Part IV – Environmental Studies for the Academic Year 2023-2024 onwards Syllabus

(For all UG Courses)

MANONMANIAM SUNDARANAR UNIVERSITY

TIRUNELVELI -627012

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UG COURSES – AFFILIATED COLLEGES

Part IV – Environmental Studies for the Academic Year 2023-2024 onwards

Syllabus (For all UG Courses)

III Semester

ENVIRONMENTAL STUDIES

Course Objectives:		
The main objectives of this course are:		
Enable the students to be aware of our natural resources, ecosystems and their linkages to society, livelihood, environment and conservation.		
Course	**:**	
Course title	**:**	Environmental Studies
Credits	**:**	2
Expected Course Outcome:		
Upon completion of this course, Students would have		
CO1	To have a basic knowledge of Natural resources its classification, concepts, and natural resources of India.	**K1**
CO2	To obtain knowledge on different types of ecosystem	**K2**
CO3	To understand the values of biodiversity and conservation on global, national, and local scales	**K3**
CO4	To gain knowledge on different types of pollution in the environment	**K4**
CO5	To introduce the students in the field of Law and Policies and Acts both at the national and international level relating to environment.	**K5**
K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create		

	Units
I	**Multidisciplinary Nature of Environmental Studies and Natural Resources**: Concept of Renewable and non-renewable resource, Natural resources and associated problems: Forest resources: Deforestation, Timber extraction, mining, dams and their effects. Water resources: Over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources: Land degradation, man induced landslides, soil erosion and desertification.
II	**Ecosystem:** Concept of an Ecosystem, Structure and Functions of Ecosystem, Energy flow in the Ecosystem; Ecological Succession, Food Chains, Food webs and Ecological Pyramids, Characteristic Features of the following Ecosystem: Forest Ecosystem, Grassland Ecosystem and Desert Ecosystem, Aquatic Ecosystem (Ponds, Streams, Lakes, Rivers and Ocean Estuaries)

III	**Biodiversity and its Conservation**: Definition, levels and values of biodiversity; Threats to biodiversity- habitat loss, poaching of wildlife, man-wildlife conflicts, IUCN categories of threat; Terrestrial and marine hotspots of biodiversity in India; Conservation of Biodiversity - In-situ and Ex-situ conservation; Conservation schemes :Gir lion sanctuary project, Project tiger, Project elephant, Conservation of sea turtles in India. Ecotourism
IV	**Environment Pollution**: Types, causes, effects, and control - Air, Water, Soil and Noise pollution. Nuclear hazards and human health risks. Solid waste management: Control measure of urban and industrial waste. Climate change global warming, ozone layer depletion, acid rain, and impacts on human communities and agriculture
V	**Social Issues and the Environment:** Sustainable Development, Water Conservation, Resettlement and rehabilitation of people. Disaster Management: Floods, earthquake, cyclone and landslides. Consumerism and waste products; Environment Protection Act; Air and water (Prevention and control of Pollution) Act; Wild life protection Act; Forest conservation Act; Environmental movements (Chipko, Silent valley, Bishnois of Rajasthan). Environmental ethics. Environmental communication and public awareness.

Reading list

1. Erach Bharucha, 2021, Textbook of Environmental Studies for Undergraduate Courses, Third Edition, Orient blackswan Pvt. Ltd., Hyderabad.
2. V. K. Ahluwalia, Environmental Studies (Second Edition), Ane books India, T-Nagar, Chennai.
3. Y.K. Singh, 2006, Environmental science, New Age International (P) Ltd., Publishers, New Delhi.
4. S. P. Misra, 2023, Essential Environmental Studies, 4th Edn, Ane Books Pvt. Ltd., New Delhi.
5. G.S. Vijayalakshmi, A.G.Murugesan and N.Sukumaran, 2006, Basics of Environmental Science, Manonmaniam Sundaranar University Publications, Tirunelveli.

Recommended texts

1. N. Arumugam and V. Kumaresan, 2014, Environmental studies, 4th edition, Saras Publication, Nagercoil, TamilNadu.
2. M. Basu, and S. Xavier, 2016, Fundamentals of Environmental Studies, Cambridge University Press.
3. A.K. Mitra and R. Chakraborty, 2016, Introduction to Environmental Studies, Book Syndicate.
4. J.S. Singh, S.P.Singh, and S.R. Gupta, 2014, Ecology, Environmental Scienceand Conservation. S. Chand Publishing, New Delhi.

Mapping with Programme Outcomes*										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**

CO1	M	M	M	M	M	S	M	S	M	M
CO2	M	S	S	M	S	S	M	M	M	S
CO3	M	S	S	S	S	S	S	S	S	M
CO4	M	M	S	S	S	M	S	S	S	M
CO5	M	S	S	S	S	S	M	M	S	M

*S-Strong; M-Medium; L-Low

UNIT - I

Multidisciplinary Nature of Environmental Studies and Natural Resources:

Multidisciplinary Nature of Environmental studies and Natural resources:

Natural resources are materials or things that people use from the earth. There are two types of natural resources. The first are renewable natural resources. They are called renewable because they can grow again or never run out. The second are called non-renewable natural resources. These are things that can run out or be used up. They usually come from the ground**.**

RENEWABLE RESOURCE:

Renewable resources are those that cannot be depleted. They are always available and thus could be reused. The various types of Renewable resources are given below:

Examples

- **Sun** - The energy obtained from sunlight is solar energy. The sun is the ultimate natural resource for all living beings on the earth. Plants utilise solar energy and make their own food through photosynthesis.
- **Wind** - It is an important renewable resource required for the survival of living organisms. Air is important to carry out photosynthesis (the process by which green plants turn carbon dioxide and water into food using energy from sunlight) and respiration (the inhaling of oxygen and the exhaling of carbon dioxide) in plants and animals, respectively. The energy that is obtained from wind is termed as wind energy.
- **Water** - Water is required for survival. Humans use water for a variety of reasons, including drinking, washing, cooking, and cultivating crops. Hydro energy is generated by water flowing into a river or water held in a dam. Hydro energy is power that is generated from moving water such as rivers.
- **Soil**- Soil is a valuable resource as it is the layer in which plants grow. Living beings require food to live. Plants produce most of the food that is required by living organisms.
- **Biogas**- Biogas is a form of fuel that is a mixture of gases such as methane, carbon dioxide, hydrogen, and other gases produced by the breakdown of animal and plant wastes such as animal dung in the presence of water with the help of microorganisms. It is commonly used as a fuel for gas stoves, particularly in rural regions.

ON-RENEWABLE RESOURCE:

Natural resources that are limited in quantity are referred to as non-renewable resources. These resources cannot be supplied or regenerated in a short duration of time. These resources cannot be reused. The various types of non-renewable resources are as follows.

Examples

- **Fossil Fuels-** Fossil fuels are non-renewable energy sources. This means that they will ultimately be finished, which is why energy prices are rising. Fossil fuels consist of coal, natural gas and petroleum.
- **Coal-** Coal is used as a fuel, to generate electricity, and in factories and steam engines.
- **Natural gas-** Natural gas, often known as compressed natural gas, is an excellent alternative to petrol and diesel. It burns quickly and generates a large amount of heat. It's an excellent source of hydrogen.
- **Petroleum-** Mineral oil or crude oil are other names for petroleum. Petrol, diesel, cooking gas, and kerosene are all made from this liquid mineral. It can be found deep within the earth.
- **Nuclear energy-** This energy source involves use of radioactive material that is found in nature. Uranium is primarily used to make nuclear reactor fuel rods. Heat is generated when neutrons (neutral particles present in the atom) hit with the fuel rods. This converts water to steam, which is used to move turbines. As a result, it generates electricity.

