy items with minimal packaging, avoid buying disposable items and also avoid asking for plastic carry bags.

Recycling

- It is reusing some components of the waste that may have some economic value.
- Recycling has readily visible benefits such as conservation of resources reduction in energy used during manufacture and reducing pollution levels.
- Some materials such as aluminum and steel can be recycled many times. Metal, paper, glass and plastics are recyclable.
- Mining of new aluminum is expensive and hence recycled aluminum has a strong market and plays a significant role in the aluminum industry.
- Paper recycling can also help preserve forests as it takes about 17 trees to make one ton of paper.
- Crushed glass (cullet) reduces the energy required to manufacture new glass by 50 percent.
- Cullet lowers the temperature requirement of the glassmaking process thus conserving energy and reducing air pollution.
- However even if recycling is a viable alternative, it presents several problems.
- The problems associated with recycling are either technical or economical.
- Plastics are difficult to recycle because of the different types of polymer resins used in their production. Since each type has its own chemical makeup different plastics cannot be recycled together.
- Thus separation of different plastics before recycling is necessary.
- Similarly in recycled paper the fibers are weakened and it is difficult to control the colour of the recycled product.
- Recycled paper is banned for use in food containers to prevent the possibility of contamination.
- It very often costs less to transport raw paper pulp than scrap paper. Collection, sorting and transport account for about 90 percent of the cost of paper recycling.
- The processes of pulping, deinking and screening wastepaper are generally more expensive than making paper from virgin wood or cellulose fibers.
- Very often thus recycled paper is more expensive than virgin paper. However as technology improves the cost will come down.

Disposal

Disposal of solid waste is done most commonly through a sanitary landfill or through incineration. A modern sanitary landfill is a depression in an impermeable soil layer that is lined with an impermeable membrane.

The three key characteristics of a municipal sanitary landfill that distinguish it from an open dump are:

• Solid waste is placed in a suitably selected and prepared landfill site in a carefully prescribed manner.

• The waste material is spread out and compacted with appropriate heavy machinery.
• The waste is covered each day with a layer of compacted soil.

Incineration

It is the process of burning municipal solid waste in a properly designed furnace under suitable temperature and operating conditions. Incineration is a chemical process in which the combustible portion of the waste is combined with oxygen forming carbon dioxide and water, which are released into the atmosphere. This chemical reaction called oxidation results in the release of heat.

Vermi – Composting

Nature has perfect solutions for managing the waste it creates, if left undisturbed. The biogeochemical cycles are designed to clear the waste material produced by animals and plants. We can mimic the same methods that are present in nature. All dead and dry leaves and twigs decompose and are broken down by organisms such as worms and insects, and is finally broken down by bacteria and fungi, to form a dark rich soil-like material called compost. These organisms in the soil use the organic material as food, which provides them with nutrients for their growth and activities. These nutrients are returned to the soil to be used again by trees and other plants. This process recycles nutrients in nature. This soil can be used as a manure for farms and gardens.

ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

- Develop respect or reverence for all forms of life.
- Try to plant trees wherever you can and more importantly take care of them. They reduce air pollution.
- Reduce the use of wood and paper products wherever possible.
- From the mail you receive reuse as many envelopes that you can.
- Do not buy furniture, doors, window frames made from tropical hardwoods such as teak and mahogany. These are forest based.
- Help in restoring a degraded area near your home or join in an afforestation program.
- Use pesticides in your home only when absolutely necessary and use them in as small amounts as necessary. Some insect species help to keep a check on the populations of pest species.
- Advocate organic farming by asking your grocery store to stock vegetables and fruits grown by an organic method. This will automatically help to reduce the use of pesticides.
- Reduce the use of fossil fuels by either walking up a short distance using a car pool, sharing a bike or using public transport. This reduces air pollution.
- Shut off the lights and fans when not needed.
- Don’t use aerosol spray products and commercial room air fresheners. They damage the ozone layer.

