Govt. Degree College Kilam
Department of Environmental Science
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Credit II: Natural Resources

2.1 Land resources: Global land use patterns, concept of land degradation and Desertification.
2.2 Forest resources: Use and consequences of over-exploitation.
2.3 Water resources: Use and consequences of over-utilization, concept of water harvesting and watershed management, water conflicts.
2.4 Energy resources: Renewable and non renewable resources, growing energy needs and alternate energy sources

Resource: A resource is anything which can be transformed in a way that it becomes more valuable and useful to meet the needs and desires of humans. The resource that is directly available for us from nature is called a natural resource, which includes fresh air, fresh water in lakes and rivers, soil, land, forest, grasslands, biodiversity, fisheries, ecosystems, minerals, salts, fossil fuels etc. In other words, natural resources are the goods and services supplied by our environment.

Type of Resources: Natural resources can be classified in different ways as follows:-

1. Based on their utility, natural resources can be classified as source of food, raw materials, energy etc.
2. Based on their origin, they are classified as biotic (living) or abiotic (non-living) resources. Biotic resources include all living organisms which includes plants, animals and micro-organisms. Abiotic resources include air, water, land, minerals etc.
3. Based on their quantity in nature and extent of continuous availability, they are classified into two categories:

a. **Inexhaustible resources**: These are the resources which occur in unlimited quantites in nature and are not likely to be exhausted soon by human use and thus would last for fairly a longer period. These include air, water, sun.

b. **Exhaustible resource:** These are the resources which occur in limited amount in nature and therefore, likely to become exhausted one day due to continuous use. These include minerals, fossil fuels, forests, wildlife etc. These exhaustible resources are of two types:

(i) **Renewable resources:-**Although exhaustible, these can be renewed (regenerated) simultaneously along with their exploitation, and hence are always available for longer periods. They can maintain themselves by natural recycling and reproduction or can be replenished if managed wisely. These include forests, crops, animals etc. These resources too may get

exhausted if not managed properly. For example, a species may get extinct by its over exploitation.

(ii)**Non-renewable resources:-**These cannot be recycled or replenished and hence, they get exhausted due to unlimited continuous use. They include mineral ores, coal petroleum etc.

Formation of such resources takes several thousand of years, so once they are used in unlimited ways they cannot be replaced easily.

Land Resource: Land is one of the most vital resource as it is used for production of crops and other biological materials needed for food, fodder, medicine, fibres etc. the physical limits of cultivated land are temperature, moisture, topography and soil. Its availability and cultivability also vary according to human social pattern, particularly the use pattern of energy.

L**and is a finite resource.** Land is one of the main components of our environment and occupies a little fewer than 30% of our earth's surface. It has been estimated that the total land area on the earth's surface is 13,382 million hectares, out of which 13,069 million hectares is without ice (ice free) and the remaining 313 million hectares as ice covered. Because of this finite area of land, it is considered a non renewable type of resource. About 36.6% of the land area is covered by houses, factories, roads, railways, desert and dunes, glaciers, mountains and polar ice marshes, about 30% by forests and about 22% by meadows and pastures. Only 11% of land area is fit for tilling.

Land use Pattern: Land is used for building homes, cultivating food, maintaining pastures for domestic animals, developing industries to provide goods and supporting the industries by creating towns and cities. Equally importantly, man needs to protect wilderness area in the forests, grasslands etc. to protect our critically valuable biodiversity.

Humans shape the land through increasing populations, agricultural expansion, mineral and forest resource excavation, changing the flow of rivers, and with layers of industrial and urban infrastructure. **Land cover** is the physical and biological material found on the surface of the land, existing as vegetation or the built environment (human-created structures). **Land use** describes the various ways in which human beings make use of and manage the land and its resources. Land use practices vary considerably across the world. The United Nations' Food and Agriculture Organization explains that "Land use concerns the products and/or benefits obtained from use of the land as well as the land management actions (activities) carried out by humans to produce those products and benefits. As of the early 1990s, about 13% of the Earth was considered arable land, with 26% in pasture, 32% forests and woodland, and 1.5% urban areas. Land use and land management practices have a major impact on natural resources including water, soil, nutrients, plants and animals. Land use information can be used to develop solutions for natural resource management issues such as salinity and water quality. India has total land area of 2.4% of the world total, but supports a population of over 16% of the world. Thus the per capita land availability was only 0.48% hectare as against 8.43hectare in former USSR, and 0.98 hectare in china.

Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. The pattern of land use on our earth varies

from one country to another country in different sectors. Land is a scarce resource, whose supply is fixed for all practical purposes. At the same time, the demand for land for various competing purposes is continuously increasing with the increase in human population and economic growth. Broadly at the global level the land use pattern is.

Agricultural land= 11%

Pastures and Meadows = 24%

Forest land = 31%

Other land = 34%

(i.e. land area occupied by human dwellings and factories, roads and railways, deserts, glaciers, rocks and mountains)

India has just 2.4% of the world's total land area and holds almost 16% of world's total population. The patterns of land use in India vary a lot as regards the global use. In India the land is used for

Agricultural land = 51%

Pastures and Meadows = 6.40%

Forest Land= 23.80%

Other land = 18.80%

The total land area of India is 328m hectares.

The demand for land is increasing rapidly as population is increasing and as a result more and more land is brought under agriculture, human settlements, industrial sector and other related uses. Almost 70% of potentially cultivable land in developed countries and 36% in developing countries are currently used for agriculture. At the global level the total land area which is potentially cultivable has been estimated to be 3200 million hectares.

Land degradation: All land use activities particularly those which are poorly managed involve destruction or disturbance to get a greater or lesser extent of natural or semi natural ecosystem. Land degradation may be defined as the decline in the soil productivity through adverse changes in the nutrient status, organic matter, structural stability and concentration of electrophytes and toxic chemicals.

Effects: Land degradation incorporates a number of environmental problems, some of which are interrelated, including soil erosion, compaction, water excess and deficit, acidification, toxic accumulation of agriculture chemicals and urban pollutants, contamination of surface and ground water and many implications on human health.

Causes of land degradation:

According to global assessment of soil degradation project, about 15% of the global land area between 72N and 57S is degraded. Of this an area slightly less than that of india(328 million hectares) is strongly degraded largely as a result of:

(a). Deforestation (113 million hectares)

(b). inappropriate management of cropped land (83 million hectares)

(c).Overgrazing (75 million hectares).

The other causes of land degradation are as follows:

(d) Soil erosion

(e) Landslides

(f) Shifting cultivation(jhum cultivation)

(g) Salinity

(h) Urbanization

(i) Desertification

The global rate of soil degradation is 10 million hectares per year.

Desertification: Desertification is a systematic process of conversion of productive land into unproductive arid region, or Desertification is the process by which fertile land is turned into barren land or desert. An estimated 135 million people are directly affected by desertification, mainly in Africa, the main Subcontinent and South America.

United Nations Conference On Desertification (UNCOD) data suggests that about 6000 sq kms of land are turned into deserts each year and production capacity of further 2,10,000 sq.kms is ruined each year. More recent data suggests that over 3.1 million sq.kms of worlds range land (80% of total), 3.35 million sq.kms of rain fed crop lands (60% of total) and 0.4 million sq.kms of irrigated dry lands (30% of the total) are threatened by moderate to severe desertification.

Impacts of desertification:

1. Stress on food producing capacity.
2. Reduction in biodiversity.
3. Modification of climate.

Causes of desertification:

The various causes of desertification are:

1. Inappropriate land use practice.
2. Over exploitation of water and land resources.
3. Over grazing and deforestation.
4. Pollution.
5. Improper soil and water management.
6. Population explosion.

Process of desertification:

Decline in diversity of plant and animal communities.

⇩

Decrease in overall vegetation cover and increase in proportion of barren ground.

⇩

Change in soil structure including reduction in organic matter and loss of water holding capacity.

⇩

Further reduction in soil fertility leading to further loss of vegetation.

⇩

Attack of land surface by wind and water erosion.

⇩

Results into extensive bare areas of infertile and badly eroded soils.

Measures to control desertification: The various measures to control desertification are:-

1. Stabilization of desert sands.
2. Increase the water retaining capacity of desert soils to enable crops to grow.
3. Reduction of salinization of irrigated lands.
4. Population stabilization.
5. Conservation of water, land and biological resources.
6.

Forest Resources: A forest is a biotic community, predominantly of trees, shrubs or any other woody vegetation. Forests are one of the most important natural resources, which are covering the earth like green belts. A forest can be defined as a biotic community spread over a large tract of land predominated by trees, shrubs or any other woody vegetation usually with a closed canopy. The word Forest is derived from a Latin word *'foris'* which means *'outside'* refers to villages fenced boundary which in uninhabited and uncultivated. Forests are important renewable natural resources but they are exhaustible. Forests cover 31% of total land area. The world's total forest area is just over 4 billion hectares, which corresponds to an average of 0.6 ha per capita. This is down from the preindustrial era of 5.9 billon hectares.

Importance/ uses of Forests: The Forests and human beings are closely related with each other from the very beginning of the human history. It is not possible to sum up the importance of forests in just a few words. Forests impact on our daily lives in so many ways, even in the midst of a busy, noisy, concrete city centre. Forests are of immense value to the life and prosperity of human beings and nations. They not only provide a safe heaven for a richly diverse biota but also favorably modify climatic parameters. The importance of forest resources can be explained as under:

i. Forests and wildlife are essential to maintain ecological balance of an area.

ii. Forest contributes to the economic development of the country because they provide goods and services to the people and industry.

iii. The forest enhances the quality of environment by influencing the life supporting system.

iv. Forest checks air pollution and soil erosion. Thus, they exercise safety and against pollution.

v. Forest saves the hill-slopes from landslides.

vi. In deserts, trees reduce wind erosion by checking wind velocity.

vii. The forest checks pollution of air through increasing oxygen content of the air.

viii. By causing condensation of water vapors in clouds, forests attract rains.

ix. The floods are controlled because forests dry up rainwater like sponge.

x. **Supply of Raw Material:** Forest supply wood, which is used as under:

(*i*) Fuel,
(*ii*) Raw material for various industries as pulp, paper, newsprint, board;
(*iii*) Timber for furniture items;

4. To be used in packing articles like fruits, tea etc.
5. For preparing matches, sport goods etc.

xi. Minor forest products: Some examples of minor forest products are canes, gums, resins, dyes, flocks, medicines, tannins, lac, fibers, katha etc. For tribal people are provided with food like tuber, roots, leaves, fruits, meat from birds and other animals etc.

Over-exploitation and Deforestation: With the world population growing at a pace hard to match, the increasing need for space is turning out to be an area of concern. The increasing demand of land for agricultural, industrial and most importantly urban needs to contain cities and their growing population, a direct action that we have come to recognize as "Deforestation". Deforestation is the permanent destruction of forests in order to make the land available for other uses. Deforestation is defined as the complete clearing of tree formations and their replacement by using land for other purposes or in other words deforestation is the temporary or permanent removal of forest cover from a forested land for agriculture or other purposes. Deforestation refers to the cutting, clearing, and removal of rainforest or related ecosystems into less bio-diverse ecosystems such as pasture, cropland, or plantations (Kricher, 1997). The extent of deforestation can easily be summarized from the comparison between the present forest cover and that during the pre-agricultural period. Ten thousand years ago before the advent of agriculture, forests covered 6.2 billion hectares or almost 50% of the total land area on earth's surface. Now we are left with only 4 billion hectares and even that cover is dwindling rapidly.

- **Causes of Deforestation:** *Deforestation is one of the major causes to the environmental degradation which is affected by the agents* like small farmers, ranches, loggers and plantation companies. There are many causes of deforestation. The various reasons which are responsible for large scale deforestation are as under.

