

Lecture note
For
Environmental Studies



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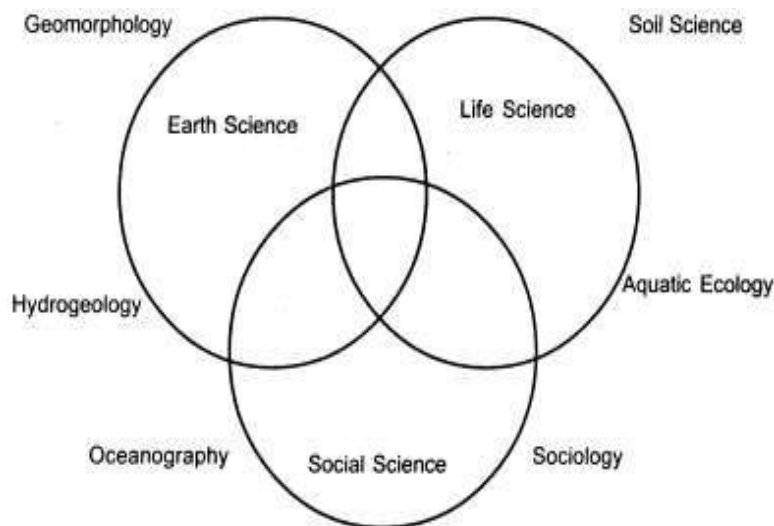
Chapter 1

The multidisciplinary nature of environmental studies

The term environment means surroundings and is generally used as an abstract concept. The surroundings may be natural, man-made, physical, chemical or biotic. The environment is thus, a complex of many things encompassing an organism that interact not only with the organisms but also among themselves. As a result of this it is difficult to isolate or alter any one of them without affecting the other components.

The wise management of environment depends upon an understanding of those components: namely rock, minerals and water, of its present and potential vegetation, animal life, livestock husbandry and climate. It demands positive and realistic planning that balances human needs against the potential environment.

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



Various Disciplines of Environmental Science

With the advancement in the knowledge of environment, explosive increase in human population, scarcity of space, food problems, deterioration of hygienic conditions, threatening depletion of natural resources and socio-economic problems, one needs

extensive and exhaustive study of the environment, particularly in relation to human survival and benefit. The subject is gaining more popularity with its name as "environmental biology". However, the environmental are not a new discipline but simply an extension of ecologies approach which stresses the study of the environment in its totality with special emphasis on the welfare of man and his comfort. Man has been considered the most evolved and an intelligent component of the ecosystem.

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

Scope and Importance

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

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

Necessity for Environmental Awareness and Education

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

- i. Theoretical aspects dealing with the identification of environmental problems.
- ii. Applied aspects dealing with development of solutions to the environmental problems identified above.

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

Chapter 2

Natural Resources

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

Natural Resources:

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

Natural resources can be divided into two main categories –

i. Renewable resources

ii. Non-renewable resources

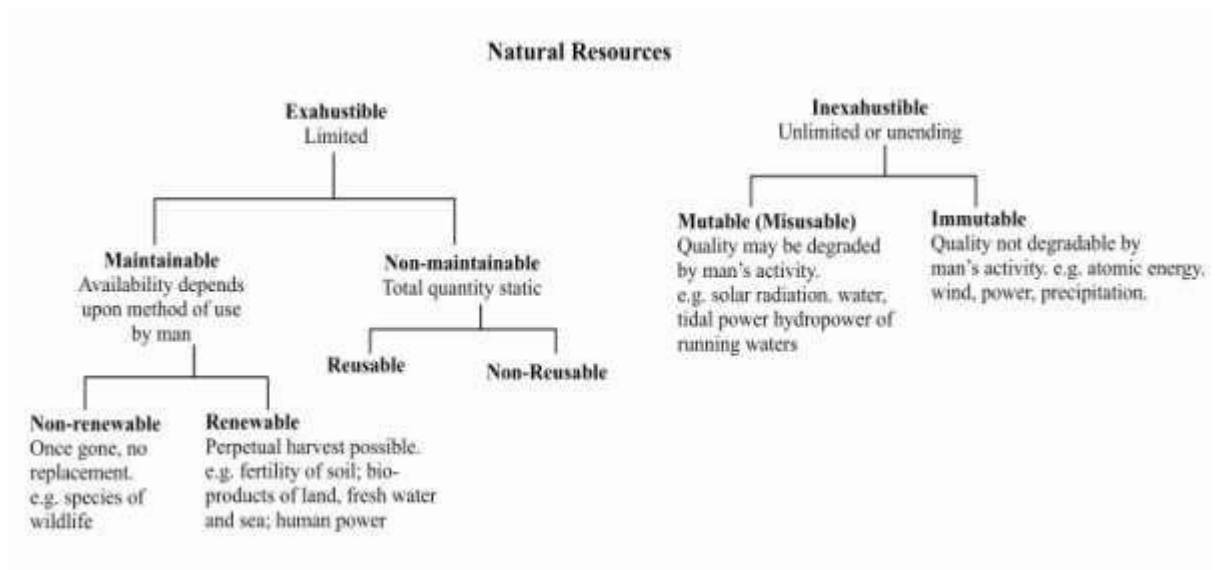
i) Renewable resources: The resources that can be replenished through rapid natural cycles are known as renewable resources, e.g. Water, Air, Soil, Solar energy, Forest. **ii) Non-renewable resources:** The resources that can't be replenished through natural processes are called non-renewable resources. These are available in limited amount and which once used exhaust forever. e.g. Fossil, petrol, coal, metals, iron, copper, gold, silver etc.

Non renewable resources can be further divided into two types

a) Recyclable and b) Non-Recyclable.

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

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



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

Ecological Uses:

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

Economic uses:

1. They provide grasses for feeding, thatching, paper industry etc. In Forests provide timber for house building, ship building, railway carriages, log bodies, carts, furniture, tool handles etc.
2. They supply fire wood and charcoal in homes and in industries.

3. Forests provide raw materials for various forest based industries, i.e., pulp and paper, rayon, matches, soaps, paints, rubber etc.
4. Products like bamboos, resins, gums, canes, training materials, dye stuffs, oils (Sandal) fibers, medicine, Kattha, lac etc are also obtained from the forests.
5. They provide honey for food and medicines, bee wax for candles etc.

Over exploitation of forests-

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

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

Deforestation :

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

Effect of deforestation:

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

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

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

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

Water Resources:

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

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

The various forms of water are found in every section of the ecosphere, atmosphere, the lithosphere and the hydrosphere. However, in spite of enormous quantity of the substance that exists, only a small proportion of it is actually usable by human beings. The ocean alone constitute 97 percent of the hydrosphere, and the polar ice caps, ice fields and glaciers make up another 2 percent in the form of ice. Inland surface water (lake and rivers) account for barely 0.02, percent.

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

i) Surface Water Resources

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

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

B. Ground Water Resources

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

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

Mineral Resources:

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

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

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

Energy Resources:

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

Non Conventional Energy Sources:

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

Electrical energy comes from hydel power based on the cycle that is powered by the sun energy that supports evaporation or from thermal power stations powered by fossil fuels.

Nuclear energy is held in the nucleus of an atom and is now harnessed to develop electrical energy.

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

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

Renewable Energy

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

Bio Energy

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

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

Biogas is produced from plant material, animal waste, garbage, waste from households and some other types of wastes, such as fish processing, dairies and sewage treatment plants. It is a mixture of gases which includes methane, CO, H₂S and water vapour. Biogas plants have become increasingly popular in India in the rural sector. The Biogas plants use cow dung, which is converted into a gas which reduces smoke, and dung usage have increased in thousands of homes.

Biogas or Gobar Gas

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

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

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

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

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

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

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

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

The heat energy produced in the chain reaction of Uranium₂₃₅ (U_{235}) is used to heat turbines that produce steam, which drives turbines that produce electricity. The reaction releases very hot wastewater that damages aquatic ecosystems even though it is cooled by water system before it is released.