DISASTER MANAGEMENT: FLOODS, EARTHQUAKES, CYCLONES, LANDSLIDES

The Indian subcontinent is very vulnerable to droughts, floods, cyclones, earthquakes, landslides, avalanches and forest fires. Among the 36 states and Union territories in the country, 22 are prone to disasters.

Droughts are a perennial feature in some states of India. Sixteen percent of the country's total area is drought prone. Drought is a significant environmental problem as it is caused by a lower than average rainfall over a long period of time. Most of the drought prone areas identified by the Government lie in the arid and semi-arid areas of the country.

Earthquakes are considered to be one of the most destructive natural hazards. The impact of this phenomenon occurs with so little warning that it is almost impossible to make preparations against damages and collapse of buildings. About 50 to 60 percent of India is vulnerable to seismic activity of varying intensities. Most of the vulnerable areas are located in the Himalayan and sub-Himalayan regions.

CHAPTER-6
Social Issues and the Environment

FROM UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT:

Until two decades ago the world looked at economic status alone as a measure of human development. Thus countries that were economically well developed and where people were relatively richer were called advanced nations while the rest where poverty was widespread and were economically backward were called developing countries. Most countries of North America and Europe which had become industrialized at an earlier stage have become economically more advanced. They not only exploited their own natural resources rapidly but also used the natural resources of developing countries to grow even larger economies. Thus the way development progressed, the rich countries got richer while the poor nations got poorer. However, even the developed world has begun to realise that their lives were being seriously affected by the environmental consequences of development based on economic growth alone. This form of development did not add to the quality of life as the environmental conditions had begun to deteriorate.

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

To ensure sustainable development, any activity that is expected to bring about economic growth must also consider its environmental impacts so that it is more consistent with long term growth and development. Many 'development projects', such as dams, mines, roads, industries and tourism development, have severe environmental consequences that must be studied before they are even begun. Thus for every project, in a strategy that looks at sustainable development, there must be a scientifically and honestly done EIA, without which the project must not be cleared.

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 materials used, such as wood and bricks handled temperature changes better than the current concrete, glass and steel of ultra-modern buildings.

WATER CONSERVATION, RAINWATER HARVESTING, WATERSHED MANAGEMENT:

Water Conservation:

Conserving water has become a prime environmental concern. Clean water is becoming increasingly scarce globally. With deforestation surface runoff increases and the sub soil water table drops as water has no time to seep slowly into the ground once vegetation is cleared.

As deforestation and desertification spreads due to extensive changes in land use the once perennial rivers are becoming increasingly seasonal. To this is added serious problems caused by rapid surface flow of water during the rains, which leads to extensive floods with loss of life and property.

Saving water in agriculture:

Drip irrigation supplies water to plants near its roots through a system of tubes, thus saving water. Small percolation tanks and rainwater harvesting can provide water for agriculture and domestic use. Rainwater collected from rooftops can be stored or used to effectively recharge subsoil aquifers.

Saving water in urban settings:

Urban people waste large amounts of water. Leaking taps and pipes are a major source of loss of water. Canals and pipes carrying water from dams to the consumer lead to nearly 50% loss during transfer. Reducing the demand for water by saving it is more appropriate than trying to meet growing demands.

Rain water Harvesting

As our world faces serious water shortages, every drop of water we can use efficiently becomes of great value. One method is to manage rain water in such a way that it is used at the source. If as much water as possible is collected and stored this can be used after the rainy season is over. In many parts of the world especially in very dry areas this has been traditionally practiced. However the stored water has to be kept pollution free and clean so that it can be used as drinking water. Stored water can grow algae and zooplankton (microscopic animals). This can be pathogenic and cause infections. Thus keeping the water uncontaminated is of great importance.

Watershed Management:

Watershed management begins by taking control over a degraded site through local participation. People must appreciate the need to improve the availability of water both in quantity and quality for their own area. Once this is adequately demonstrated, the community begins to understand the project, people begin to work together in the activities that lead to good watershed management.