(i) Agricultural Expansion: Agricultural expansion is one of the most important causes of deforestation as demands on agricultural products increases, more and more forest land is brought under cultivation and result is in forest clearing.

(ii) Shifting Cultivation: Shifting cultivation or Jhum is often blamed for destruction of forests. Also known as slash and burn cultivation or jhum cultivation is a primitive agricultural system in which parts of a forest land are repeatedly cleared, cultivated and then abandoned for regeneration over a period of many years. This is practiced by mostly landless indigenous people or tribals. In this practice a small plot of a forest land is cleared by burning which releases nutrients required for the cultivating crops. After a few seasons of cultivation the plot is abandoned and this fallow period allows the forest to regenerate and soil fertility to be regained.

(iii) Fuel wood Collection: To majority of rural population and a large number of people living in small towns and cities of developing countries, the only fuel is wood which is burned to cook food and to provide heat in chilly winters. Firewood collection contributes much to the depletion of tree cover, especially in localities which are lightly wooded.

Growing population increases this demand for fuel wood and in consequence leads to deforestation.

(iv) Timber Extraction for Industrial purposes: Timber obtained from forests are used for the manufacture of various types of goods and furniture items at various industrial sectors. These products are readily available in national and international markets and their demand is on a rise. As a result forests are exploited and result in deforestation. Commercial logging is also an important cause for deforestation. Commercial logging is cutting of trees of only selected species which fetch better prices e.g. Cedrus deodar in the valley of Kashmir.

(v) Overgrazing: Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. It can be caused by either livestock in poorly managed agricultural applications, or by overpopulations of native or non- native wild animals. Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods

(vi) Developmental activities: Various types of developmental activities such as constriction of roads, railway tracks, Dams and hydropower projects, mining of various resources etc also cause large scale deforestation.

- **Consequences of Deforestation:** With deforestation ecological balance maintain by nature breaks away. Destruction of our forests has far reaching adverse effects on the environmental functions and all types of living organisms including humans. Some of the effects of deforestation are summed up as follows:

(i) Soil Degradation and Erosion: Forests act as a cover on the surface of soil and prevent it from such agents such as water and wind which are responsible for its loss from the land areas. In the absence of forest cover these agents will remove the top layer of soil and cause loss of its fertility and lead to formation of less fertile land areas in the form of deserts.

(ii) Decline in Rainfall: Forests are helpful in bringing out rainfall because of high transpiration rates from them. In their absence there will be less transpiration and thereby affecting rainfall patterns.

(iii) Loss of wildlife habitats: Considering that about 80% of the world's documented species can be found in tropical rainforests, deforestation poses a serious threat to the Earth's biodiversity. Forests act as an important wildlife habitat and thereby protecting and preserving the large variety of flora and fauna. Their depletion will cause loss of this valuable habitat and emerging as a serious threat to the destruction of amazing variety of life.

(iv) Environmental threats: Deforestations causes an increase in atmospheric CO_2 level and leading to increase in global temperature which has harmful impacts. The increasing greenhouse gases which are further raising the temperature of the earth, and this is called as the greenhouse effect. Also deforestation leads to lowering of water table due to less recharging of underground aquifers and also causes loss of important medicinal plants.

Deforestation also causes loss of industrial timber and thereby affecting economy. It also leads to fuel wood shortage causing tremendous miseries among tribal people.

Severe flooding is a result of deforestation because removal of the forest leaves little vegetative cover to hold heavy rains.

Water Resources:` "Water is the driver of life" said Leonardo da Vinci. Water is the most vital resource for life. In our planet earth approximately 97.2% water lies in oceans as salt water, while 2.15% in frozen ice form and the remaining 0.65% remains as fresh water either on surface or as ground water.

Distribution of water on earth:

Water resource	Volume(cubic km)	Percentage
Seawater	**$1.37x10^9$**	**97.3**
Fresh water lakes	**$1.3x10^5$**	**0.009**
Saline lakes and inland seas	**$1.0x10^5$**	**0.008**
Rivers	**$1.3x10^3$**	**0.0001**
Ground water	**$8.4x10^6$**	**0.62**
Ice caps	**$2.9x10^7$**	**2.14**
Water vapor	**$1.3x10^4$**	**0.001**

In India over three trillion cubic meters of water is received from rainfall, which is perhaps highest among the world. Fourteen major river systems share 83% of drainage basin and serve 80% of the total population of the country. There are also 44 medium and 55 minor rivers which mostly originate in the coastal mountains and 80% of their discharge occurs during the monsoon months. The estimated available ground water is over 210 billion cubic meters. India has a very low per capita availability of drinking water, about 2.43 thousand cubic meter/year.

Uses of Water resources

Agriculture use of Water: Water has always been a vital part of agriculture. Just like humans, crops need water to survive and grow. There are four main areas of water use in agriculture: growing of crops, supplying drinking water to livestock, cleaning farm, buildings and animals, and supplying drinking water for those who work on the farm.

Irrigation: Nearly 60% of the world's freshwater that is used by humans is used for irrigation. Of this water that is applied to crop fields, only about half returns to surface water or groundwater sources.

Aquaculture: Aquaculture is the farming of animals or plants under controlled conditions in aquatic environments. Aquaculture usually refers to growing animals and plants in fresh or brackish water (water that has a salt content between that of freshwater and that of ocean water).

Commercial water use: In modern day, water is essential to people's daily lives. Without water, restaurants could not supply meals or even clean up after the meals, cars would go unwashed, and fires could be disastrous, with no means of dousing the blaze. Green parks, recreational fields, and golf courses rely on water to keep the grass and soil moist and healthy. Roadways would become dirty and grimy in the absence of any water-based cleaning program. Offices would grind to a halt with no water available for drinking and bathrooms, and office buildings, stores, and public and private centers would also be dark places without the water necessary to generate electricity for lighting.

Industrial water use: Industries require large supplies of water. Machinery relies on water to cool it to a temperature that allows the manufacturing process to keep going. The mining industry needs water to wash off the material that has been brought up from underground in order to sort out the genuine product from other particles. Water is also used to clean machinery, buildings, and even, in the case of the meat processing industry, the carcasses of the cattle, pigs, and other animals that will be trimmed into the items found in the meat section of the local supermarkets. In oil producing regions, vast amounts of water are used.

Over exploitation of ground and surface water: The demand for freshwater has increased day by day and will increase with the rapid growth of population, agriculture and industry. As a result the freshwater reserve (surface and groundwater) depletes day by day too. The requirement of clean water per person is about 2.7 liters per day, thus the global requirement is about 16.5 billion liters per day only for drinking purposes. World per capita use of water is 710 cubic meters per year. Total human use of water is 6000 cubic kilometers per year. For every 1000 gallons of water on earth, only 3 gallons are drinkable due to increased pollution.

The over utilization of water occurs at various levels. Most people use more water than they really need. Most of us waste water during a bath or washing clothes. Many agriculturists use more water than necessary to grow crops. Pollution caused by industries, factories, agriculture, domestic activities also minimizes the availability of drinking water and water for agriculture.

Use of water also depends upon the level of modernization or development. In poorer developing countries some rural communities exists on 15 liters Per capita per day of water where as modern society in advanced countries might consume in excess of 400 liters per capita per day.

Water harvesting:

Rain water harvesting is the gathering or accumulating and storing of rain water. This is done by constructing special water harvesting structures like dug wells, percolation pits, lagoons, check dams etc. Traditionally rain water harvesting has been practiced in arid and semi arid areas and has provided drinking water, domestic water for livestock, water for small irrigation and a way to replenish ground water levels.

Rain water harvesting has the following objectives:

- To reduce run off loss
- To avoid flooding of roads.
- To increase ground water table through artificial recharge.
- To reduce ground water contamination.
- To meet the increasing demands of water.

Water harvesters are the system used for rain water harvesting. It consists of a storage tank to store the water and piping.

The most common harvesting of rainwater involves water collected from the roof of buildings and storing in rainwater tanks. The collection of rain water from the roofs of buildings can easily take place in cities and towns. All that is necessary to capture this water is to direct the flow of rainwater from roof gutters to a rainwater storage tank. By doing this water can be collected and used for various uses. If people are reliant on collected rainwater and are not connected to a town's water supply, then the water collected will be especially important to them.

Trapping of rainwater either in small ponds or pumping them into the ground directly from many collection localities is in use in some places even today. Collection in open areas may lead to substantial loss of evaporation. With urbanization and high rise building blocking recharge of ground water during rainy days, it may be necessary to pump water collected in individual buildings directly so that the ground water is recharged and used for non rainy days.

Watershed management: A watershed is an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel. Watershed is a catchment or drainage basin, which is the total area of land that drains into a water body. It can also be defined as the drainage basin which includes all the areas that drain into the shared waterway. Water from a geographical area drains into creeks which join together as streams and each stream feeds a river and so on until the river empties into the ocean. Watershed is thus, the fundamental unit of surface run off systems, and it is a topographically delineated area that is drained by a stream system.

Watersheds are not only hydrologic units, they are also useful land units for planning and managing multiple natural resources, such as forests, soil, water and living resources. Using watersheds as a planning unit, the effects of management activates can be determined for the whole land area directly affected by such management.

"Watershed management is a concept which recognizes the judicious management of three basic resources of soil, water and vegetation, on watershed basis, for achieving particular objective for the well being of the people". Watershed management is planning, guiding and organizing land use so that desired goods and services are produced from a watershed without harming soil productivity and water resources. The goods and services produced from water sheds include food, forage for livestock and wild life, wood and other forest products, outdoor recreation, wild life habitat, scenic beauty and water. The overall objective of watershed management is to ensure that sustainable production from natural resources is accompanied by adequate environmental production.

The main Objective of watershed management are:

i. To control damaging runoff and degradation and thereby conservation of soil and water.

ii. To manage and utilize the runoff water for useful purpose.

iii. To protect, conserve and improve the land of watershed for more efficient and sustained production.

iv. To protect and enhance the water resource originating in the watershed.

v. To check soil erosion and to reduce the effect of sediment yield on the watershed.

vi. To rehabilitate the deteriorating lands.

vii. To moderate the floods peaks at downstream areas.

viii. To increase infiltration of rainwater.

ix. To improve and increase the production of timbers, fodder and wild life resource. To enhance the ground water recharge, wherever applicable.

Watershed protection is a means of protecting a lake, river, or stream by managing the entire watershed that drains into it.

Water Conflicts: Water is considered to be a very important natural resource. It is the backbone of all kinds of human activities and plays a very crucial role in the economic development of countries. Because of its necessity, use and scarcity, conflicts over water are found at all levels- international as well as national. According to many experts water is much more likely reason for countries to go to war than oil. In many countries inter-state conflicts are due to problems related to irrigation, agriculture, industries, and electricity. India is also facing undesirable situations arising out of the river conflicts among a number of states such as Tamil Nadu, Karnataka, Bihar, Jharkhand, Madhya Pradesh, Rajasthan, Gujarat, Haryana and Punjab. Recent conflict has come up and strained the relations between Rajasthan and Gujarat. Rajasthan has been planning to utilize waters of Mansi Vakal fully for Udaipur and its lakes. Gujarat had raised objections about this project and complained that it will deprive the state of water by obstructing the flow of river Sabarmati. Similarly the Sardar Sarovar Project in Gujarat has become a cause of conflict among the states of Madhya Pradesh, Gujarat, Maharashtra and Rajasthan. Also, the dispute over sharing of water of the river Kaveri has strained the relations between the states of Tamil Nadu & Karnataka. The dispute between the two states is yet to be solved amicably. In fact, it has become worse owing to the bandhs sponsored by the states and violence, both of which have put normal life out of gear. Even recently the Karnataka state had to be put under curfew resulting in tremendous loss to the economy of the state.