FOREST RESOURCES:

Forests cover almost a third of the Earth's land area, half of which – two million hectares – is in warm regions. Natural and planted forests have a major social, economic and ecological impact on a global level, for the planet, and also on a national and local level for individual countries, firms and people.

Water is one of the most vital sources for all living organisms. Although water is a renewable resource, scarcity of quality water is still a big issue in many parts of the world. We need water for various purposes such as to grow food, keep clean, generate electricity, control fire, and most importantly to stay alive.

Deforestation:
Deforestation can be defined as the large-scale removal of trees from forests (or other lands) for the facilitation of human activities. It is a serious environmental concern since it can result in the loss of biodiversity, damage to natural habitats, disturbances in the water cycle, and soil erosion. Deforestation is also a contributor to climate change and global warming.

Causes of Deforestation

- Agriculture – small-scale and large-scale farming
- Logging – cutting of trees for use as raw material
- Mining and urban expansion – clearing of forest area for the construction of infrastructure.

Timber extraction:
Timber extraction refers to the process of removing trees from forests for commercial purposes, such as to produce wood products or to clear land for agriculture or other uses. Timber extraction can have significant impacts on forest ecosystem and the communities that rely on them, including:

1. Biodiversity loss: Timber extraction can result in the loss of plant and animal species, as well as the fragmentation of habitats, which can lead to declines in biodiversity.
2. Soil erosion: Timber extraction can result in soil erosion and degradation, which can lead to reduced soil fertility and agricultural productivity.
3. Water cycle disruption: Trees paly a critical role in regulating the water cycle, and timber extraction can disrupt the balance of water in ecosystems, leading to reduced water availability, increased flooding, and change in river flows.
4. Impact on local communities: Timber extraction can have significant impacts on local communities, including displacement, loss of livelihoods, and impacts on cultural and spiritual practices.

Mining, dams and their effects on forest:
Mining and dams can have significant impacts on forest ecosystems and the indigenous and tribal communities that depend on them.

1. Deforestation: Mining and dams can enquire large areas of land to be cleared, resulting in deforestation and the loss of important forest habitats.
2. Displacement: Indigenous and tribal communities that live in or near mining or dam construction areas may be forced to relocate, resulting in displacement and loss of livelihoods

3. Water pollution: Mining can result in water pollution from the discharge of mine waste, which can harm aquatic life and affect downstream communities that rely on clean water sources.
4. Loss of cultural heritage: Mining and dam construction can result in the loss of cultural heritage sites and sacred places, which can have significant impacts on the identity and well-being of indigenous and tribal communities.
5. Health impacts: Mining and dam construction can result in air and water pollution, which can have negative impacts on the health of nearby communities.

WATER RESOURCES:

Water resource, any of the entire range of natural waters that occur on the Earth, regardless of their state (i.e., vapour, liquid, or solid) and that are of potential use to humans. Of these, the resources most available for use are the waters of the oceans, rivers, and lakes; other available water resources include groundwater and deep subsurface waters and glaciers and permanent snowfields

Types of Water Resources

Saltwater Resources:

- The planet's atmosphere is covered in saltwater. However, when it relates to potable water sources, saltwater is actually ineffective. Desalination plants, though they do operate, are in short supply due to the high energy costs associated with the operation.
- Apart from spectacular ocean views, there have been saltwater opportunities through which humans gain profit. Saltwater fish is indeed a staple of many people's diets around the world. In addition, tidal waters have been used to generate hydroelectric power.

Groundwater Resources:

- Of all the freshwater resources, groundwater in the water natural resources is perhaps the most abundant. Part of the water that filters down into the soil via layers of dirt, clay, and rock stacks to the uppermost layers, providing water to the plants.
- This water is in the vadose region, which means it is unsaturated. Instead of water, almost all of the pores in the vadose zone are filled with air.
- Inputs, outputs, and storage are the same for groundwater as they are for surface water. The crucial distinction is that, due to the slow turnover rate, groundwater storage is typically much greater (in volume) than surface water storage in comparison to inputs.
- Because of this distinction, humans may use groundwater in an unsustainable manner over an extended period of time without suffering serious repercussions. Nonetheless, the

average rate of drainage above a groundwater source is the upper limit for average groundwater use during the longer run.

Surface Water Resources:

- The water in lakes and rivers is known as surface water. Potable water, recreation, industry, agriculture, transportation, livestock, and hydroelectric energy are all uses for this water.
- Groundwater natural resources provide over 63 percent of the municipal water supply. Irrigation relies on surface water for 58 percent of all its water supply. Irrigation relies on groundwater for 58 percent of its water system.
- Surface water systems have nearly 98 percent of the water used by industry. As a result, maintaining and improving the surface water quality is critical. Watershed entities track streamflow and groundwater management on a regular basis.
- Flooding and drought conditions are predicted by monitoring streamflow. Since surface water provides most of the water used within the United States, water resources information and management are important. It is a chemical, biological, and physical test that determines how acceptable the water is.
- Electrical conductivity, temperature, pH, dissolved oxygen levels, phosphorus levels, bacteria levels, and nitrogen levels are evaluated as indicators of water quality.

Though earth is called the water planet as it is occupied by 75 percent of water, this water cannot be used for domestic purposes. Ocean water is saline in nature and is not fit for human consumption. Freshwater is just around 2.7 percent of the total water on the earth. Issues such as global warming and perpetuating water pollution have made a considerable amount of impact on making freshwater unfit for human consumption.

Uses of Freshwater

Water resources are used in various fields such as agricultural, industrial, domestic, recreational, and environmental activities. Most of the uses require fresh water. However, around 97 percent of the water on the earth is saltwater and only three percent is freshwater. About two-thirds of the available freshwater is frozen in glaciers and polar ice caps. The remaining freshwater is found underground and a negligible portion of it is present on the ground or in the air.

The following are detailed views on how water is used in different sectors.

Agricultural Use: Agriculture accounts for about 69 per cent of all water consumption especially in agricultural economies like India. Agriculture thereby becomes the largest consumer of the Earth's available freshwater.

By 2050, the global water demand for agriculture is estimated to increase by an additional 19% due to irrigation needs. Increasing irrigation needs are likely to put immense pressure on water storage. It is still not concluded whether further expansion of irrigation and additional water withdrawals from rivers and groundwater is possible in the future.

Industrial Use: Water is the lifesaver of the industry. It is used for various purposes such as a raw material coolant, a solvent, a transport agent, and as a source of energy. Manufacturing industries are considered to have a considerable share of the total industrial water consumption. Besides, paper and allied products, chemicals, and primary metals are major industrial users of water. Worldwide, the industry consumes around 19 percent of total water consumption. In industrialized countries, the industries use more than half of the water available for human use.

Domestic Use: It includes usages like drinking, cleaning, personal hygiene, garden care, cooking, washing of clothes, dishes, vehicles, etc. Since the end of World War II, there has been a trend of people migrating out of the country to the ever-expanding cities. This trend has an important role in our water resources.

The government and communities are in a need to provide large water-supply systems to deliver water to new growing populations and industries. Comparing all water consumption in the world, domestic uses about 12 percent of the total water consumed.