The first technical step is **to take appropriate soil conservation measures**. This is done by constructing a series of long trenches and mounds along contours of the hill to hold the rainwater and allow it to percolate into the ground. This ensures that underground stores of water are fully recharged. This is enhanced by allowing grasses and shrubs to grow and by planting trees (mainly local species) which hold the soil and prevents it from being washed away in the monsoon. Local

grass cover can however only increase if free grazing of domestic animals is prevented by stall feeding.

The next measure is **to make 'nala' plugs in the streams so that the water is held in the stream and does not rush down the hillside.** In selected sites, several small check dams are built which together hold back larger amounts of water. All these measures constitute sound watershed management. It improves the water table and keeps the streams and nalas flowing throughout the year.

RESETTLEMENT AND REHABILITATION OF PEOPLE: ITS PROBLEMS AND CONCERNS

Major projects such as dams, mines, expressways, or the notification of a National Park disrupts the lives of the people who live there and may also require moving them to an alternative site. Uprooting people is a serious issue. It reduces their ability to subsist on their traditional natural resource base and also creates great psychological pressures. Especially tribal people, whose lives are woven closely around their own natural resources, cannot adapt to a new way of life in a new place. Thus no major project that is likely to displace people can be carried out without the consent of the local people.

Resettlement requires alternate land. However, in our overpopulated country, there is no arable high quality land available. Thus most project affected persons are given unusable wasteland. Rehabilitation involves more than just giving land.

Resettlement not only puts pressure on the project affected people but also on the people who have been living in the area that has been selected for resettlement.

ENVIRONMENTAL ETHICS: ISSUES AND POSSIBLE SOLUTIONS

Environmental ethics deals with issues related to the rights of individuals that are fundamental to life and well being. This concerns not only the needs of each person today, but also those who will come after us. It also deals with the rights of other living creatures that inhabit our earth.

- Resource consumption patterns and the need for their equitable utilisation
- Equity – Disparity in the Northern and Southern countries
- Urban – rural equity issues
- The need for Gender Equity
- Preserving resources for future generations
- The rights of animals
- The ethical basis of environment education and awareness
- The conservation ethic and traditional value systems of India

CLIMATE CHANGE, GLOBAL WARMING, ACID RAIN, OZONE LAYER DEPLETION, NUCLEAR ACCIDENTS AND HOLOCAUST

Climate change:

The average temperature in many regions has been increasing in recent decades. The global average surface temperature has increased by 0.6° + 0.2° C over the last century. Projections of future climate change are derived from a series of experiments made by computer based global climate models. These are worked out on estimates of aspects such as future population growth and energy use. Climatologists of the Intergovernmental Panel on Climate Change (IPCC) have reviewed the results of several experiments in order to estimate changes in climate in the course of this century. These studies have shown that in the near future, the global mean surface temperature will rise by 1.4° to 5.8°C. Warming will be greatest over land areas, and at high latitudes. The projected rate of warming is greater than has occurred in the last 10,000 years. The frequency of weather extremes is likely to increase leading to floods or drought.

Global warming:

About 75% of the solar energy reaching the Earth is absorbed on the earth's surface which increases its temperature. The rest of the heat radiates back to the atmosphere. Some of the heat is trapped by greenhouse gases, mostly carbon dioxide. As carbon dioxide is released by various human activities, it is rapidly increasing. This is causing global warming. The average surface temperature is about 15°C. This is about 33°C higher than it would be in the absence of the greenhouse effect. Without such gases most of the Earth's surface would be frozen with a mean air temperature of -18°C.
Human activities during the last few decades of industrialisation and population growth have polluted the atmosphere to the extent that it has begun to seriously affect the climate.