Conflicts are brewing now over rivers & river basins shared by many countries around the world also. This is not unexpected given the fact that more than two hundred bodies are shared by two or more countries. Strife over water erupted throughout the Middle East from the water sheds of the Nile to the Tigris & Euphrates Rivers. The Nile which is regarded as the longest river in the world formed the base on which the Egyptians civilization thrived. There is a major ongoing conflict between countries situated along the river & its tributaries regarding the distribution of its water. To solve the national water tensions, countries tend to look beyond their borders for wider reign over water basins they share with other countries.

Energy Resources: Energy is defined by physicists as the capacity to do work. Energy is found on our planet in a variety of forms, some of which are immediately useful to do work, while others require a process of transformation.It is a primary input for almost all economic activities and is therefore vital for improvement in quality of life.

We use energy for household use, agriculture, industry, transport, telecommunications etc. All living organisms require energy to perform work or to produce power and human society in particular is solely dependent upon a continuous flow of energy.

Non Renewable energy sources: 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. To produce electricity from non-renewable resources the material must be ignited. Non renewable energy sources are those natural resources which are exhaustible and cannot be replaced once they are used. These are available in limited amount and develop over a longer period of time. Nonrenewable energy sources come out of the ground as liquids, gases, and solids.

***Coal**:* Coal is a combustible black or brownish-black sedimentary rock with a high amount of carbon and hydrocarbons. Coal is classified as a non-renewable energy source because it takes millions of years to form. Coal contains the energy stored by plants that lived hundreds of millions of years ago in swampy forests. There are mainly three types of coal namely anthracite (hard coal), Bituminous (soft coal) and lignite (Brown coal). Anthracite has the maximum carbon intent of about 90% followed by bituminous and lignite having 80 and 70% approximately. It is expected that the coal may last for another 1500 years as regards its usage is concerned which has declined in recent past due to development of other sources of energy.

For almost 200 years, coal was the primary energy source fuelling the industrial revolution in the 19th century. At the close of the 20th century, oil accounted for 39% of the world's commercial energy consumption, followed by coal (24%) and natural gas (24%), while nuclear (7%) and hydro/renewable (6%) accounted for the rest.

Oil and natural gas: Crude oil is a fossil fuel that is a mixture of hydrocarbons that formed from plants and animals that lived millions of years ago. Crude oil exists in a liquid form in underground pools or reservoirs, in tiny spaces within sedimentary rocks, and near the surface in *tar (or oil)* sands. Petroleum products are fuels made from crude oil and other hydrocarbons contained in natural gas. Oil, the golden resource also called the liquid gold is not inexhaustible. It is a limited treasure- a treasure that is fast depleting. On the other hand natural gas is mainly composed of methane (95%) with small amounts of propane and ethane. It is a fossil fuel.

The main ingredient in natural gas is methane, a gas (or compound) composed of one carbon atom and four hydrogen atoms. Millions of years ago, the remains of plants and animals (diatoms) decayed and built up in thick layers. This decayed matter from plants and animals is called organic material it was once alive. Over time, the sand and silt changed to rock, covered the organic material, and trapped it beneath the rock. Pressure and heat changed some of this organic material into coal, some into oil (petroleum), and some into natural gas — tiny bubbles of odorless gas. Natural gas and crude oil are found primarily along young tectonic belts at plate boundaries. Natural gas deposits mostly accompany oil deposits because it has been formed by decomposing remains of dead animals and plants buried under the earth. Natural gas is the cleanest fossil fuel. Natural gas and oil are expected to get depleted in 120 years and 60 years respectively based on their current rates of usage.

Renewable and non renewable energy sources:

1. **Renewable energy sources:** These are also called as inexhaustible energy sources. These are the resources which can reproduce themselves in nature and can be harvested continuously through sustained proper planning and management. Examples are fire wood, energy from biomass, water energy, solar energy, etc.

- **Energy from biomass**: Biomass is organic matter that can be burnt directly as a fuel or converted to a more convenient form and then burnt. It has provided a major source of energy to human beings throughout the history of civilization. Firewood is the best known and most widely used biomass fuel in the world. On a global scale over one billion people in the world even today use wood as a primary source of energy.
- **Solar energy**: The sun is almost inexhaustible source of energy. Sun's heat is being used directly in solar cookers to cook food or solar heaters to heat water. India being a tropical country has huge potential of solar energy. The first 200 Kw partial grid interactive solar photovoltaic power projects at kalyanpur Aligarh, and Mau district in U.P. solar pond in Bhuj, Kutch Gujarat first and only in Asia.
- **Wind energy**. The traditional wind mill is well known but it is not used these days. The newer types of wind mills are developed which could be the good source of energy. The wind energy potential of India is estimated about 25,000 Mega Watt; out of this about 6000 Mega watt is located in Tamilnadu and 5000 Mega watt in Gujarat.

  Asia's largest wind farm cluster is located at Muppandel Perugandi Kaniyakumari in Tamilnadu and Asia's largest wind power cluster is located in Mandwi Kutch, Gujarat.
- **Tidal energy:** The energy associated with the tides of ocean can be converted into electrical energy. France constructed the first tidal power plant in 1966.
- **Micro hydel energy**: Energy generated from small water resources is probably the cheapest and reliable of all renewable energy sources. It can be harnessed conventionally from nearby canal or stream in the mostly eco-friendly manner.

  Non renewable energy sources: These are also called as exhaustible energy sources. These are the sources that lack the ability for recycling and replacement or which cannot reproduce themselves in nature and are finite. Examples are fossil fuels like coal, petroleum and minerals and nuclear energy.

  (a). Coal : Partially decomposed vegetation deeply buried in sedimentary environment is slowly transformed into solid, brittle, carbonaceous rock commonly known as coal. Coal is by far the most abundant fossil fuel with total recoverable resources of about 6000 billion tons. Currently coal provides about 27% of the world's commercial energy and since 1950 its use has more than doubled. Coal is used to generate 39% of the world's electricity.

  (b). Oil: Petroleum or crude oil is a liquid consisting mostly of hydrocarbon compounds with small amount of oxygen, sulfur and nitrogen compounds. Crude oil and natural gas are often trapped together deep within the earth's crust, dispersed in pores and cracks in rock formation. Saudi Arabia with 25% has the largest known crude oil reserves.

Currently USA has only 4% of the world's soil reserves, but uses nearly 30%of the oil extracted worldwide each year.

Alternate energy sources:

With the rising population the use of energy resources also increases. The non renewable energy sources like coal, petroleum etc. are depleting at a very high rate due to the increasing energy needs. So it is a high time to use alternate sources of energy like wind energy, tidal energy, solar energy, geothermal energy etc. The use of these alternate energy sources has evolved over a long period of time, but we need to enhance their use so as to conserve non renewable energy sources. Alternate energy sources are as follows:

(a). Geothermal power: Geothermal energy is the energy stored within the earth (geo means earth and thermal means heat) the idea of harvesting the earth's internal heat are not new. As early as 1904 geothermal power utilizing dry steam was adopted in Italy and natural internal heat is now being used to generate electricity in many parts of the world.

(b).Nuclear energy: It is now over 50 years since the power of atom has been harnessed for the benefit of mankind. The first controlled nuclear fission, demonstrated in 1942 led to the development of primary use of uranium-explosive and as a source of heat. One kg of uranium oxide produces heat equivalent to approximately 16 metric tons of coal.

(c).Solar energy: Solar heat energy is being directly used in solar cookers to cook food or in solar heaters to heat water. The solar energy can be concentrated by big concave reflectors and used to boil water to obtain steam or melt any metal or ore. Solar cells can convert the solar energy into the electricity. The biggest advantage of the solar energy is that it does not bring about any pollution.

(d).Wind energy: Wind power like solar power has evolved over a long period of time. Wind has propelled ships as well as driven wind mills used to grind grain and pump water. More recently wind has been used to generate electricity. There are problems with the wind energy because wind tends to be highly variable in time, place and intensity.

(e).Biogas: Biogas is rather a vague term used to represent the various compositions of different gasses which are produced as an action of anaerobic microorganism on raw material such as domestic and agricultural wastes generally within simple digesters, properly known as biogas plants.

Growing Energy Needs

Global Level: Energy consumption is an index of advancement of a country. The demand for energy has increased with the economic development of the world. Between 1950 and 1990 the world's energy needs increased four times. Energy is derived from non renewable (conventional) and renewable (non conventional) resources. The conventional resources include fossil fuels i.e oil, coal and natural gas which is in the process of depletion and their formation takes million of years. Renewable resources include solar energy, wind energy, water energy and biomass. Approximately 80% of the world's energy is produced by fossil fuels, but some

countries like France, have established nuclear reactors which produce enough energy to meet 70% of country's requirement. World demand for fossil fuels is increasing day by day and the demand will continue to grow. Of the developing countries, China has the highest per capita consumption of energy. For India per capita consumption is lower than that of China. Among non- conventional resources, hydropower is the largest. Hydropower projects are in operation both in developed and developing countries .Hydropower potential is huge and at present only 15-20% of the potential in the developing world is being utilized. Wind power also has great potential and is a fast growing resource. Wind mills and sails are supplying near about 10% of worlds electricity. The use of solar energy is through photovoltaic cells which converts light directly into electricity and the photovoltaic production is increasing day by day. Fifteen European Union Nations, including Spain and Germany, who are world leaders in renewable sources of energy, have committed that by 2020, they would generate 20% of the energy using renewable resources.

Indian Scenario: Coal, oil, gas and water constitute the main sources of energy in our country. Traditionally India has been deficient in power generation vis-a vis its demand. The main share of energy comes from coal (56%) and petroleum (32%). Apart from commercial energy, a large amount of traditional energy is derived from the fuel wood, agricultural waste and animal waste. About 5% of world's coal is found in India. In India industrial sector is the largest consumer of conventional energy followed by transport sector. A deficit of 220 million tons of coal was projected for the year 2011-12.In the domestic sector, the consumption of natural fuel (mostly wood) energy is very high.

The Integrated Energy Policy Report (IEPR) PREPARED by the Planning Commission has provided a long term vision for the next 25 years. The aim is that at least 10% of the power generation installed capacity in the country should come from renewable sources by the end of the 11th Plan Period. With petroleum prices touching $80 a barrel and our import dependence on crude oil at more than 70% and rising, alternate energy resources are no longer just an option. India has put in place several renewable initiatives and the country is now the world's fourth largest generator of wind energy with an installed capacity of 7,093MW. The wind power potential of our country is estimated to be about 20,000 MW, while at present we are generating about 1,020 MW. The largest wind farm of our country is near Kanyakumari in Tamil Nadu, and it generates 380-MW electricity. In the outskirts of Delhi a solar powered sustainable building with passive designs such as sky lighting, insulation, double –glazed windows, and underground tunnels into which air is sucked and distributed similar to ancient underground cellars that were cool in summer and warm in winter. The complex saves 40% to 50% of energy costs incurred by conventional buildings.

Govt. Degree College Kilam
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Credit IV: Environmental Issues, policies and practices

4.1 Causes, effects and control measures of: Air, water, Soil, Noise and solid waste pollution

4.2 Concept of natural disasters and Global environmental issues: Increase in green house gases, Climate change, Acid rain and stratospheric ozone layer depletion.

4.3 Salient features of:

4.3.1 Water (Prevention and control of pollution) Act, 1974.

4.3.2 Air (Prevention and control of pollution) Act, 1981.

4.3.3 Environmental Protection Act, 1986.

4.4 Environmental education, Environmental Movements (Chipko, Silent valley) and Environmental Ethics

Environmental Pollution: Pollution is an undesirable change in the physical, chemical or biological characteristics of air, water and soil that may harmfully affect the human life. The undesirable change is brought by solid, liquid or gaseous substances present in such concentration as may be or tend to be injurious to the environment.