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

Food Resources

Food may be defined as anything which is able to satisfy appetite and to meet physiological needs for growth, to maintain all body processes and to supply essential energy required

for maintaining body temperature and activity. Food is a mixture of many different chemical components. The six major components of food are carbohydrates, proteins, fats, minerals, vitamins and water. To maintain good health, ingesting a diet containing these nutrients in correct amounts is essential.

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

Problems of agriculture Overgrazing:

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

Water Logging

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

- 1) Deep percolation after rain.
- 2) The land remaining submerged under floods.
- 3) Poor natural drainage of the subsoil under unfavourable geology like existence of hard pan or rock outcrops near the soil surface.

The artificial conditions responsible for water logging are as follows:

1. No maintenance of natural drainages.
2. Blocking of natural drainage channels by roads and railways.
3. Irrigated fields enclosed with embankments choking up natural drainage.
4. Heavy seepage from unlined canals.
5. High intensity of irrigated agriculture irrespective of the soil and subsoil.

Salinity

The term "Salinity" refers to the amount of dissolved salt that is present in water. Sodium and chloride are predominant ions in seawater, and the concentrations of magnesium, calcium, and sulfate ions are also substantial. Naturally occurring waters vary in salinity from the almost pure water, devoid of salts, to the saturated solutions in salt lakes such as the Dead Sea. Salinity in the oceans is constant but is more variable along the coast where seawater is diluted with freshwater from runoff of rivers. This brackish water forms a barrier separating marine and freshwater organisms.

Land Resources

Land is regarded as a natural resource because it is essential for the functioning of organisms, populations and ecosystems. Along with sunlight, air and water, land supports all living beings

i.e. plants and animals. All terrestrial plants have their roots in soil from which they absorb water and nutrients. Man and all land animals, in turn, depend on these plants for food, directly or indirectly.

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

Soils:

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

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

Methods of Conservation

1. Biodiversity Conservation

Biodiversity or biological diversity denotes the number and variety of different organisms and ecosystems in a certain area. Preserving biodiversity is essential for ecosystems to respond flexibly to damage or change. For example, a single species of corn crop may be quickly destroyed by a certain insect or disease, but if several different species of corn are planted in the field, some of them may resist the insect or disease and survive.

2. Forest Conservation

Forests provide many social, economic, and environmental benefits. In addition to timber and paper products, forests provide wildlife habitat and recreational opportunities, prevent soil erosion and flooding, help provide clean air and water, and show tremendous biodiversity. Forests are also an important defense against global climate change. Through the process of photosynthesis, forests produce life giving oxygen and consume huge amounts of carbon dioxide, the atmospheric chemical most responsible for global warming.

3. Soil Conservation

Soil, a mixture of mineral, plant, and animal materials, is essential for most plant growth and is the basic resource for agricultural production. Soil-forming processes may take thousands of years, and are slowed by natural erosion forces such as wind and rain. Humans have accelerated these erosion processes by developing the land and clearing away the vegetation that holds water and soil in place.

4. Water Conservation

Clean freshwater resources are essential for drinking, bathing, cooking, irrigation, industry, and for plant and animal survival. Unfortunately, the global supply of freshwater is distributed unevenly. Water can be conserved by holding maximum amount of rain water mainly in hilly tracts which serve as catchment areas. This is usually done by allowing the vegetation to grow on slopes of hills. Hence, afforestation is important by which plants can bind the soil and the soil can hold water.

5. Energy Conservation

All human cultures require the production and use of energy that is, resources with the capacity to produce work. Energy is used for transportation, heating, cooling, cooking, lighting, and industrial production. The world energy supply depends on many different resources including traditional fuels such as firewood and animal waste, which are significant energy sources in many developing countries. Fossil fuels account for more than 90 percent of global energy production but are considered problematic resources. They are non renewable that is, they can be depleted, and their use causes air pollution.

6- Mineral Conservation

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