Use for Hydropower Generation: Electricity generated from water is called hydropower. Hydropower is one of the highly renewable sources of electricity in the world. It accounts for around 16 percent of the total electricity generated globally. There are numerous opportunities for hydropower development around the world. At present, the leading hydropower generating countries are China, the US, Brazil, Canada, India, and Russia.

Use for Navigation and Recreation: Navigable waterways are defined as watercourses that can be used to transport interstate or foreign commerce. Moving of agricultural and commercial goods on the water is done on a large scale around various parts of the world. Water is also used for recreational purposes like boating, swimming, and sporting activities.

These usages affect the quality of water and pollute it. The highest priority should be given to public health and drinking water quality while permitting such activities in reservoirs, lakes, and rivers.

Overutilization of Surface and Groundwater: Water scarcity has become a big global issue. The UN has held several conventions on the water in recent decades. Continuous overutilization of surface and groundwater has led to increased water scarcity in the world today. The depleting sources for high growth in the human population over the centuries and increased man-made water pollution across the world have created unforeseen water scarcity around the globe. As a result, there has been continuous overutilization of the existing water sources due to unconditional growth in the world population.

Groundwater is the major source of water in various parts of the world. However, there has been continuous depletion of this source due to its overexploitation by the rising human population and the rapid rise in industrialization and urbanization in modern times.

Consequences of Overutilization: Water scarcity has now become a very important topic in international diplomacy. From a small village to the United Nations, water scarcity is a widely-discussed topic in decision-making. Nearly three billion people around the world suffer from water scarcity. International, intrastate and regional rivalries on the water are not new to the world.

According to World Health Organization (WHO) sources, a combination of the rising global population, economic growth, and climate change means that by the year 2050, more than five billion (52%) of the world's projected 9.7 billion people will live in areas with freshwater scarcity. Researchers estimated that about 1 billion more people will be living in areas where water demand will exceed surface-water supply.

Climate Change: Scientists, environmentalists, and biologists worldwide are now warning that climate change will have a major impact on the drainage pattern and hydrological cycle of the earth thereby affecting the surface and groundwater availability to a new extent. Climate change is believed to raise the global temperature at an increasing pace. The increase in temperature affects the hydrological cycle by directly increasing the evaporation of available surface water and vegetation transpiration. As a result, precipitation amount, timing, and intensity rates are largely affected. It impacts the storage of water in surface and subsurface reservoirs.

LAND RESOURCES:

The term “land resources” encompasses the physical, biotic, environmental, infrastructural and socio-economic components of a natural land unit, including surface and near-surface freshwater resources important for management.

Causes of Land Degradation

Deforestation: Forest is very important for maintaining the fertility of the soil. Roots of trees hold on to soil thus preventing washing away of soil by rain, flood, or wind.

Overgrazing: Farmers take their cattle and livestock for grazing, but they mostly don’t do rotation. Due to this the grass and another type of vegetation do not get a chance to grow thus causing land degradation.

Water-logging: In the agriculture field when proper irrigation is not done or maintenance the drainage system lacks, then excessive waterlogging can happen. If this happens then the surface water and the groundwater gets mixed which will bring salt from the groundwater level, thus ruining the fertility of the land.

Desertification: In arid, dry sub-humid and semi-arid regions due to natural and human activities desertification happens. Desertification is when land becomes desert-like.

Soil erosion: When the wind and water cause the displacement or washes away the top layer of soil it is called soil erosion. The loss of the top layer of soil causes degradation of the quality of land, then it will not be able to provide minerals to plants. It will reduce the crop yielding potential of land, the groundwater level will go down, and can cause sinkholes.

Conservation of land resources

Steps and measures that should be taken to conserve land resources are afforestation, proper grazing and maintaining irrigation, regulating pesticides and fertilizers for agriculture, properly using wasteland and fallow land.

SOIL EROSION

In this process, the soil particles are loosened or washed away in the valleys, oceans, rivers, streams or faraway lands. This has been worsening due to human activities such as agriculture and deforestation.

Cause of Soil Erosion

Following are the important causes of soil erosion:

Rainfall and Flooding: Higher intensity of rainstorms is the main cause of soil erosion. Four types of soil erosion are caused by rainfall:

- Rill erosion
- Gully erosion
- Sheet erosion
- Splash erosion

The raindrops disperse the soil, which is then washed away into the nearby streams and rivers. Regions with very heavy and frequent rainfall face a large amount of soil loss. The flowing water during floods also erodes a lot of soil by creating potholes, rock-cut basins, etc.

Agriculture: The farming practices are the major cause of soil erosion. The agricultural activities disturb the ground. The trees are cleared and the land is ploughed to sow new seeds. Since most of the crops are grown during the spring season, the land lies fallow during winters. Most of the soil is eroded during winters. Also, the tyres of tractors make grooves on the land, making a natural pathway for water. Fine soil particles are eroded by wind.

Grazing: The grazing animals feed on the grasses and remove the vegetation from the land. Their hooves churn up the soil. They also pull out plants by their roots. This loosens the soil and makes it more prone to erosion.

Logging and Mining: A large number of trees are cut down to carry out the logging process. Trees hold the soil firmly. The canopy of the trees protects the soil from heavy rainfall. The leaf litter that protects the soil from erosion, is also lost during logging. Mining activities also disturb the land and leave the soil more prone to erosion.

Construction: The construction of roads and buildings exposes the soil to erosion. The forests and grasslands are cleared for construction purposes, which exposes the soil making it vulnerable to erosion.

Rivers and Streams: The flowing rivers and streams carry away the soil particles leading to a V-shaped erosion activity.

Heavy Winds: During dry weather or in the semi-arid regions, the minute soil particles are carried away by the wind to faraway lands. This degrades the soil and results in desertification.

Effects of Soil Erosion

The major effects of soil erosion include:

Loss of Arable Land: Soil erosion removes the top fertile layer of the soil. This layer is rich in the essential nutrients required by the plants and the soil. The degraded soil does not support crop production and leads to low crop productivity.

Clogging of Waterways: The agricultural soil contains pesticides, insecticides, fertilizers, and several other chemicals. This pollutes the water bodies where the soil flows. The sediments accumulate in the water and raise the water levels resulting in flooding.

Air Pollution: The dust particles merge in the air, resulting in air pollution. Some of the toxic substances such as pesticides and petroleum can be extremely hazardous when inhaled. The dust plumes from the arid and semi-arid regions cause widespread pollution when the winds move.

Desertification: Soil erosion is a major factor for desertification. It transforms the habitable regions into deserts. Deforestation and destructive use of land worsens the situation. This also leads to loss of biodiversity, degradation of the soil, and alteration in the ecosystem.

Destruction of Infrastructure: The accumulation of soil sediments in dams and along the banks can reduce their efficiency. Thus, it affects infrastructural projects such as dams, embankments, and drainage.

Soil Erosion Prevention

Soil erosion is a serious environmental issue. Steps should be taken to curb this problem. Following are some of the methods of soil erosion prevention:

1. Plant trees on barren lands to limit erosion of soil.
2. Add mulch and rocks to prevent the plants and grass underneath to prevent soil erosion.
3. Mulch matting can be used to reduce erosion on slopes.
4. Put a series of fibre logs to prevent any water or soil from washing away.
5. A wall at the base of the slope can help in preventing the soil from eroding.