Acid rain:

When fossil fuels such as coal, oil and natural gas are burned, chemicals like sulfur dioxide and nitrogen oxides are produced. These chemicals react with water and other chemicals in the air to form sulfuric acid, nitric acid and other harmful pollutants like sulfates and nitrates. These acid pollutants spread upwards into the atmosphere, and are carried by air currents, to finally return to the ground in the form of acid rain, fog or snow. The corrosive nature of acid rain causes many forms of environmental damage. Acid pollutants also occur as dry particles and gases, which when washed from the ground by rain, add to the acids in the rain to form a more corrosive solution. This is called acid deposition.

Effects:
Acid rain dissolves and washes away nutrients in the soil which are needed by plants. It can also dissolve naturally occurring toxic substances like aluminium and mercury, freeing them to pollute water or poison plants. 2. Acid rain indirectly affects plants by removing nutrients from the soil in which they grow. It affects trees more directly by creating holes in the waxy coating of leaves, causing brown dead spots which affect the plant's photosynthesis. Such trees are also more vulnerable to insect infestations, drought and cold. Spruce and fir forests at higher elevations seem to be most at risk. Farm crops are less affected by acid rain than forests. 3. Acid rain that falls or flows as ground water to reach rivers, lakes and wetlands, causes the water in them to become acidic. This affects plant and animal life in aquatic ecosystems. 4. Acid rain also has far reaching effects on wildlife. By adversely affecting one species, the entire food chain is disrupted, ultimately

endangering the entire ecosystem. Different aquatic species can tolerate different levels of acidity. For instance clams and mayflies have a high mortality when water has a pH of 6.0, while frogs can tolerate more acidic water, although with the decline in supply of mayflies, frog populations may also decline. Land animals that are de pendent on aquatic organisms are also affected.

Solutions:

The best way to stop the formation of acid rain is to reduce the emissions of sulfur dioxide and nitrogen oxides into the atmosphere. This can be achieved by using less energy from fossil fuels in power plants, vehicles and industry. Switching to cleaner burning fuels is also a way out. For instance using natural gas which is cleaner than coal, using coal with lower sulfur content, and developing more efficient vehicles. If the pollutants have already been formed by burning fossil fuels, they can be prevented from entering the atmosphere by using scrubbers in smokestacks in industry. These spray a mixture of water and limestone into the polluting gases, recapturing the sulfur.

Nuclear Accidents and Nuclear Holocaust:

Nuclear energy was researched and discovered by man as a source of alternate energy which would be clean and cheap compared to fossil fuels. And although this did happen, along with the benefits of nuclear energy came its downfalls. In the short history of nuclear energy there have been accidents that have surpassed any natural calamity or other energy source extraction in their impacts. A single nuclear accident can cause loss of life, long-term illness and destruction of property on a large scale for a long period of time. Radioactivity and radioactive fallout leads to cancer, genetic disorders and death in the affected area for decades after, thus affecting all forms of life for generations to come.

Nuclear holocaust:

The use of nuclear energy in war has had devastating effects on man and earth. The Hiroshima and Nagasaki incident during World War II, the only use of nuclear power in war in history, is one of the worst disasters in history. In 1945, the United States dropped atomic bombs in Japan over the towns of Hiroshima and Nagasaki. These two atomic bombs killed thousands of people, left many thousands injured and devastated everything for miles around. The effects of the radiation from these nuclear bombs can still be seen today in the form of cancer and genetic mutations in the affected children and survivors of the incident.

THE ENVIRONMENT (PROTECTION) ACT

The Environment (Protection) Act, 1986 not only has important constitutional implications but also an international background. The spirit of the proclamation adopted by the United Nations Conference on Human Environment which took place in Stockholm in June 1972, was implemented by the Government of India by creating this Act.

THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT

The Government passed this Act in 1981 to clean up our air by controlling pollution.

This Act is created ‘to take appropriate steps for the preservation of the natural resources of the earth which among other things includes the preservation of high quality air and ensures controlling the level of air pollution.