Pollutants are often the residues of materials we make rise or throw away e.g. smoke from industries and automobiles, sewage from homes and hotels, radioactive substances from nuclear plants, discarded households articles.

Air pollution: Air pollution can be defined as the presence of materials in the air in such concentration which are harmful to man and his environment. A number of substances find their way in the air and these are mostly gases, which rapidly spread over wide areas.

Sources of Air pollution: **Point Sources:** It includes fossil fuels, industries, etc.

Line or Mobile sources: It includes those sources which do not cause pollution at a specific point but are moving sources. These include automobiles as the major sources.

Area sources: It includes those sources of pollution which are prevalent in certain specific area e.g.,natural sources like volcanic eruptions, pollen grains; mining activities etc.

Effects of Air Pollution

- Increased higher concentration of green house gases in air (e.g. CO_2, CH_4, NO_2, SO_2**,** CFC's, water vapour etc) have caused increase in average global temperature (Global warming) which can lead to serious consequences.
- Depletion of ozone layer by CFC's is yet another serious effect of air pollution. It was led to increased inflow of ultraviolet radiations reaching the earth's surface which can lead serious health hazards in humansand animals. Constant exposure can damage the vegetation as well.
- Acid rain is another consequence of air pollution. Gases like oxides of carbon; Sulphur, nitrogen etc combine with water and fall down as acid rain which causes damage to flora, fauna and abiotic structural assets like historical monuments etc. The effects are more pronounced in aquatic systems.
- Carbon monoxide proves to be fetal even in small concentrations as it blocks hemoglobin for binding of oxygen and reduces the oxygen carrying capacity of blood.
- Increased ozone concentration in air can lead to pulmonary edema. It along with aldehydes irritates eyes and respiratory organs. Air pollution leads to many respiratory diseases including bronchitis and asthma due to the presence of particulate and irritating gasses.
- Lead and other metallic particulates have adverse effects on various physiological and biochemical processes of organisms. Fluorides cause fluorosis in animals.
- Crops are adversely affected by increased concentrations of oxides of sulphur, nitrogen, ozone etc.
- Air pollution adversely affects the climate in terms of rain fall, humidity and temperature fluctuations.

Control of Air Pollution: Air pollution can be minimized by the following methods,

- Sitting of industries after proper environmental impact Assessment studies.
- Using low sulphur coal in industries.
- Removing sulphur from coal (by washing or with the help of bacteria).
- Removing (NO) during the combustion process.
- Vehicular pollution can be checked by regular tune up of engines, replacement of more polluting vehicles, installing catalytic converters etc.
- Using mass transport system like bicycles.
- Shifting to less polluting fuels (hydrogen gas).
- Using non-conventional sources of energy.
- Planting more trees.
- Use of biological filters and bioscrubbers.
- Enactment of environment laws.
- Creating public awareness through debates, discussion, seminars, symposia, etc about the hazards of air pollution

Water pollution: Water pollution can be defined as the presence in water, of some foreign substances or impurities (organic, inorganic, radiological or biological) in such quantity, so as to constitute a health hazard by lowering the water quality and making it unfit for use.In nature water is in its pure form. Impurities get added to it as it percolates beneath the surface of earth and also when it is used for human activities.

Sources of Water Pollution:

Point Sources: In which almost definite, constant and fixed composition of effluents are dischargeddirectly into a water body like industrial discharge and sewage etc.

Non Point or Diffused Sources: In which the effluents are added at different positions with variedcomposition and volume. These are generally dispersed and diverse in nature e.g. agricultural and domestic run off etc.

Effects of water pollution:

Water is a vital resource essential for sustaining life therefore its contamination has immediate as well as far reaching effects on the health and environment of living beings. The main effects of water pollution are listed below:

- Water polluted with domestic sewage can spread such epidemic diseases as cholera, typhoid, dysentery or diarrhea and a number of minor ailments and water borne diseases.
- Heavy influx of nutrients like nitrates and phosphates from adjoining areas increases growth of weeds in aquatic bodies there by leads to process of eutrophication.
- .Influx of methyl mercury into aquatic ecosystem was responsible for infamous disease called Minamataepidemic. Problems like loss of hearing, speech, sight and many deaths were reported during this epidemic.
- Excess of fluoride in drinking water causes defects in teeth and bones called fluorosis.
- Excess nitrates in drinking water are harmful for human health and may be fatal for infants. At a concentration of 25 mg per liter nitrates cause blue baby syndrome or methaemoglobinemia in human beings.
- Insecticides and herbicides are very harmful. These destroy a number of valuable aquatic food organisms by destroying the larval stages. By the food chain process the phytoplankton arc seen in the body of carnivores in high concentration and produce fatal effects so that large numbers of fishes are found dead in areas polluted with DDT. The bird population also reduces. In Man DDT enters by eating the carnivores and may cause cancer, nervous disorders and leukemia and other serious ailments.

Control of water pollution

- Prohibition should be enforced to avoid contamination of main sources of drinking water. Bathing and washing in rivers and streams and discharging untreated or treated domestic, commercial and industrial sewage in water bodies should be prohibited.
- Strict check should be maintained on the quality of drinking water. Improved methods for handling and disposal of sewage, garbage and night soil should be introduced.

- To control the epidemics and other disease, proper methods of sterilization of water drawn from shallow wells, should be developed. The city waste and sewage needs proper treatment.
- For effective water pollution control, legal provisions regarding water pollution should be enforced by special administered machinery comprising of highly qualified and experienced personal.

Soil Pollution: It is considered as a major challenge for healthy environment. The weathering of earth's crust forms, soil over the centuries that supports the variety of microscopic and macroscopic life-forms.

Dumping of various types of materials especially domestic and industrial wastes in the soil due to which it becomes unsuitable for environment and reduces productivity, is called soil pollution.

Sources of Soil Pollution

Soil pollution mainly occurs due to the following:

1. Industrial wastes: disposal of industrial wastes is the major problem for soil pollution. Industrial pollutants are mainly discharged from various origins such as pulp band paper mills, chemical industries, oil refineries, sugar factories, textiles, steel etc. These pollutants affect and alter the chemical and biological properties of soil.
2. Urban wastes: Urban wastes consist of both commercial and domestic wastes including sludge and sewage. All the urban solid wastes are commonly referred to as refuse. The refuse consists of garbage and rubbish materials like plastics, glasses, metal cans, fibers, paper, street sweepings, fuel residues etc.
3. Agricultural practices: Agricultural wastes causing soil pollution include excessive use of fertilizers, pesticides, herbicides, weedicides etc.

Effects of Soil Pollution: Soil pollution is a very serious problem throughout the world. Soil contamination has several negative impacts on the soil and the environment. These are some of the effects soil pollution:

- **Poor crop output:** Increased use of inorganic fertilizers, chemical fertilizers, as well as pesticides, eventually decreases the soil fertility at a faster rate. It also alter the soil structure. Reduced soil quality will lead to poor crop output. Soil can become less productive for growing crops when it is heavily polluted.
- **Unstable chemical composition:** Different soil types naturally have different chemical compositions that are carefully balanced. The introduction of pollutants such as mercury or sulfides can destabilize this balance.
- **Effect on ecosystem and biodiversity:** Soil pollution can lead to the lack of biodiversity in an ecosystem. The life of bird, insect, mammal and reptile species who live in the soil can get affected by pollution. The soil is an important habitat.
- **Effect on Human health:** Living, playing or working on polluted soil can cause skin complaints, respiratory issues and other ailments. Drinking contaminated water as a result of surface run-off can also cause health problems.
- **Contamination of water sources:** When it rains, surface run-off carries contaminated soil into water sources causing water pollution. The contaminated water is thus unfit for both animal and human consumption. It will also affect aquatic life since the organisms that live in these water bodies will find their habitats inhabitable.

Control of soil pollution: Soil pollution can have a devastating impact on plant and animal life, and as such it should be halted. If we act now, we can prevent soil pollution from taking hold. Some useful preventative measures that we can take to this end are listed below.

1. **Go organic:** Organic agriculture uses much fewer chemical fertilizers and pesticides, preventing chemicals from seeping into the soil.
2. **Proper farming methods:** Finding alternatives to chemical fertilizers and pesticides is an ideal way to avoid soil erosion. Rotational and mixed farming are also encouraged.
3. **Dispose of household waste responsibly:** Recycling waste and not dumping it in landfill will keep the soil free of pollution. Not throwing batteries and electrical items into household waste bins will help to keep the soil free of dangerous chemicals.
4. **Prevent or Manage industrial waste:** Properly managing industrial and domestic waste can help prevent soil erosion. Solid waste treatment is also a good preventive measure. Regular health and safety checks and adequate waste disposal methods will ensure that industrial chemicals and other waste are not allowed to contaminate our precious soil.
5. **Community Awareness:** Creating awareness about the effects of soil pollution can help prevent its occurrence.
6. **Burn fewer fossil fuels:** Cleaner air makes it easier for us to have cleaner soil. Fresh, pure rain will keep the soil free of pollutants.

Noise pollution: Noise is considered as environmental pollution, even though it is thought to have less damage on humans than water, air or land pollution. But people who are affected by severe noise pollution know that it is a massive issue that needs attention.The word noise (Latin nausea) is usually defined as an unwanted or unpleasant sound that causes discomfort. Noise is also defined as the wrong sound in the wrong place at the wrong time. Noise pollution means an unwanted sound dumped into the atmosphere leading to health hazards.The unit of measurement of intensity (or loudness) of noise is decibel (dB).

Sources of noise pollution

- Household sources causing noise pollution include gadgets like food mixer, grinder, vaccum cleaner, washing machine, cooler, air conditioners, T.V etc
- Social events like places of worship, parties and other social events also create a lot of noise by using loud speakers.
- Commercial and industrial activities like printing presses, manufacturing industries, construction sites, automobile repair shops etc also cause noise pollution.
- Various modes of transportation also result in noise pollution

Effects of Noise pollution

- **Auditory effects** include both hearing loss and speech interference. The most immediate and acute effect of noise pollution is impairment of hearing. A sudden loud noise can cause severe damage to the ear drum. Long exposure to loud noise can cause hearing loss which may become permanent.

- **Sociological or Psychological effects.**Psychological /sociological effects include an acoustical privacy. Noise pollution increases the rate of heart beat. It causes constriction of blood vessels and cause dilation of the pupils of the ear. Fluctuations in arterial blood pressure, impairment of night vision, are some effects. It causes headache, irritability (annoyance) and extreme emotional disturbances. It aggravates existing disease by disturbing peace of mind and sleep.

Control of Noise Pollution: The noise pollution can be controlled by the following ways:

- Technically/modifying and fabricating the machines and using the quieter machines to replace the noisy ones.
- Regular replace of machinery can reduce noise because much of this noise may be due to inefficiency of the machinery.
- Construction of walls in the highly noisy polluted area can reduce noise in that area.
- Restricting the use of public address systems.
- Growing plants can absorb and dissipate sound energy and thus act as a buffer zone.
- Noise produced by vehicles can be reduced by banning pressure horns and strictly following the traffic laws.
- Use of silencers, improvement in design and better installation of machinery in industries can minimize the noise.
- Each industrial establishment must have such facilities in order to have a check on the intensity of noise pollution, being produced throughout the working period.
- Industrial areas should be planned in such a way that these should be away from residential areas.

Solid Waste pollution: Solid waste is any waste generated by every day human activities. Solid waste may be in the form of house hold garbage, leftovers of food and other wastage that include old house hold items such as papers, plastic waste in the form of kitchen equipment or any other products that are consumed during every day activities.

The solid wastes include the materials; food wastes, paper, metals, plastics, ceramics, worn-out clothes, garden wastes, agriculture wastes, Building wastes, hazardous wastes, dust from mining, hospital wastes including discarded cotton, bottles etc; broken utensils ashes from fires, and a variety of other wastes.