6. Every household should have a proper drainage system so that water flows down into proper water collecting systems.

DESERTIFICATION

Desertification is the degradation process by which a fertile land changes itself into a desert by losing its flora and fauna, this can be caused by drought, deforestation, climate change, human activities or improper agriculture. Desertification is a process of degradation of the land. It occurs because of man-made activities and climate change. Desertification takes place when a particular type of biome converts into a desert biome.

Desertification Causes

1. Overgrazing
2. Deforestation
3. Farming Practices
4. Urbanization and other types of land development
5. Climate Change
6. Stripping the land of resources
7. Natural Disasters

Desertification Impacts

1. Farming becomes difficult or even impossible in the area
2. Flooding chances are more
3. Hunger – because of no farming
4. Poor quality of water
5. Overpopulation
6. Poverty as a result of the above

UNIT II

Ecosystem:

ECOLOGY AND ECOSYSTEMS

The term ‘Ecology’ was first coined by the German biologist Ernst Haeckel in 1869. Haeckel defined ecology as ‘the study of natural environment including the relations of organisms to one another and to their surroundings.’ It is derived from two Greek words - "oikos" meaning home and "logos" meaning study. Thus literally, ecology is the study of life at home with main emphasis on pattern of relations between organisms and their surrounding environment. Clements (1916) considered ecology to be the “science of communities.” Odum (1963) has defined ecology as the “study of the structure and function of nature.” It was broadly defined by Andrewarth (1961) as “Ecology is the scientific study of interactions that determine the distribution and abundance of organisms.” Modern ecologist Smith (1977) has defined it as “a multidisciplinary science which deals with organism and its place to live and focuses on ecosystem.” In simple words, it deals with the intricate web of relationships between living organisms and their non-living surroundings. The surroundings consist of other living organisms and non-living environment such as water, air, soil, etc. Ecologists mainly focus on the distribution, life processes and adaptations among the organisms, which further are associated with the analysis of flow of energy and nutrients.

CONCEPT OF ECOSYSTEM

In nature, the living organisms (plants, animals and microorganisms) and nonliving environment (e.g. water, air, soil, etc.) are inseparably interrelated and interact with each other. No living organism can exist by itself, or without an environment. Every organism uses energy, nutrients and water from its surrounding environment in various life activities.

1. The plants obtain the energy directly from the sun, and, in case of animals and microorganisms, energy is taken from other organisms through feeding on plants, predation, parasitism and/or decomposition.

2. The terrestrial plants obtain water mainly from soil, while animals get it from free standing water in the environment or from their food.

3. The plants obtain most of their nutrients from the soil or water, while animals get nutrients from plants or other organisms. Microorganisms are the most versatile, obtaining nutrients from soil, water, food, or other organisms.

ECOSYSTEM STRUCTURE

The ecosystem is largely divided into two components - Abiotic and Biotic components. Ecosystem structure is created due to interaction between abiotic and biotic components, varying over space and time.

1. Abiotic Components The abiotic components of an ecosystem refer to the physical environment or the non-living factors. The organisms cannot live or survive without their abiotic components. They mainly include i) inorganic substances required by organisms such as carbon dioxide, water, nitrogen, calcium, phosphorus, etc. that are involved in material cycles. The amount of these inorganic substances present at any given time in ecosystem is called as standing state or standing quality of ecosystem. ii) organic compounds like proteins, carbohydrates, amino acids, lipids, humic substances and others are synthesized by the biotic counterpart of an ecosystem. They make biochemical structure of ecosystem. iii) climatic factors including mainly rain, light, temperature, humidity, wind and air and iv) edaphic and other factors such as minerals, soil, topography, pH, etc. greatly determine the functions, distribution, structure, behavior and inter-relationship of organisms in a habitat.

2. Biotic Components The biotic components of the ecosystems are the living organisms including plants, animals and microorganisms. Based on their nutritional requirement, i.e. how they get their food, they are categorized into three groups –

i) Producers are mainly the green plants with chlorophyll which gives them the ability to use solar energy to manufacture their own food using simple inorganic abiotic substances, through the process of photosynthesis. They are also called as photoautotrophs (photo light, auto-self, troph-nutrition). This group is mainly constituted by green plants, herbs, shrubs, trees, phytoplankton, algae, mosses, etc. There are some chemosynthetic bacteria (sulphur bacteria) deep beneath in the ocean which can synthesize their food in absence of sunlight, thus known as chemoautotrophs (chemo-chemical, auto-self, troph-nutrition).

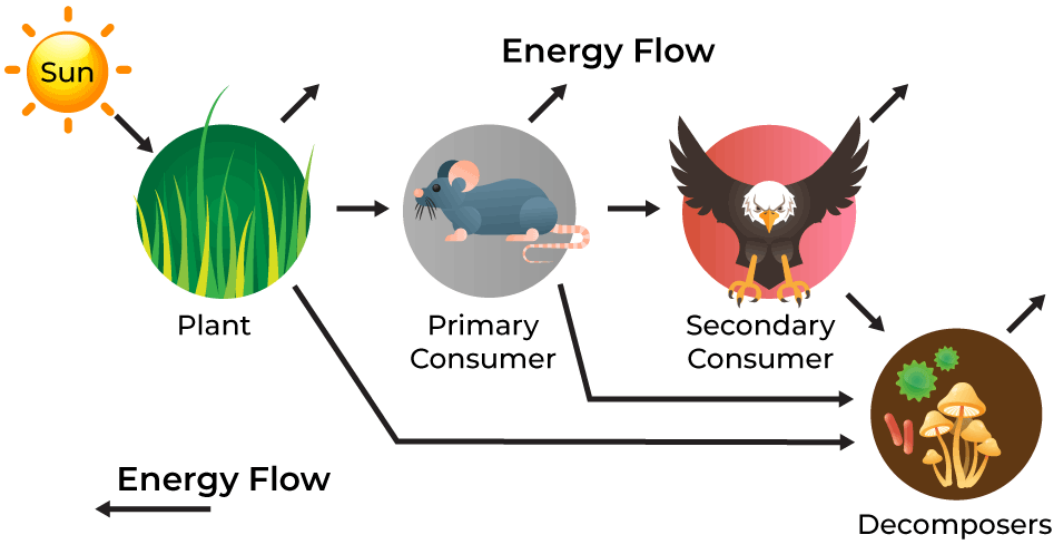
ii) Consumers lack chlorophyll, so they depend on producers for food. They are also known as heterotrophs. They mainly include herbivorous (feed on plants), carnivorous (feed on other animals), omnivorous (feed on both plants and animals) and detritivores organisms (feed on dead parts, waste, remains, etc. of plants and animals,).

iii) Decomposers (saprotrophs) are the microorganisms, bacteria and fungi, which break down complex dead organic matter into simple inorganic forms, absorb some of the

decomposition products, and release inorganic nutrients that are reused by the producers. All ecosystems have their own set of producers, consumers and decomposers which are specific to that ecosystem.

Energy Flow of Ecosystem:

Energy flow in an ecosystem is defined as the movement or transfer of energy from one trophic level to another in an ecosystem. The energy that is passed is in the form of chemical energy.



ECOLOGICAL SUCCESSION

Ecological succession is the steady and gradual change in a species of a given area with respect to the changing environment. It is a predictable change and is an inevitable process of nature as all the biotic components have to keep up with the changes in our environment.