The main objectives of the Act are as follows:

- To provide for the Prevention, Control and abatement of air pollution.
- To provide for the establishment of Central and State Boards with a view to implement the Act.
- To confer on the Boards the powers to implement the provisions of the Act and assign to the Boards functions relating to pollution.

What can an individual do to control air pollution?

1) When you see a polluting vehicle take down the number and send a letter to the Road Transport Office (RTO) and the Pollution Control Board (PCB).

2) If you observe an industry polluting air, inform the Pollution Control Board in writing and ascertain if action is taken.

3) Use cars only when absolutely necessary. Walk or cycle as much as possible instead of using fossil fuel powered vehicles.

4) Use public transport as far as possible, as more people can travel in a single large vehicle rather than using multiple small vehicles which add to pollution.

5) Share a vehicle space with relatives and friends. Carpools minimise the use of fossil fuels.

6) Do not use air fresheners and other aerosols and sprays which contain CFCs that deplete the ozone layer.

7) Do not smoke in a public place. It is illegal and endangers not only your own health but also that of others.

8) Coughing can spread bacteria and viruses. Use a handkerchief to prevent droplet in fection which is air borne. It endangers the health of other people.

THE WATER (PREVENTION AND CONTROL OF POLLUTION) ACT

The Government has formulated this Act in 1974 to be able to prevent pollution of water by industrial, agricultural and household wastewater that can contaminate our water sources.

The main objectives of the Water Act are

To provide for prevention, control and abatement of water pollution and the maintenance or restoration of the wholesomeness of water.

It is designed to assess pollution levels and punish polluters. The Central Government and State Governments have set up Pollution Control Boards that monitor water pollution.

What can individuals do to prevent water pollution?

1. Inform the Pollution Control Board of any offender who is polluting water and ensure that appropriate action is taken. One can also write to the press.

2. Do not dump wastes into a household or industrial drain which can directly enter any water body, such as a stream, river, pond, lake or the sea.

3. Do not use toilets for flushing down waste items as they do not disappear but reappear at other places and cause water pollution.

4. Use compost instead of chemical fertilizers in gardens.

5. Avoid use of pesticides at home like DDT, Melathion, Aldrin, and use alternative methods like paste of boric acid mixed with gram flour to kill cockroaches and other insects. Use dried neem leaves to help keep away insects.

PUBLIC AWARENESS

- Using an Environmental Calendar of Activities:
  There are several days of special environmental significant which can be celebrated in the community and can be used for creating environmental awareness.

- What can I do?
  The following are some of the things you can do to contribute towards our ecological security and biodiversity conservation.
    1. Plant more trees of local or indigenous species around your home and your workplace. Encourage your friends to do so. Plants are vital to our survival in many ways.
    2. If your urban garden is too small for trees, plant local shrubs and creepers instead. These support bird and insect life that form a vital component of the food chains in nature. Urban biodiversity conservation is feasible and can support a limited but valuable diversity of life.
    3. Look for ways to reduce the use of paper. Use both sides of every sheet of paper. Send your waste paper for recycling.
    4. Buy recycled paper products for your home. For example sheets of paper, envelopes, etc.
    5. Reuse cartons and gift-wrapping paper. Recycle newspaper and waste paper instead of throwing it away as garbage.

CHAPTER 7
Human Population and the Environment

POPULATION GROWTH, VARIATION AMONG NATIONS

Our global human population, 6 billion at present, will cross the 7 billion mark by 2015. The needs of this huge number of human beings cannot be supported by the Earth's natural resources, without degrading the quality of human life.

Increase in production per capita of agricultural produce at a global level ceased during the 1980's. In some countries, food shortage has become a permanent feature. Two of every three children in South Africa are underweight.

In other regions famines due to drought have become more frequent. Present development strategies have not been able to successfully address these problems related to hunger and malnutrition. On the other hand, only 15% of the world's population in the developed world is earning 79% of income! Thus the disparity in the extent of per capita resources that are used by people who live in a 'developed' country as against those who live in a 'developing' country is extremely large. Similarly, the disparity between the rich and the poor in India is also growing.