Sources of urban and industrial wastes

Urban solid waste consists of:

Waste from homes (domestic waste) like discarded polythene bags, metal cans, glass bottles, waste paper, waste food etc.

Waste from shops (commercial wastes) like waste paper, bottles, polythene bags, egg shells etc. Biomedical wastes (hospital waste) like needles, syringes, gloves, waste medicine etc. Construction or demolition waste like debris, wood, concrete etc.

Horticulture waste& waste from slaughter houses include vegetable parts, residues and remains of animals. The urban solid wastes that can be degraded by micro-organisms are called bio-degradable wastes. e.g. vegetable wastes, food wastes, dry wastes etc. wastes that cannot be degraded by micro-organisms are called non-biodegradable wastes e.g. polythene bags, glass bottles etc.

An **industrial waste** consists of large number of materials including factory rubbish, packaging material etc. The main sources of industrial wastes are chemical industries, metal and mineral processing industries.

Radioactive wastes are generated by nuclear power plants. Solid wastes from other types of industries include scrap metal, rubber, plastic, paper, glass, leather etc.

Effects of Wastes

On Health: For the general public, the main risks to health are indirect and these arise from the breeding of disease vectors primarily files and rats. The most serious is the transfer of pollution to water, air and soil. Industries are also introducing danger of different kinds like hazardous wastes during transport and disposal, entry of heavy metals in the food chain etc.

On Environment: The environmental damage caused by solid wastes mostly pertains to aesthetics. Also there is the danger of water pollution when the refuse dump enters the water resources. In addition, uncontrolled burning of open dumps can cause air pollution. Water will pollute air and land filling may leach the water and pollute ground water.

Control of Wastes

- Utilization of wastes for generating electricity and biomass.
- Recycling of the waste.
- Composting for the generation of organic material and it use as soil conditioner.
- Land fill disposal
- Re-organization of the man-power.
- Incineration
- Hydro pulping andPyrolysis.
- Re-use of waste materials

Natural disasters: A natural disaster is a major adverse event resulting from natural processes of the earth e.g floods, hurricanes, tornadoes, volcanic eruptions, tsunamis etc. A natural disaster can cause loss of life or property damage and typically leaves some economic damage in its wake, the severity of which depends on the affected population's resilience, or ability to recover and also on the infrastructure available.

Earthquake: An **earthquake** occurs when the earth releases pent-up energy and causes the ground to shake. Earth's ground is made up of several very large pieces of land called tectonic plates. Most earthquakes occur when these plates rub against each other in some way. These same plates also create mountains when they push against each other. As the mountains are formed, earthquakes may be felt. Sometimes, people cause earthquakes when they do mine blasts or nuclear tests.

Tsunamis: A **tsunami** consists of huge waves caused by either an underwater earthquake or volcanic eruption. In Japanese, the word means 'harbor wave.' These waves can get as high as 100 feet and aren't the gentle waves that you surf on. No, these are destructive waves that can knock down buildings, trees, and anything else in their path.

Floods: A flood is an overflow of water that covers the earth. This overflow can damage buildings and cars in its path. In a severe flood, the water can seep into houses and completely cover them, ruining everything. And, if people get caught up in the flood, they can be washed away with the flood and drown.

Hurricanes, typhoons, and cyclones refer to the same weather phenomenon, where a really large storm swirls in circles. You'll see the cloud of the storm turning in a spiral, touch down on the ground, and then reach toward the sky. When a storm reaches a wind speed of over 74 miles per hour, it gets classified as a hurricane, typhoon, or cyclone depending on where the storm is located. The storm is called a hurricane if it happens in the Atlantic and northern Pacific. If the storm occurs in the northwestern part of the Pacific, then it is called a typhoon. In the southwestern Pacific and the Indian Ocean, the same type of storm is called a cyclone.

Increase in Green house gases: A green house gas is any gas in the atmosphere that is capable of absorbing infrared radiation, thereby trapping and holding heat in the atmosphere. By increasing the heat in the atmosphere, green house gases are responsible for the green house effect, which ultimately leads to global warming.

Green house effect can be defined as the progressive warming up of the earth's surface due to blanketing effect of manmade CO2and other gases in the atmosphere .**Global warming** may be defined as increase in average mean global temperature due to increase in the concentration of green house gases like carbon dioxide, ozone, methane, nitrous oxide etc. the main causes of global warming are industrialization and deforestation.

The increasing green house gases responsible for global warming are as follows:
Carbon dioxide: It is the most abundant green house gas contributing to about 50% to green house effect. The concentration of CO2 in the atmosphere has increased mainly due to fossil fuel burning in homes and industries etc., deforestation and change in land use. Its concentration in 2016 was 400 ppm. Currently its concentration is increasing at a rate of 1.5 ppm every year.
Methane: It is another green house gas contributing to 18% to green house effect. It is produced by incomplete decomposition of organic matter, paddy fields, wetlands, ruminant's stomach and biomass burning.
Chlorofluorocarbons(CFC's) are non toxic, non flammable, chemically inert synthetic gaseous compounds of carbon and halogens. These are24% responsiblefor green house effect. These are released by refrigerators, air conditioners, jet fuels, foams etc.
Nitrous oxide(N2O): It contributes to 6% in green house effect. The main sources of N2O are agriculture, biomass burning, industrial processes.
The other green house gases are Ozone, water vapor etc.
Climate change : When any major change occurs in temperature, precipitation, wind patterns and it extends for longer periods of time (decades) is called as climate change.
Over the last several years' extensive growth in population, rapid industrialization, excessive use of fossilfuels, deforestation, increase in automobiles and jet-aero planes caused a drastic change in climate. Due to the natural and anthropogenic activities like soil erosion, flood, landslides, volcanic eruption, earthquake, drought, forest fire, population growth, over-grazing, transportation, urbanization, consumerism etc. severalproblems arise which are harmful to both humans and nature. These activities release greenhouse

gases like Co_2, CH_4, N_2O, and CFC's etc. in the atmosphere and cause increase in the average global temperature. Theimplications of greenhouse gases are serious. The Inter-Governmental Panel on Climate Change (IPCC) has predicted that this rise of one degree will happen by the year 2025.

Effects of Climate change: A rise in global temperature cause sea levels to rise as polar ice caps and glaciers begin to melt, along with thermal expansion of water.

- More droughts and floods.
- More terrible storms.
- Many more hot days.
- More diseases like malaria and dengue.
- Impacts on ecosystem would change the crop production potential of a region, especially in Asia, Africa and south and Central America.
- Sea level rise
- Global temperature rise
- Erratic precipitation
- Extreme events
- Ocean acidification

Acid rain: Acid rain, or acid deposition, is a broad term that includes any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic. The term acid rain was first used by Robert Angus Smith.

Causes of Acid rain: Acid rain results when sulfur dioxide (SO_2) and nitrogen oxides (NO_X) are emitted into the atmosphere and transported by wind and air currents. The SO_2 and NO_X react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground.

While a small portion of the SO_2 and NO_X that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels. The major sources of SO_2 and NO_X in the atmosphere are:

- Burning of fossil fuels to generate electricity. Two thirds of $SO_2$and one fourth of NO_X in the atmosphere come from electric power generators.
- Vehicles and heavy equipment.
- Manufacturing, oil refineries and other industries.

Measuring acid rain: Acidity and alkalinity are measured using a pH scale for which 7.0 is neutral. The lower a substance's pH (less than 7), the more acidic it is; the higher a substance's pH (greater than 7), the more alkaline it is. Normal rain has a pH of about 5.6; it is slightly acidic because carbon dioxide (CO_2) dissolves into it forming weak carbonic acid. Acid rain usually has a pH between 4.2 and 4.4.

Winds can blow SO_2 and NO_X over long distances and across borders making acid rain a problem for everyone and not just those who live close to these sources.

Effects of acid rain:

- Acid rain dissolves and washes away nutrients in the soil, which are needed by plants.

- Acid rain affects the trees by creating holes in the waxy coating of leaves, causing brown dead spots which affect photosynthesis.
- Acid rain that falls on ground Reach Rivers and lakes causes the water in them to become acidic. This affects the plant and animal life in aquatic ecosystems.
- Acid rain causes extensive damage to building and sculptural materials, marble, automobiles, car finishes, paints etc.

Ozone layer depletion: A layer of ozone in the upper atmosphere that prevents dangerous radiation from the sun from reaching the surface of the Earth is called as stratospheric ozone layer. An atmospheric layer at heights of about 20 to 30 miles (32 to 48 kilometers) that is normally characterized by high ozone content which blocks most solar ultraviolet radiation from entry into the lower atmosphere. The concentration of ozone in stratosphere is 10ppm and in troposphere 0.5 ppm.

Formation of ozone: Ozone is formed by a photo chemical reaction, followed by a three body reaction.

$O_2 + hv\ (242nm) \rightarrow O + O$

$O + O_2 + M\ (N_2 \text{ or } O_2) \rightarrow O_3 + M$

The third body (M) absorbs the excess energy liberated by the above reactions and thereby stabilizes the O3 molecule.

Ozone strongly absorbs ultraviolet light in the region 220- 330nm and thereby protects life on earth from severe radiation damage.

Depletion of ozone: The rate of destruction of ozone is enhanced by the oxides of Nitrogen released from exhausts of large supersonic aircrafts. Nuclear explosions also produce large quantities of NO which directly enter into stratosphere. Following reactions exists between NO and O3.

$NO + O_3 \rightarrow NO_2 + O_2$

$NO_2 + O_3 \rightarrow NO_3 + O_2$

$NO_2 + O \rightarrow NO + O_2$

The major contribution in ozone depletion is of CFC's or of Halons. (Halons are the bromine analogues of CFC's e.g. CF2ClBr)

CFC's and halons are entirely manmade with wide applications in air conditioning, refrigeration, aerosols and modem fire fighters. Widely used CFC's are CFCl3 and CFCl2 which are in use since 1930. It takes about 20-40 years for these chemicals to travel and reach the stratosphere. In stratosphere they undergo UV photolytic decomposition as:

$CFCl_3 + hv\ (\lambda\ 290nm) \rightarrow CFcl_2 + cl^{\cdot}$

$Cl^{\cdot} + O_3 \rightarrow ClO^{\cdot} + O_2$

$ClO^{\cdot} + O_3 \rightarrow Cl^{\cdot} + 2O_2$

Also depleted in following ways:

$CF_3Br + hv\ (\lambda\ 290nm) \rightarrow CF_3 + Br^{\cdot}$

$Br^{\cdot} + O_3 \rightarrow BrO^{\cdot} + O_2$

$BrO^{\cdot} + O_3 \rightarrow Br^{\cdot} + 2O_2$

Chemicals containing Bromine are much more reactive than chlorine analogues in terms of ozone depletion.

Methyl bromide used as fumigant for soils, plants and seed stocks are known to destroy ozone layer. It can release Br, which is 30- 60 times as destructive to the ozone layer than CFC's.

Water (Prevention and Control of Pollution) Act 1974: This is an Act which is meant for the prevention and control of water pollution and for the matters which are connected with the abatement of pollution. Under the Act, water pollution is defined as such contamination of water, or such alteration of the physical, chemical or biological properties of water, or the discharge of any sewage or trade effluent (whether directly or indirectly) which is likely to render such water harmful or injurious to

(a) public health or safety
(b) domestic, commercial, industrial, agricultural or other uses.
(c) life and health of plants, animals or aquatic organisms.

Objectives of the Act

- To provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water.
- To establish Central and State Boards for the prevention and control of water pollution.
- To establish Central and State water testing laboratories.

Silent features

- Prevention, control and abatement of water pollution.
- The water act is designed to assess pollution levels and punish polluters.
- The central government and state governments have set-up pollution control boards to monitor water pollution.
- The water act of 1974 along with amendments in 1978 is an extensive legislation with more than sixty sections for prevention and control of water pollution.
- Central and state boards have been created under this act for preventing water pollution.