Types of Ecological Succession

These are the following types of ecological succession:

Primary Succession

Primary succession is the succession that starts in lifeless areas such as the regions devoid of soil or the areas where the soil is unable to sustain life. When the planet was first formed

there was no soil on earth. The earth was only made up of rocks. These rocks were broken down by microorganisms and eroded to form soil. The soil then becomes the foundation of plant life. These plants help in the survival of different animals and progress from primary succession to the climax community. If this primary ecosystem is destroyed, secondary succession takes place.

Secondary Succession

Secondary succession occurs when the primary ecosystem gets destroyed. For eg., a climax community gets destroyed by fire. It gets recolonized after the destruction. This is known as secondary ecological succession. Small plants emerge first, followed by larger plants. The tall trees block the sunlight and change the structure of the organisms below the canopy. Finally, the climax community arrives.

FOOD CHAIN:

A food chain refers to the order of events in an ecosystem, where one living organism eats another organism, and later that organism is consumed by another larger organism. The flow of nutrients and energy from one organism to another at different trophic levels forms a food chain.

The food chain also explains the feeding pattern or relationship between living organisms. Trophic level refers to the sequential stages in a food chain, starting with producers at the bottom, followed by primary, secondary and tertiary consumers. Every level in a food chain is known as a trophic level.

The food chain consists of four major parts, namely:

- **The Sun:** The sun is the initial source of energy, which provides energy for everything on the planet.
- **Producers:** The producers in a food chain include all autotrophs such as phytoplankton, cyanobacteria, algae, and green plants. This is the first stage in a food chain. The producers make up the first level of a food chain. The producers utilise the energy from the sun to make food. Producers are also known as autotrophs as they make their own food. Producers are any plant or other organisms that produce their own nutrients through photosynthesis.
- **Consumers:** Consumers are all organisms that are dependent on plants or other organisms for food. This is the largest part of a food web, as it contains almost all

living organisms. It includes herbivores which are animals that eat plants, carnivores which are animals that eat other animals, parasites that live on other organisms by harming them and lastly the scavengers, which are animals that eat dead animals' carcasses.

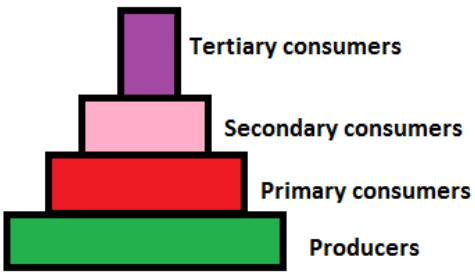
ECOLOGICAL PYRAMID:

An ecological pyramid is a graphical representation of the relationship between the different living organisms at different trophic levels. Charles Elton developed the concept of the pyramid of numbers. Later, G.Evylen Hutchinson and Raymond Lindeman developed the idea of the pyramid of energy or productivity. It can be observed that these pyramids are in the shape of actual pyramids, with the base being the broadest, which is covered by the lowest trophic level, i.e., producers. The next level is occupied by the next trophic level, i.e., the primary consumers and so on.

Types of Ecological Pyramid

Three types of ecological pyramids exist. They are as follows:

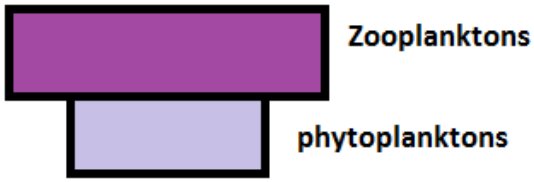
Pyramid of Numbers



Pyramid of numbers

In this type of ecological pyramid, the number of organisms in each trophic level is considered as a level in the pyramid. The pyramid of numbers is usually upright except for some situations like that of the detritus food chain, where many organisms feed on one dead plant or animal.

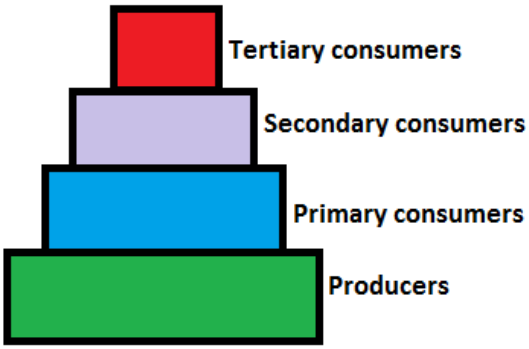
Pyramid of Biomass



Pyramid of biomass in oceans

In this particular type of ecological pyramid, each level takes into account the amount of biomass produced by each trophic level. The pyramid of biomass is also upright except for that observed in oceans where large numbers of zooplanktons depend on a relatively smaller number of phytoplanktons.

Pyramid of Energy



Pyramid of energy

Pyramid of energy is the only type of ecological pyramid, which is always upright as the energy flow in a food chain is always unidirectional. Also, with every increasing trophic level, some energy is lost into the environment.

Importance of Ecological Pyramid

The importance of ecological pyramid can be explained in the following points:

1. They show the feeding of different organisms in different ecosystems.
2. It shows the efficiency of energy transfer.
3. The condition of the ecosystem can be monitored, and any further damage can be prevented.

FOREST ECOSYSTEM

Study of interdependent relations of flora and fauna in a forest is termed as Forest Ecosystem. In such ecosystems, the entire interaction happens naturally between all abiotic and biotic components. The ecological potential of any species depends on their habitat requirements like temperature, climate, frugality, their lifespan and, reproducing capacity.

Types of Forest Ecosystem

1. Temperate Forest Ecosystem
2. The Tropical Rainforest Ecosystem
3. Boreal or Taiga Forests

There are **Producers** who prepare food for the entire forest ecosystem. Trees and plants are thus called the primary producers. **Consumers** are the one who cannot produce their own food and thus depend on producers for their food and energy sources. Organisms that only eat plants are referred to as primary consumers. For example, herbivores such as deer and rabbits are primary consumers. Secondary consumers feed on herbivores and are called as Carnivores. Omnivores are the consumers that feed both on plant and animals.

Organisms like worms, microbes, fungi, ants, and other bugs are called **Decomposers** as they break down the plant and animal wastes into small particles which ultimately blends with the environment. Human beings are omnivores as they feed on both flora and fauna and thus are a part of this forest ecosystem.

Forest Biome: Forests can be divided into 5 main categories, depending on the types of trees found in them. They are –

1) Coniferous Forest: As the name suggests, the trees found in these forests mainly consists of cone-bearing trees like the spruce, pine, fir, and hemlock. These are found mostly in the northern parts of North America, Asia, and Europe.

2) Deciduous Forest: The trees of these forests are broadleaved and are shed between late summer to early autumn. The leaves are usually green but later acquires yellow, red and

orange colours gradually. These forests are found in America, Western and Central Europe, and Northeastern Asia where the winters are cold and summers are warm.

3) Mixed Forests: Deciduous and Coniferous trees as both types constitute mixed forests, which are mostly found in mountainous areas. These are found almost every part of the world.

4) Mediterranean Forests: They are also called scrublands as its temperature is suitable for short oaks and pines to grow. The Mediterranean forest contains a wide variety of wildflowers and insect-eating birds. This forest is also termed as "maquis".

5) Tropical Rainforest: These forests are situated in the areas with hot temperatures like South America, Africa, Asia and Australia. Thus they are called Tropical and due to continuous rainfall throughout the year, they are called Rainforests. It is a habitat for various insects, colourful birds and mammals.