The increasing pressures on resources place great demands on the in-built buffering action of nature that has a certain ability to maintain a balance in our environment. However, current development strategies that essentially lead to short-term gains have led to a breakdown of our Earth's ability to replenish the resources on which we depend.

POPULATION EXPLOSION – FAMILY WELFARE PROGRAM

In response to our phenomenal population growth, India seriously took up an effective Family Planning Program which was renamed the Family Welfare Program. Slogans such as '**Hum do hamare do**' indicated that each family should not have more than two children. It however has taken several decades to become effective. At the global level by the year 2000, 600 million, or 57% of women in the reproductive age group, were using some method of contraception. However the use of contraceptive measures is higher in developed countries – 68%, and lower in developing countries - 55%. Female sterilization is the most popular method of contraception used in developing countries at present. This is followed by the use of oral contraceptive pills and, intrauterine devices for women, and the use of condoms for men. India and China have been using permanent sterilization more effectively than many other countries in the developing world.

ENVIRONMENT AND HUMAN HEALTH

Environment related issues that affect our health have been one of the most important triggers that have led to creating an increasing awareness of the need for better environmental management. Changes in our environment induced by human activities in nearly every sphere of life have had an influence on the pattern of our health. The assumption that human progress is through economic growth is not necessarily true. We expect urbanization and industrialization to bring in prosperity, but on the down side, it leads to diseases related to overcrowding and an inadequate quality of drinking water, resulting in an increase in waterborne diseases such as infective diarrhoea and air borne bacterial diseases such as tuberculosis. High-density city traffic leads to an increase 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 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. At times the cure is as damaging as the disease process itself.

HUMAN RIGHTS

Several environmental issues are closely linked to human rights. These include the equitable distribution of environmental resources, the utilisation of resources and Intellectual Property Rights (IPRs), conflicts between people and wildlife especially around PAs, resettlement issues around development projects such as dams and mines, and access to health to prevent environment related diseases.

- Equity
- Nutrition, health and human rights
- Intellectual Property Rights and Community Biodiversity Registers

VALUE EDUCATION

Value education in the context of our environment is expected to bring about a new sustainable way of life. Education both through formal and non-formal processes must thus address understanding

environmental values, valuing nature and cultures, social justice, human heritage, equitable use of resources, managing common property resources and appreciating the cause of ecological degradation.

- **Environmental Values**
- **Valuing Nature**
- **Valuing cultures**
- **Social justice**
- **Human heritage**
- **Equitable use of resources**
- **Common Property Resources**
- **Ecological degradation**

ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT AND HUMAN HEALTH

The understanding of environmental concerns and issues related to human health has exploded during the last few years due to the sudden growth of Information Technology. The computer age has turned the world around due to the incredible rapidity with which IT spreads knowledge. IT can do several tasks extremely rapidly, accurately and spread the information through the world's networks of millions of computer systems. A few examples of the use of computer technology that aid environmental studies include software such as using Geographical Information Systems (GIS). GIS is a tool to map land use patterns and document change by studying digitized topo sheets and/or satellite imagery. Once this is done, an expert can ask a variety of questions which the software can answer by producing maps which helps in land use planning.

The Internet with its thousands of websites has made it extremely simple to get the appropriate environmental information for any study or environmental management planning. This not only assists scientists and students but is a powerful tool to help increase public awareness about environmental issues. Specialised software can analyse data for epidemiological studies, population dynamics and a variety of key environmental concerns. The relationship between the environment and health has been established due to the growing utilisation of computer technology. This looks at infection rates, morbidity or mortality and the etiology (causative factors) of a disease. As knowledge expands, computers will become increasingly efficient. They will be faster, have greater memories and even perhaps begin to think for themselves.