The Act empowers the board to take:

- Water samples for analysis
- Govern discharge of sewage.
- Trade effluents
- Study or inspect appeals.
- Set minimum and maximum penalties
- Publication of names of offenders.
- Offences by companies or departments
- Establish or recognize water testing laboratories and standard testing procedures.
- Any person discharging effluents into a water body can be given the penalty of imprisonment up to 3 months or fine up to Rs.10,000 or both.
- In case of damaging or destroying the property of Board, the penalty is imprisonment of 3 months or fine up to Rs. 10,000 or both.

Air (Prevention and Control of Pollution) Act 1981: The Government passed this Act in 1981 to clean up our air by controlling pollution and it came into force on 30 March, 1981. The Act extends to whole of India including the state of J&K. the silent features of the Act are as follows:

- **Objectives of the Act:**

- Prevention, control and abatement of air pollution.
- Maintaining the quality of air.
- Establishment of boards for the prevention and control of air pollution.

- The Air act provides for establishment of central and state boards for implementation of rules under the act.
- The Air act aims at prevention, control and abatement of air pollution.
- Pollution beyond certain limits due to various pollutants discharged through industrial emission is monitored by pollution control boards set up in every state.
- The Central Pollution Control Board (CPCB) implements legislation to improve quality of air, prevent and control air pollution in the country.
- The board advises the central government on matters concerning quality of air. It also coordinates activities, provides technical assistance and guidance to state boards in addition to setting the standards for quality of air.
- It collects and disseminates information in respect to air pollution and performs functions prescribed by the act.
- The state boards advise the state government on matters concerning prevention and control of air pollution.
- The state boards possess the right to inspect at all reasonable times any control equipment, industrial plant or manufacturing process and give orders to take necessary steps to control pollution.
- The state board inspects air pollution control areas at regular intervals or whenever necessary.
- They are empowered to provide standards for emissions to be laid down for different industrial plants with regard to quantity and composition of emissions.
- A state board may recognize or establish a laboratory for this purpose.
- State government has powers to declare air pollution control areas after consulting with state boards. In the same manner, state government can give instructions to ensure standards of emission from automobiles and restrict operation of certain industrial units.
- Penalties are imposed by the state board and it might appeal to the court to restrain persons for causing air pollution.

Penalties :

- Any person who violates any provision of the act is punishable with imprisonment for a term extending to three months or a fine of Rs.10, 000 or both. If the offence continues, an additional fine may extend to Rs. 5000 per day for everyday during which the violation continues after conviction for the first violation.

Environment Protection Act 1986: This Act has been brought into force from November,19, 1986 and extends to whole of India including the State of J&K. The objectives of the Act are as follows:

- Protection and improvement of the environment.
- Prevention of hazards to all living creatures (plants, animals and humans) and property.
- Maintenance of harmonious relationship between humans and their environment.

Its silent features are:

(a) Conferring powers on the Central Government to:

(i). Take all necessary measures for **protecting** quality of **environment**,
(ii). Co-ordinate actions of States, officers and other authorities under this Act.

(iii). Plan and execute a nationwide programme for prevention, control and abatement of environmental pollution.

(iv). Lay down standards for discharge of environmental pollutants.

(v). Empower any person to enter, inspect, take samples and test.

(vi). Establish or recognize environmental laboratories.

(vii). Appoint or recognize government analysts.

(viii). lay down standards for quality of environment.

(ix). Restrict areas in which any industries, operations or processes may not be carried out subject to certain safeguards.

(x). Lay down safeguards for prevention of accidents and take remedial measures in case of such accidents.

(xi). Lay down procedures and safeguards for handling hazardous substances.

(xii). Constitute an authority for exercising powers.

(xiii). Issue directions to any person, officer or authority including the power to direct closure, prohibition or regulation of any industry, operation or process.

(xiv). Require any person, officer or authority to furnish any prescribed information.

(xv). Delegate powers to any officer of a state or authority.

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

(c). The Act makes it obligatory for the person in charge of a place to inform the prescribed authorities regarding any accidental discharge of any pollutant in excess of prescribed standards.

The concerned authorities, on receipt of such information, shall take remedial measures to prevent or mitigate pollution caused by such accidents and expenses incurred by the authorities in respect of remedial measures are recoverable with interest from the polluter.

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

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

A comprehensive Environment (Protection) Act came into being in 1986 to remedy the lacunae noticed in the earlier laws and to serve as a single legislation on the subject.

The Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974 were amended to bring their provisions at par with those of The Environment (Protection) Act, 1986 and to give more powers to the implementing agencies.

Environmental Education: Environmental education may best be defined as a **process** directed at creating **awareness and understanding about environmental issues that leads to responsible individual and group actions.** Successful environmental education focuses on processes that promote critical thinking, problem solving, and effective decision-making skills. Environmental education utilizes processes that involve students in observing, measuring, classifying, experimenting, and other data gathering techniques. These processes assist students in discussing, inferring, predicting, and interpreting data about environmental issues.

Goals of Environmental Education: In 1977, the goals of environmental education were agreed in the Tbilisi declaration at the Intergovernmental Conference on Environmental Education held at Tbilissi. They were amended at UNESCO meetings in the Asia-Pacific region in order to capture the notion of sustainability.

The three goals of environmental education agreed upon are:
1. To foster clear awareness of, and concern about, economic, social, political and economic interdependence at local, regional, national and international levels.

2. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment.

3.To develop and reinforce new patterns of environmentally sensitive behavior among individuals, groups and society as a whole for a sustainable environment.

Objectives of Environmental Education:

Awareness: to help social groups and individuals acquire awareness and sensitivity towards, “the environment as a whole, and, “issues, questions and problems related to environment and development.

Attitudes: to help individuals, groups and societies acquire: “a set of values and feelings of concern for the environment, and “the motivation to actively participate in protection of the environment.

Knowledge: to help individuals, groups and societies gain a variety of experience in, and acquire a basic understanding of what is required to create and maintain a sustainable environment.

Skills: to help individuals, groups and societies acquire the skills for: "identifying, anticipating, preventing and solving environmental problems.

Evaluation ability: i.e. evaluates environmental measures and education programs in terms of ecological, economic, social, aesthetic and educational factors.

Participation: to provide individuals, groups and societies with an opportunity and the motivation to be actively involved at all levels in creating a sustainable environment.

Environmental movements in India: An environmental movement can be defined as a social or political movement, for the conservation of environment or for the improvement of the state of the environment. The terms 'green movement' or 'conservation movement' is alternatively used to denoted the same.

Chipko Movement:

- Year: 1973
- Place: In Chamoli district and later at Tehri-Garhwal district of Uttarakhand.
- Leaders: Sundarlal Bahuguna & Chandi Prasad Bhatt
- Aim: The main objective was to protect the trees on the Himalayan slopes from the axes of contractors of the forest.

Mr. Bahuguna enlightened the villagers by conveying the importance of trees in the environment which checks the erosion of soil, cause rains and provides pure air. The women of Advani village of Tehri-Garhwal tied the sacred thread around trunks of trees and they hugged the trees, hence it was called 'Chipko Movement' or 'hug the tree movement'. The main demand of the people in these protests was that the benefits of the forests (especially the right to fodder) should go to local people. The Chipko movement gathered momentum in 1978 when the women faced police firings and other tortures. The then state Chief Minister, Hemwati Nandan Bahuguna set up a committee to look into the matter, which eventually ruled in favor of the villagers. This became a turning point in the history of eco-development struggles in the region and around the world.

Silent Valley Movement:

- Year: 1978
- Place: Silent Valley, an evergreen tropical forest in the Palakkad district of Kerala, India.
- Leaders: The Kerala Sastra Sahitya Parishad (KSSP) an NGO, and the poet-activist Sughathakumari played an important role in the Silent Valley protests.
- Aim: In order to protect the Silent Valley, the moist evergreen forest from being destroyed by a hydroelectric project.

What was it all about: The Kerala State Electricity Board (KSEB) proposed a hydroelectric dam across the Kunthipuzha River that runs through Silent Valley. In February 1973, the Planning Commission approved the project at a cost of about Rs 25 crores. Many feared that the project would submerge 8.3 sq km of untouched moist evergreen forest. Several NGOs strongly opposed the project and urged the government to abandon it. In January 1981, bowing to unrelenting public pressure, Indira Gandhi declared that Silent Valley

will be protected. In June 1983 the Center re-examined the issue through a commission chaired by Prof. M.G.K. Menon. In November 1983 the Silent Valley Hydroelectric Project was called off. In 1985, Prime Minister Rajiv Gandhi formally inaugurated the Silent Valley National Park.

Environmental ethics or Eco ethics: Ethics is a branch of philosophy which seeks to define fundamentally what is right and what is wrong, regardless of cultural differences. e.g. most cultures have a reverence for life and feel that all individuals have a right to live. It is considered unethical to deprive an individual of life.

Morals differ somewhat from ethics because morals reflect the predominant feelings of a culture about ethical issues. e,g. when a country declares war, most of its people accept the necessity of killing the enemy.

Environmental issues also evolve a consideration of ethics and morals. As ethics and morals are not always the same, thus, it is often difficult to clearly define what is right and what is wrong. Some individuals view the world's energy situation as serious and have reduced their own consumption. Others do not believe there is a problem, and therefore, have not modified their energy use. Other similar issues are population growth and pollution.

Most of the attitudes towards the environment can be divided into following three groups.

1. **Development ethic:** It assumes that human race in and should be the master of nature and that the earth and its resources exist for our benefit and pleasure.
2. **Preservation ethic:** It considers nature is special in itself and should be preserved at social and economic cost.
3. **Conservation ethic:** It is related to scientific preservationist view, but extends the rational consideration to the entire earth and for all times. It recognizes the desirability of decent living standards, but it works towards a balance of resource use and resource availability. It stresses a balance between total development and absolute preservation.

Govt. Degree College Kilam
Department of Environmental Science
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Credit III: Biodiversity and its Conservation

3.1. Biodiversity: definition, levels and values (commercial, ecological, social and aesthetic)
3.2 Threats to the biodiversity: Habitat loss, poaching of wildlife, man-wildlife Conflicts.
3.3 Concept of endemism and hot spots of biodiversity.
3.4 Conservation of biodiversity: In-situ and Ex-situ concepts.

Biodiversity: The term biodiversity is made of two words **"bio"** and**" diversity"**; **"bio"**means**"living"**and**"diversity"**means**"variety".** So the variety or variability of organisms and ecosystem is referred as biodiversity. Before 1985 it was called as biological diversity. The term biodiversity was coined by **Walter G Rosen** in 1985.Biodiversity can also be defined as;"the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are a part". This includes diversity within species, between species and of ecosystems. This definition was used in the United Nations Convention on Biological Diversity.

Levels of Biodiversity

Genetic Diversity: Genetic diversity occurs between the members of the same species. Within any given species there can be several varieties, strains or races which slightly differ from each other in one or more characteristics such as size, shape, resistance against diseases, pests, insects etc. and resilience to survival under adverse environmental conditions. Such variability in the genetic makeup among individualswithin a single species is referred to as genetic diversity.

Species with more number of races, varieties and strains are considered to be rich and more diverse in its genetic organization. Genetic diversity is needed by any species to maintain its reproductive vitality, resistance to disease and the ability to adapt to changing conditions.

Species Diversity: The number of species of plants and animals that are present in a region constitute its species diversity. It includes full range of species from microorganisms to giant varieties of plants and animals e.g single celled bacteria and viruses etc. and multicellular plants, animals and fungi. This diversity is seen both in natural ecosystems and in agricultural

ecosystems. Some are richer in species than others. The species richness is measured by two popular indices known as Shanon weiner and Simpson index. At present scientists have been able to to identify about 1.8 million species on earth. India is one among the nations that is rich in species diversity. Areas that are rich in species diversity are called hotspots of diversity.