GRASSLAND ECOSYSTEM:

The terrestrial ecosystem in which grasses and herbaceous plants are dominant is referred to as the grassland ecosystem. Grass controls the grassland ecosystems with few or no trees where there is not enough for a forest and too much for a desert. Hence, it is also called a transitional landscape. The grassland ecosystem is called the largest biomes on earth and it covers about 10 per cent of the earth's surface. It is mainly found where rainfall is about 15-75 cm per year, not enough to support a forest, but more than that of a true desert.

The Grassland ecosystems are called by various names in several regions, such as pampas in South America, Veldt in South Africa, Steppes in Europe and Asia, and Downs in Australia. In India, these ecosystems are found mainly high in the Himalayas. The rest of India's grasslands are primarily composed of the Savanna and Steppes.

Types of Grassland ecosystems

This ecosystem contains five types of grasslands that are:

- Desert Grasslands
- Flooded Grasslands
- Montane Grasslands
- Tropical Grasslands
- Temperate Grasslands

Importance of Grassland ecosystem

A Grassland Ecosystem is a mixture of small herbs, weeds, grass, trefoil, dicotyledonous, shrubs and other leguminous species, contributing to a high degree of preservation. The economic importance of the grassland ecosystem is that it serves in the maintenance of the

crop of many domesticated and wild herbivores such as cattle, sheep, goats, ass, pigs, horses, mules, camels, deer, zebras, etc. These animals provide food, milk, wool and transportation to man.

DESERT ECOSYSTEM

Despite several pieces of research about life on other planets, it has come to a conclusion that Earth is the one and only planet where living organisms are found. Survival requires specific forms of atmospheres, land formations, and ecosystems that only Earth comprises. Each continent on this planet includes a desert and comprises its own ecology, better referred to as the desert ecosystem. The word desert is a largely barren, dry and abandoned land without flora or fauna in the sand. It might be cold and hot. The Desert is the most dried area on the planet that gets negligible precipitation on an annual basis. It receives less rainfall throughout the year. So, the desert ecosystem is a community of non-living and living organisms living and interacting with each other in an abandoned environment. It's the interaction between Abiotic and Biotic Components of this environment.

Characteristics of Desert Ecosystem

- **Less Rainfall or Precipitation:** Less precipitation is a significant desert feature and the reason behind its dryness. Deserts receive seasonal rainfall that occurs for a small duration (just around 25 to 30 centimeters).

- **Aridity:** Aridity implies a deficiency of dry moisture. As it experiences less rainfall, it results in aridity

- **Wind Velocity:** Wind velocity is high in this ecosystem. That's why deserts experience dust storms or sandstorms of higher intensity, forming sand dunes.

- **Extreme temperature:** This type of ecosystem experiences extreme hot or cold temperatures during night and day! The days happen to be hot, while nights are extremely cold.

- **Humidity:** Its humidity level is low in the daytime, while it turns out to be high during the nights.

- **Population Density:** Population density happens to be low in the deserts. And there's a dearth of food and water, plus the climatic conditions are harsh which is certainly not preferable for living.

- **Scarcity of water:** As it receives negligible rainfall, there's a scarcity of water. This shortage of water makes deserts experience drought for more than six months!

- **Biodiversity:** Surviving in a desert ecosystem is challenging. But in spite of this face, deserts house different animals and plants. They have adapted the survival skills to live in such extreme and harsh conditions of a desert.

- **Soil Quality:** Deserts are rocky, dry, sandy, and thin. Thus, it experiences low growth in vegetation. The soil is grey in color that does not have any organic contents such as phosphorus and nitrogen.

AQUATIC OR WATER ECOSYSTEM.

Water supports many lives. Organisms which survive in water are called aquatic organisms. They depend on water for their food, shelter, reproduction and all other life activities. An aquatic ecosystem includes a group of interacting organisms which are dependent on one another and their water environment for nutrients and shelter. Examples of aquatic ecosystem include oceans, lakes and rivers. An aquatic ecosystem includes freshwater habitats like lakes, ponds, rivers, oceans and streams, wetlands, swamp, etc. and marine habitats include oceans, intertidal zone, reefs, seabed and so on. The aquatic ecosystem is the habitat for water-dependent living species including animals, plants, and microbes.

Types of Aquatic Ecosystem

Different types of aquatic ecosystems are as follows:

Freshwater Aquatic Ecosystem: They cover only a small portion of earth nearly 0.8 per cent. Freshwater involves lakes, ponds, rivers and streams, wetlands, swamp, bog and temporary pools. Freshwater habitats are classified into lotic and lentic habitats. Water bodies such as lakes, ponds, pools, bogs, and other reservoirs are standing water and known as lentic habitats. Whereas lotic habitats represent flowing water bodies such as rivers, streams.

Lotic Ecosystems: They mainly refer to the rapidly flowing waters that move in a unidirectional way including the rivers and streams. These environments harbor numerous species of insects such as beetles, mayflies, stoneflies and several species of fishes including

trout, eel, minnow, etc. Apart from these aquatic species, these ecosystems also include various mammals such as beavers, river dolphins and otters.

Lentic Ecosystems: They include all standing water habitats. Lakes and ponds are the main examples of Lentic Ecosystem. The word lentic mainly refers to stationary or relatively still water. These ecosystems are home to algae, crabs, shrimps, amphibians such as frogs and salamanders, for both rooted and floating-leaved plants and reptiles including alligators and other water snakes are also found here.

Wetlands: Wetlands are marshy areas and are sometimes covered in water which has a wide diversity of plants and animals. Swamps, marshes, bogs, black spruce and water lilies are some examples in the plant species found in the wetlands. The animal life of this ecosystem consists of dragonflies and damselflies, birds such as Green Heron and fishes such as Northern Pike.

MARINE AQUATIC ECOSYSTEM

Marine ecosystem covers the largest surface area of the earth. Two third of earth is covered by water and they constitute of oceans, seas, intertidal zone, reefs, seabed, estuaries, hydrothermal vents and rock pools. Each life form is unique and native to its habitat. This is because they have adaptations according to their habitat. In the case of aquatic animals, they can't survive outside of water. Exceptional cases are still there which shows another example of adaptations (e.g. mudskippers). The marine ecosystem is more concentrated with salts which make it difficult for freshwater organisms to live in. Also, marine animals cannot survive in freshwater. Their body is adapted to live in saltwater; if they are placed in less salty water, their body will swell (osmosis).

Ocean Ecosystems: Our planet earth is gifted with the five major oceans, namely Pacific, Indian, Arctic, and the Atlantic Ocean. Among all these five oceans, the Pacific and the Atlantic are the largest and deepest ocean. These oceans serve as a home to more than five lakh aquatic species. Few creatures of these ecosystems include shellfish, shark, tube worms, crab small and large ocean fishes, turtles, crustaceans, blue whale, reptiles, marine mammals, seabirds, plankton, corals and other ocean plants.

Coastal Systems: They are the open systems of land and water which are joined together to form the coastal ecosystems. The coastal ecosystems have a different structure, and diversity. A wide variety of species of aquatic plants and algae are found at the bottom of the coastal

ecosystem. The fauna is diverse and it mainly consists of crabs, fish, insects, lobsters snails, shrimp, etc. Plants and animals in an aquatic ecosystem show a wide variety of adaptations which may involve life cycle, physiological, structural and behavioural adaptations. Majority of aquatic animals are streamlined which helps them to reduce friction and thus save energy. Fins and gills are the locomotors and respiratory organs respectively. Special features in freshwater organisms help them to drain excess water from the body. Aquatic plants have different types of roots which help them to survive in water. Some may have submerged roots; some have emergent roots or maybe floating plants like water hyacinths.

UNIT III

Biodiversity and its Conservation:

BIODIVERSITY CONSERVATION

"Biodiversity conservation refers to the protection, up-liftment, and management of biodiversity in order to derive sustainable benefits for present and future generations."

LEVELS OF BIODIVERSITY

Biodiversity is segregated into different levels on the basis of diversity of genes, species and resources in a particular region.

Species Diversity: A unique collection of species which interacts with each other is found in every ecosystem. Some ecosystems may have many more species in comparison to others. In some ecosystems, one species dominates the natural community as it has grown so larger than the others. A large number of species can help recover from ecological threats in an ecosystem, even if some species go extinct.

Genetic Diversity: Genetic diversity describes how the members of one species are closely related in a given ecosystem. Simply, if all members have many similar genes, a low genetic diversity is seen in the species. Endangered species may have low genetic diversity due to inbreeding and thus they have small populations. Inheritance of undesirable traits can make the species more susceptible to diseases and thereby can pose a threat to the population. A high genetic diversity helps species to adapt to the changing environments.

Ecosystem Diversity: A region may have one or several ecosystems. Examples of regions with low ecological diversity would be wide expanses of oceans or deserts. In accordance with this sense, a mountain area that has lakes, forests and grasslands would have higher biodiversity. A region that has several ecosystems may be able to provide more resources for the survival of native species, especially when an ecosystem is suffering from drought or disease.

Functional Diversity

Functional diversity means a way of how species behave, obtain food and use the natural resources of an ecosystem. A species-rich ecosystem is assumed to have high functional diversity, because there exist many species with many different natures. A functional diversity of the ecosystem can be useful to ecologists who are trying to conserve or restore it,

because with the known nature and roles of species, they can point to gaps in a food cycle or ecological niches which species lack.

CONSERVATION OF BIODIVERSITY

Biodiversity conservation refers to the protection, preservation, and management of ecosystems and natural habitats and ensuring that they are healthy and functional.

The three main objectives of Biodiversity Conservation are as follows-

- To protect and preserve species diversity.
- To ensure sustainable management of the species and ecosystems.
- Prevention and restoration of ecological processes and life support systems.

Biodiversity Conservation Methods

Two types of methods are employed to conserve biodiversity. They are- In situ conservation and Ex-situ conservation.

- In-situ Conservation
- Ex-situ Conservation

In Situ Conservation

In Situ Conservation refers to the preservation and protection of the species in their natural habitat. It means the conservation of genetic resources in natural populations of plant or animal species. In situ conservation involves the management of biodiversity in the same area where it is found.

In situ, biodiversity conservation has many advantages

- It preserves species as well as their natural habitat.
- It ensures protection to a large number of populations.
- It is economic and a convenient method of conservation
- It doesn’t require species to adjust to a new habitat.

Different methods of In-situ conservation include biosphere reserves, national parks, wildlife sanctuaries, biodiversity hotspots, gene sanctuary, and sacred groves.

In-situ conservation possesses numerous advantages. Some of the important advantages of in-situ conservation are as follows:

- It is a cost-effective and convenient way of biodiversity conservation.
- Various living organisms can be conserved at the same time.

- They can evolve better and can easily get adapted to various environmental conditions.
- In-situ conservation occurs in places like national parks, wildlife sanctuaries, and biosphere reserves.

i) **Biosphere Reserves:** These are national governments nominated sites, large areas (often up to 5000 square km) of an ecosystem where the traditional lifestyle and natural habitat of the inhabitants of that ecosystem are protected. They are mostly open to tourists and researchers. Example- Sundarban, Nanda Devi, Nokrek, and Manas in India.

ii) **National Parks:** These are limited reserves maintained by the government for the conservation of wildlife as well as the environment. Human activities are prohibited in national parks and they are solely dedicated to the protection of natural fauna of the area. They mostly occupy an area of 100-500 square km. There are a total of 104 national parks in India, right now. The national parks may even be within a biosphere reserve. These are small reserves that are protected and maintained by the government. Its boundaries are well protected, where human activities such as grazing, forestry, habitat, and cultivation are restricted. Example- Kanha National Park, Gir National Park, Kaziranga National Park, and so on.

iii) **Wildlife Sanctuaries:** Wildlife Sanctuaries are protected areas meant only for the conservation of wild animals. A few human activities such as cultivation, wood collection, and other forest product collection are allowed here, but they must not interfere with the conservation of the animals. Tourist visits are also allowed in these areas. There are a total of 551 wildlife sanctuaries in India. These are the places where only wild animals can be found. Certain human activities like timber harvesting, cultivation, collection of woods, and other forest products are permitted unless they interfere with the conservation project. Recreation tourism is also permitted. Example- Ghana Bird Sanctuary, Abohar Wildlife Sanctuary, Mudumalai Wildlife Sanctuary, etc.

iv) **Biodiversity Hotspots:** A biodiversity hotspot are the areas of conservation where there is strictly a minimum of 1500 species of vascular plants and a habitat that has lost its 70% cover. These are protected areas for various purposes where the wildlife, inhabitant lifestyle, and domesticated plants and animals are conserved. Tourist and

research activities are allowed. Example- The Himalayas, The Western Ghats, The North East, and The Nicobar Islands.

v) **Gene Sanctuary:** Gene sanctuary is a conservation area reserved only for plants. India has its only gene sanctuary set up in Garo Hills of Meghalaya for the conservation of wild species of Citrus. Plans to open more such sanctuaries are underway.

vi) **Sacred Groves:** Sacred Groves are conserved areas for wildlife protected by communities due to religious beliefs. It is mostly a part of the forest where its wildlife is given complete protection.

Ex Situ Conservation

Ex Situ Conservation means conservation of life outside their natural habitat or place of occurrence. It is the method in which part of the population or the entire endangered species is taken from its natural habitat which is threatened and breeding and maintaining of these species take place in artificial ecosystems. These artificial ecosystems could be zoos, nurseries, botanical gardens, etc. The living environments are altered in these conservation sites, so there are fewer survival struggles like scarcity of food, water, or space. Ex-situ conservation of biodiversity consists of breeding and maintenance of endangered species using artificial environments like zoos, nurseries, botanical gardens, gene banks, etc. The competition for food, water, and space among the organisms is low.

Advantages of Ex Situ Conservation Include

- Essential life-sustaining conditions like climate, food availability, veterinary care can be altered and are under human control.
- Artificial breeding methods can be introduced leading to successful breeding and creating many more offspring of the species.
- The species can be protected from poaching and population management can be efficiently done.
- Gene techniques can be applied to increase the population of the species and they can again be reintroduced into the wild.

Biodiversity Conservation Strategies

- **Conservation of Ecosystems**- The intent of the conservation of biodiversity is to provide long term viability to the ecosystems. It is to make sure that ecological

integrity is intact. The landscapes of the region which have undergone historical or evolutionary deterioration can be reinstated. The threats can be removed and the ecosystems should be able to continue with ecological processes.