Ecosystem diversity: It studies variation in the biological communities in which species live, exist and interact. Ecosystem diversity is the variety of biotic and abiotic components that interact with one another and it represents the collective response of a community of species to different environmental conditions. The overall diversity of any given area depends upon the range of habitats. It includes the diversity of the component habitats and are ranked as follows:

- Alpha diversity: diversity within a site or habitat.
- Beta diversity: Differences of diversity between habitats.
- Gamma diversity: Differences in the site diversity over a large area such as continent.

Introduction/meaning of biodiversity: Biodiversity is the variety of all living things; the different plants, animals and micro organisms, the genetic information they contain and the ecosystems they form. The variety and variability of organisms is referred to as biological diversity or biodiversity Biological diversity or Biodiversity in short is the sum of all the different species of microorganisms, fungi, plants and animals living on earth and the variety of habitats in which they live. They hold an immense value for man and are central to the survival of human civilizations. The full range and extent of biodiversity is still not known, leave alone their greatest values and benefits.

The term biodiversity has been defined differently. The Global convention on biodiversity (CBD) has defined it as "the variability among living organisms from all sources including terrestrial, aquatic (fresh, estuarine and marine) and the ecological complexes of which they are a part. This includes diversity within species, between species and of ecosystems."

Levels of Biodiversity:

Generally three hierarchical levels of biodiversity are recognized namely genetic diversity, species diversity and ecosystem diversity.

Genetic Diversity: Genetic diversity occurs between the members of the same species. Within any given species there can be several varieties, strains or races which slightly differ from each other in one or more characteristics such as size, shape, resistance against diseases, pests, insects etc and resilience to survival under adverse environmental conditions. Such variability in the genetic makeup among individuals within a single species is referred to as genetic diversity.

Species with more number of races, varieties and strains are considered to be rich and more diverse in its genetic organization. Genetic diversity is needed by any species to maintain its reproductive vitality, resistance to disease and the ability to adapt to changing conditions.

Species diversity: Species diversity represents the variety of species in different habitats on earth or in other words we can say that species diversity refers to the total number of species i.e.

species richness of our earth. Species diversity can be measured on the basis of number of species in a region.

Currently about **1.9 million species** are known but this is thought to be a significant underestimate of the total member of species. It is estimated that the total number of species could be 5-30 million on our earth and one more estimate by UNEP (1993-94), the total number of species that might exist on earth range between 9-52 million.

Ecosystem Diversity: Ecosystem diversity and ecological diversity is the variety of biotic and abiotic components that interact with one another and it represents the collective response of a community of species to different environmental conditions.

An ecosystem develops its own characteristic community of living organisms based upon the availability of abiotic resources and conditions of the environment, so that is because different types of ecosystems represent they unique diversity each with a characteristic biotic community.

Values of Biodiversity

Biodiversity has a fundamental value to humans because we are so dependent on it for our cultural, economic, and environmental well-being. Biodiversity is vital to our biosphere's health, stability and its proper functioning. Biodiversity provide an enormous range of goods and other services, immediate as well as long term, material as well as spiritual and psychological which are vital to our well being. The global concern for the need to preserve biological diversity stems from its enormous significance and inestimable value to mankind. Our tendency to evaluate everything in terms of direct economic benefits or costs has resulted in the severe undervaluing of biodiversity in the past. Even now it is not possible to convert the potential benefits of biodiversity into monetary values for assessment. The values of the earth's biological resources can broadly be classified into following:

Direct Values: Also known as use value and commodity value and are assigned to the products harvested by people. The direct values include food resources like grains, vegetables, fruits which are obtained from plant resources and meat, fish, egg, milk and milk products from animal resources. These also include other values like medicine, fuel, timber, fiber, wool, wax, resin, and rubber, silk and decorative items. The direct values are of two types

Consumptive use value: These are the direct values where the biodiversity products can be harvested and consumed directly. Example food, fuel and drugs. These goods are consumed locally and do not figure in national and international market.

(a) Food : A major share of our food comes from domesticated crops and animals. Still we derive major of food from wild species. We obtain Grains, vegetables, fruits, nuts, condiments, tea-coffee, tobacco, liquor, oil from plants and meat, fish, egg, milk (and milk products), honey, etc. from animals.

(b) Fuel: Since ages forests have provided wood which is used as a fuel. Moreover fossil fuels like coal, petroleum, natural gas are also products of biodiversity which are directly consumed by humans. All through fossil fuels have productive use values.

(c) Drugs and medicines: The traditional medical practices like ayurveda utilize plants or their extracts directly. In allopathy, the pharmaceutical industry is much more dependent on nature products. Many drugs though having productive use values are derived from plants like (i) Quinine: - The famous anti-malarial drug is obtained from cinchona tree. (ii) Penicillin: - A famous antibiotic derived from pencillium, a fungus. (iii). Digitalis and Digitoxin from foxgloves have saved millions of heart patients. (iv). Recently vinblastin and vincristine- two anti cancer drugs have been obtained from Rosy Periwinkle plant which has anti cancer alkaloids.

Productive use values: These are the direct use values where the product is commercially sold in national and international markets. Many industries are dependent upon these values. Examples textile, leather, silk, pump, paper and pulp industry etc. although there is an international ban on trade of products from endangered species like tusks of elephants, wool from sheep, fur of many animals etc. these are traded in market and fetch a booming business.

Indirect values: Biodiversity provides indirect benefits to human beings which support the existence of biological life and other benefits which are difficult to quantify. There include social and culture values, ethical values, aesthetic values, option values and environment service values.

Social and cultural values: Many plants and animals are considered holy and sacred inIndia and are worshiped like tulsi, peepal, cow, snake etc. In Indian society great cultural value is given to forest and as such tiger, peacock and lotus are named as the national animal, bird and flower respectively.

Ethical: These values are related to conservation of biodiversity where ethical issue of "all life forms must be preserved" is laid down. There is an existence value which is attached to each species because biodiversity is valuable for the survival of human race. More over all species have a moral right to exist independent of our need for them.

Aesthetic value: There is a great aesthetic value which is attached to biodiversity. Natural landscape at undisturbed places are a delight to watch and also provide opportunities for recreational activities like bird watching, photography etc. It promotes ecotourism which further generates revenue by designing of Zoological parks, Botanical gardens, National parks, Wildlife sanctuaries etc.

Optional value: These values include the unexplored or unknown potentials of biodiversity.

Environment service value: - The most important benefits of biodiversity is maintenance of environmental services which include

• Carbon dioxide fixation through photosynthesis.

• Maintaining of essential nutrients by carbon, Oxygen, Nitrogen, Sulphur, and Phosphorous Cycles.

• Maintaining water cycle and recharging of ground water.

• Soil formation and protection from erosion.

• Regulating climate by recycling moisture into atmosphere.

• Detoxification and decomposition of waste.

Threats to Biodiversity:

Biodiversity is diminished or destroyed in a number of ways either by natural changes or by human disruption. Increasing population pressure and over-exploitation of the biotic resources is taking their toll on biodiversity. Biodiversity losses can be attributed to the resource demands of our rapidly growing human population. In modern times the human population has increased from 1 billion in 1900 to over 7 billion today. Like other living beings, we use natural resources to survive but we are far more resourceful and destructive to other life forms than any other species previously known. As the world's human population increases all the organisms on earth (including ourselves) must share the same limited resources (food, water, space). Yet there is less and less natural habitat remaining as land is developed for human habitation and activities.

Any disturbance in a natural ecosystem tends to reduce its biodiversity. The activities or reason resulting in the loss of biodiversity are regarded as the threats to biodiversity as under:

1. Habitat loss and fragmentation: is considered by conservation biologists to be the primary cause of biodiversity loss. Clearance of native vegetation for agriculture, housing, timber and industry as well as draining wetlands and flooding valleys to form reservoirs, destroys these habitats and all the organisms in them. In addition, this destruction can cause remaining habitats fragmented and so too small for some organisms to persist or fragments may be too far apart for other organisms to move between. Sometimes habitat fragmentation occurs due to construction of roads, towers and canals. Habitat fragmentation divides populations into isolated groups that not only limit the potential of species for dispersal and colonization but also reduces the foraging ability of animals. These isolated, small, scattered populations are increasingly vulnerable to inbreeding depression, high infant mortality and susceptible to environmental hardships and consequently in the end, possible extinction.

2. Invasive alien species: They are the second greatest threat to biodiversity worldwide, whether introduced for any purpose or accidently. Non- native species can cause severe problems in the ecosystems they invade, from affecting individuals to causing huge changes in ecosystem functioning and the extinction of many species. Virtually all ecosystems worldwide have suffered invasion by the main taxonomic groups. This problem possibly gets worsened by climate change and an increase in global trade and tourism. As well as the risks to human health alien species inflict massive economic costs to agriculture, forestry, fisheries and other human activities.

For example introduction of Nile Perch from North in Lake Victoria, Africa's largest lake has driven almost half of the 400 original fish species of the lake to near extinction.

3. Pollution: Pollution is currently poisoning all forms of life, both on land and in water and contributing to climate change. Any chemical in the wrong place or in the wrong concentration can be considered a pollutant. Transport, industry, construction, extraction, power generation and agro forestry all contribute pollutants to the air, land and water. These chemicals can directly affect biodiversity or lead to chemical imbalances in the environment that ultimately kill individuals, species and habitats.

4. Climate change: Climate change brought about by emissions of greenhouse gases when fossil fuels are burnt is making life uncomfortably hot for some species and uncomfortably cold for others. This can lead to change in the abundance and distribution of individual species around the globe and will affect the crops we grow, cause a rise in sea levels and problems to many coastal ecosystems. In addition the climate is becoming more unpredictable and extreme devastating events are becoming more frequent.

5. Over exploitation and poaching: Over exploitation by humans causes massive destruction to natural ecosystems. Exploitation of biodiversity occurs for good (e.g. fish), construction (e.g. trees), industrial products (e.g. animals, blubber, skins), the pet trade (e.g. reptiles, fish, orchids, fashion e.g. (fur, ivory) and traditional medicines (e.g. rhino horn). Selective removal of an individual species can unbalance ecosystems and all other organisms within them. In addition the physical removal of one species often harms other (e.g. fishing by catches). Poaching which means illegal /unlawful trade of wild plants and animals through hunting, harvesting, fishing or trapping is also causing loss of biodiversity at a very fast rate. The lure of spectacular profits drives the illegal trade in endangered species and their products. In spite of laws prohibiting the trade, consumers all over the world are willing to pay 95, 000 dollars for a Bengal tiger coat. Similarly a coat made of South American Ocelet costs 40000 dollars. Poaching contributes to loss of biodiversity. Poaching is of 3 types listed below:

i **Subsistence poaching:** This refers to killing animals for survival.

ii **Commercial poaching:** This refers to hunting animals in order to sell their products.

iii **Recreational or Sport or Game poaching:** This refers to the hunting of wild animals for recreational purposes or for fun.

Man- wildlife conflict: Man- wildlife occurs when growing human populations overlap with established wildlife territory creating reduction of resources or life to some people and or wild animals.

Human wildlife conflict is defined by the World Wide Fund for Nature (WWF) as "any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life, on the conservation of wildlife populations, or on the environment." As human populations expand into wild animal habitats, natural wildlife territory is displaced. Reduction in the availability of natural prey/food sources leads to wild animals seeking alternate sources. Conflicting situations with wild life starts causing immense damage and danger to man. Example: In Sambalpur, Orissa 195 humans are killed in last 5 years by elephants and in retaliation villagers killed 98 elephants and badly injured more than 30 elephants. Similarly incidents with tigers, leopards *etc*. are in news. Shrinking forest cover, human encroachment, ill and weak animals, lack of food (one adult elephant needs 200 kg green fodder and 150 kg of clean water) for animals, protecting villagers by putting electric fence are the main reasons for such happenings. As the compensation by government is not enough, conflicts occur between forest department and villagers.

Human–wildlife conflict occurs with various negative results. The major outcomes of human-wildlife conflict are:

- Injury and loss of life of humans and wildlife.
- Crop damage, livestock depredation, predation of managed wildlife stock.
- Damage to human property.
- Trophic cascades.
- Destruction of habitat.
- Collapse of wildlife populations and reduction of geographic ranges.

Threatened Species: The international union for conservation of nature and natural resources (IUCN) publishes the Red Data Book which contains list of species whose continued existence is threatened. Species are classified into different categories of perceived risk. Red data books are now being published in many different countries and provide useful information on the threat status of the species. IUCN develops different categories of species based on certain criteria.

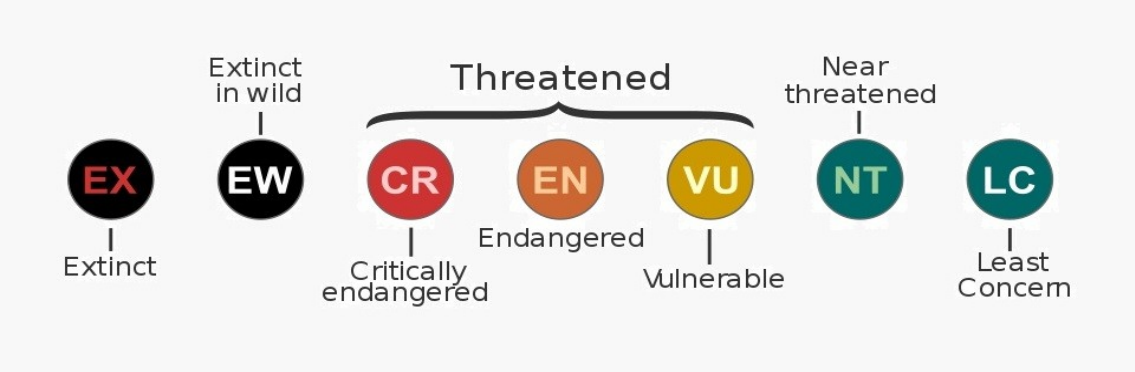
• The present and past distribution.

• Decline in the number of population in Course of time.

• Abundance and quality of natural habitat.

• Biological and potential value of species.

IUCN Red List of Threatened Species recognizes several categories of species status as under:



1. Extinct (EX), a desu applied to species in which the last individual has died or where systematic and time-appropriate surveys have been unable to log even a single individual. Examples, Passenger Pigeon, Dodo Bird.
2. Extinct in the Wild (EW), a category containing those species whose members survive only in captivity or as artificially supported populations far outside their historical geographic range. Examples, Golden Toad, Franklinia Plant. South China tiger, Alagoas curassow

3. Critically Endangered (CR), a category containing those species that possess an extremely high risk of extinction as a result of rapid population declines of 80 to more than 90 percent over the previous 10 years (or three generations), a current population size of fewer than 50 individuals, or other factors. Examples, Bengal Tiger, Arakan forest turtle, Javan rhino, Brazilian merganser

4. Endangered (EN), a designation applied to species that possess a very high risk of extinction as a result of rapid population declines of 50 to more than 70 percent over the previous 10 years (or three generations), a current population size of fewer than 250 individuals, or other factors. Examples, blue whale, snow leopard, African wild dog.

5. Vulnerable (VU), a category containing those species that possess a very high risk of extinction as a result of rapid population declines of 30 to more than 50 percent over the previous 10 years (or three generations), a current population size of fewer than 1,000 individuals, or other factors. Examples: cheetah, gaur, lion, wolverine

6. Near Threatened (NT), a designation applied to species that are close to becoming threatened or may meet the criteria for threatened status in the near future. Examples: blue-billed duck, solitary eagle, small-clawed otter

7. Least Concern (LC), a category containing species that are pervasive and abundant after careful assessment. Examples: brown rat, Nootka cypress, wood pigeon

8. Data Deficient (DD), a condition applied to species in which the amount of available data related to its risk of extinction is lacking in some way. Consequently, a complete assessment cannot be performed. Thus, unlike the other categories in this list, this category does not describe the conservation status of a species

9. Not Evaluated (NE), a category used to include any of the nearly 1.9 million species described by science but not assessed by the IUCN.

Endemic species:

An endemic species is one whose habitat is restricted to a particular area. The term could refer to an animal, a plant, a fungus, or even a microorganism. As such they are of conservation concern because they are not widespread and may be confined to only one or two protected areas.

India is quite rich in biodiversity endemism. About 33% of the country's flora is endemic and are concentrated mainly in the north east, Western Ghats, North West Himalaya and the Andaman and Nicobar islands. Similarly 62% of the known amphibian species and 50% of the lizards of the country are endemic with the majority occurring in the western- Ghats also a hotspot of biodiversity.Examples of endemic Flora species are

1. Sapria Himalayana
2. Ovaria Lurida
3. Nepenthis khasiana etc

Endemic fauna of significance in the Western Ghats are:

1. Lion tailed macaque
2. Nilgiri langur
3. Brown palm civet and
4. Nilgiri tahr

Exotic or non- native or alien species:

Exotic species are those organisms introduced into habitats where they are not native either deliberately or accidentally. Invasive exotic species are organisms not native to a region and whose introduction causes economic or environmental harm or harm to human health. In their natural habitats these organisms develop stable populations and complex relationships with other species. When removed from the predators, parasites, diseases and competitors that have kept their numbers in check, species introduced into new habitats often over run their new home and crowd out native species once established.

Humans are connected to most exotic species introductions. As people developed modes of transportation that allowed rapid and easy movement over long distances, they began to travel to new areas. Non- native species can cause severe problems in the ecosystems they invade, from affecting individuals to causing huge changes in ecosystem functioning and the extinction of many species. Virtually all ecosystems worldwide have suffered invasion by the main taxonomic groups. This problem possibly gets worsened by climate change and an increase in global trade and tourism. For example:

- Introduction of Nile Perch from North in Lake Victoria, Africa's largest lake has driven almost half of the 400 original fish species of the lake to near extinction.
- Parthenium hysterophorus (Congress grass- a tropical American weed) has invaded many of the vacant areas in cities, towns and villages in India leading to removal of the local plants and the dependent animals.
- Water hyacinth clogs lakes and riversides and threatens the survival of many aquatic species. This is common in Indian plains.

Hotspots of Biodiversity: Areas which exhibit high species richness as well as high species endemism are termed as hotspots of biodiversity. The hotspot of biodiversity concept was first introduced in ecology by a British ecologist Norman Myers in 1988. Conservation International has identified these biologically rich areas under the greatest threats of destruction as biodiversity hotspots. Hotspots of biodiversity are identified on the basis of three criteria as follows:

- The number of species present.
- The degree of threats they face.
- Number of endemic species found in ecosystem.

Thus we can say that hotspots of biodiversity are such areas on the surface of earth which have high species richness as well as high species endemism. Currently there are 35 hotspots of biodiversity in the world which support nearly 60% of the world's animal species, with a very high share of endemic species. There are 49,555 endemic species of higher plants that is 20% of the world's total plant species. India has four hotspots of biodiversity namely Northeast India, Western Ghats, Himalayas and Andaman & Nicobar Islands. Among the endemic species of India, a large portion is present in these areas. The Andaman & Nicobar Islands alone have as many as 2200 species of flowering plants and 120 species of ferns.63% of Indian mammals are found in northeast. The northeast states have 1500 endemic plant species. A major portion of amphibian and reptile species are in Western Ghats, which is also a habitat for 1500 endemic plant species.

Conservation of Biodiversity: Conservation may be defined as the management and sustainable use of natural environment and natural resources for ethical reasons and the benefits of humanity. Conservation of biodiversity mainly centers upon the wildlife conservation. The wildlife can be conserved by protecting both the animal's life and plants. In this regard, following two approaches are adopted to conserve the wildlife in protected habitats.

1. In- situ conservation
2. Ex-situ conservation

1. In-situ Conservation: It can be defined as the conservation of plants and animals in their native ecosystems. This type of conservation is applicable through protection of plants and animals in their natural ecosystems. The concept of protected areas falls under this category e.g. National parks, Wildlife sanctuaries and biosphere reserves. In India there are 103 national parks, 515 wildlife sanctuaries and 18 biosphere reserves meant for in situ conservation.

National park: It is an area dedicated for the conservation of wildlife along with its environment. It is also meant for enjoyment through tourism but without impairing the environment. Grazing of domestic animals, all private rights and forest activities are prohibited within a national park. Each national park aims at conservation of some particular species of wildlife along with others. The first national park developed in India is Hailey national park in 1936 which is now known as Jim corbet national park. Some famous national parks of India are as follows:

National park	**State**	**Important Wildlife**
Kaziranga	Assam	Rhino
Corbet	U.P	Tiger
Dachigam	Srinagar (J&K)	Hangul
Periyar	kerela	Tiger, Elephant
Gir national park	Gujrat	Lion

Wildlife sanctuaries are also protected areas where killing, hunting, shooting or capturing of wildlife is prohibited except under the control of highest authority. The private ownership rights are permissible and forestry operations are also permitted to an extent that they do not

affect the wildlife. India has 515 wildlife sanctuaries meant for in situ conservation. Among these 48 tiger reserves are governed by project tiger and are of special importance in the conservation of tiger. Some important wildlife sanctuaries are:

Gana Bird Sanctuary	Rajasthan	300 Species of birds
Wild ass sanctuary	Gujrat	Wild ass
Hazaribagh sanctuary	Bihar	Tiger
Nandni sanctuary	Jammu	Monkey

Biosphere reserves aim at conserving the biological diversity and genetic integrity of plants, animals and microorganisms in their totality as part of the natural ecosystems, so as to ensure their self-perpetuation and unhindered evolution of the living resources. In biosphere reserves the whole area is protected and not any one particular plant or animal species. Currently there are 18 major biosphere reserves in India which are meant for in situ conservation.

1. **Ex situ Conservation:**Ex Situ Conservation or Of-Site Conservation means conservation ofendangered plants and animal species away from their natural habitat under human supervision and care. Ex situ conservation involves maintenance and breeding of endangered speciesof plants and animals under partially or wholly controlled conditions in zoos, gardens, nurseries and laboratories. In ex situ conservation the endangered animal species are collected and bred under desired conditions in zoos, aquaria etc. While plant species are maintained in botanical gardens, seed banks, gene banks etc.

For the present discussions, following ex-situ conservation means have been taken into consideration.

i **Seed gene bank:** These are cold storages where seeds are kept under controlled temperature and humidity for storage and this is easiest way to store the germ plasma of plants at low temperature. Seeds preserved under controlled conditions (minus temperature) remain viable for long durations of time.

ii **Gene bank:** Genetic variability also is preserved by gene bank under normal growing conditions. These are cold storages where germ plasm is kept under controlled temperature and humidity for storage; this is an important way of preserving the genetic resources.

iii **Tissue culture:** Cryopreservation of disease free meristems is very helpful. Long term culture of excised roots and shoots are maintained. Meristem culture is very popular in plant propagation as it is virus and disease free method of multiplication.

iv **Botanical gardens:** A botanical garden is a place where flowers, fruits and vegetables are grown. The botanical gardens provide beauty and calm environment. Most of them have started keeping exotic plants for educational and research purposes.

v **Zoological Gardens:** In zoos wild animals are maintained in captivity and conservation of wild animals (rare, endangered species). In world there are about 800 zoos. Such zoos have about 3000 species of vertebrates.