- **Reverse the decline of species**- According to this strategy, the aim of conservation is to restore the population of declined species in a particular ecosystem.
- **Conservation of all biological aspects**- This strategy aims at giving cover and conserving food, livestock, microbial population, agricultural stock including plants and animals.
- Efficient utilization of natural resources.
- Strict laws on deforestation and preventions of deforestation by every means.
- Poaching and killing animals in the wild should be prevented.
- Creating public awareness about conservation of biodiversity and its importance.
- Longer time and breeding activity of the animals are provided.
- The breeding of species in captivity is reintroduced in the wild.
- Genetic techniques are used to preserve endangered species.

Threats to Biodiversity:

Climate change: Climate change is shifting ecosystems, the services they provide, and the imperiled species they support, threatening their continued health and survival. For example: melting ice is cutting off polar bear access to critical food sources and warming waters contribute to the disappearance of coral reefs. Climate change can also exacerbate droughts, drying out the habitats of species like the Sonoyta mud turtle. These are just the tip of the (melting) iceberg when it comes to the detrimental and irreversable affects climate change might have.

Overexploitation of species: Humans have a long history of overhunting species to the point of extinction. In the 17th and 18th century the dodo and Steller's sea cow were hunted out of existence and many know the story of how the passenger pigeon went from the most abundant bird in North America to disappearing forever in 1914 due to large-scale harvesting. Many don't realize, however, that the iconic southern sea otter nearly met the same fate, and now only occupy 13 percent of their historical range. Nearly a fifth of all Endangered Species Act-listed species are at risk of overexploitation.

Pollution: Air pollution, water pollution, soil pollution among others are all ubiquitous across the globe and nature is paying the price. A startling statistic underscoring the wide-reaching affects of pollution is that more than 430 species at the time of their listing under the Endangered Species Act were described as being significantly impacted by pollution. Marine plastic pollution alone has increased tenfold since 1980, affecting at least 267 species, including sea turtles, seabirds, and many marine mammals.

Habitat loss: According to the United Nations Environment Programme, more than 1,621,629 square miles of forest habitat has been lost since the 1990's. Habitat loss in general is estimated at two football fields per minute. Eighty percent of Endangered Species Act-listed species are impacted by habitat loss.

Invasive Species: Invasive species have been a factor in the decline of more than 40 percent of species listed under the Endangered Species Act and can cause damages on average of $20 billion per year in the US. Many of the other drivers of the biodiversity crisis have allowed nearly one-fifth of the Earth's surface to be at risk of invasion from non-native species. Invasive species are expected to increase by 40 percent by 2050.

IUCN

The IUCN red list provides taxonomic data, conservation status, and distribution information on species that are facing a high risk of global extinction.

Objectives

The International Union for Conservation of Nature works to achieve the following goals:

1. To provide scientific data on the status of species and subspecies at a global level.
2. To address the factors of concern and spread awareness regarding the species and biodiversity extinction.
3. To plan a layout for the conservation of biodiversity.

IUCN Red List Users

The IUCN Red List provides accurate data on the status of different species on the Earth. This information is used by various departments, institutes, and organizations.

The users of the IUCN Red List are given below:

- Government agencies (National & International)
- Wildlife organizations and departments

- Conservation-related NGOs
- Natural resource planners
- Educational organizations
- Zoos and aquariums
- Media
- Business communities

Purpose of the IUCN Red List Data

The information cited in the IUCN Red List is used by various organizations in the following ways:

- International Agreements such as CITES, Ramsar Convention use the Red List data to make important decisions in sync with the status of nature as and when required.
- World Bank Group performance standard uses the IUCN Red List data to evaluate the risk of damage to biodiversity due to large-scale infrastructures and global projects.
- Zoos and National parks use this information to upgrade important policies like parks regulations from time to time.

Following are the 9 categories in the IUCN red list:

- Extinct (EX) – No known individuals remaining.
- Extinct in the wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.
- Critically endangered (CR) – Extremely high risk of extinction in the wild.
- Endangered (EN) – High risk of extinction in the wild.
- Vulnerable (VU) – High risk of endangerment in the wild.
- Near threatened (NT) – Likely to become endangered soon.
- Least concern (LC) – Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category.
- Data deficient (DD) – Not enough data to assess its risk of extinction.
- Not evaluated (NE) – Has not yet been evaluated against the criteria

BIODIVERSITY HOTSPOTS

According to Conservation International, a region must fulfil the following two criteria to qualify as a hotspot:

1. The region should have at least 1500 species of vascular plants i.e., it should have a high degree of endemism.

2. It must contain 30% (or less) of its original habitat, i.e. it must be threatened.

Following the criteria for an area to be declared as a Biodiversity Hotspot, there are major four biodiversity hotspots in India:

1. The Himalayas
2. Indo-Burma Region
3. The Western Ghats
4. Sundaland

The Himalayas

Considered the highest in the world, the Himalayas (overall) comprise North-East India, Bhutan, Central and Eastern parts of Nepal. This region (NE Himalayas) holds a record of having 163 endangered species which includes the Wild Asian Water Buffalo, One-horned Rhino; and as many as 10,000 plant species, of which 3160 are endemic. This mountain range covers nearly 750,000 km^2.

Indo – Burma Region

The Indo-Burma Region is stretched over a distance of 2,373,000 km^2. In the last 12 years, 6 large mammal species have been discovered in this region: the Large-antlered Muntjac, the Annamite Muntjac, the Grey-shanked Douc, the Annamite Striped Rabbit, the Leaf Deer, and the Saola.

This hotspot is also known for the endemic freshwater turtle species, most of which are threatened with extinction, due to over-harvesting and extensive habitat loss. There are also 1,300 different bird species, including the threatened White-eared Night-heron, the Grey-crowned Crocias, and the Orange-necked Partridge.

The Western Ghats

The Western Ghats are present along the western edge of peninsular India and cover most of the deciduous forests and rain forests. As per UNESCO, it is home to at least 325 globally threatened flora, fauna, bird, amphibian, reptile and fish species. Originally, the vegetation in this region was spread over 190,000 km^2 but has been now reduced to 43,000 km^2. The region is also known for the globally threatened flora and fauna represented by 229 plant species, 31 mammal species, 15 bird species, 43 amphibian species, 5 reptile species and 1 fish species. UNESCO mentions that “Of the total 325 globally threatened species in the Western Ghats, 129 are classified as Vulnerable, 145 as Endangered and 51 as Critically Endangered.”

Sundaland

The Sundaland hotspot lies in Southeast Asia and covers Singapore, Thailand, Indonesia, Brunei, and Malaysia. In the year 2013, the Sundaland was declared as a World Biosphere Reserve by the United Nations. This region is famous for its rich terrestrial and marine ecosystem. Sundaland is one of the biologically richest hotspots in the world which comprises 25,000 species of vascular plants, of which 15,000 are found only in this region.

PROJECT TIGER

Project Tiger is a centrally sponsored scheme that supports the tiger states in conserving the tiger species in recognized tiger reserves. On April 1, 1973, the Indian government introduced Project Tiger to encourage tiger conservation. The project is the largest species conservation program of its kind. This was created using Core-Buffer Strategy:

- The buffer or periphery regions are a mixture of forest and non-forest land that is administered as a multiple-use area. It provides habitat supplements to wild animals and site-specific development to surrounding villages so they don't impact the core areas.
- The core portions have the legal status of a national park or a wildlife century for the conservation of tigers.

History of Tiger Conservation

Around 1970, a team of scientists and conservationists put tension on the Indian government concerning the constant decline in the tiger population. As a result, the wildlife protection act was created in 1972, legally ending all hunting in India and establishing legal protection for targeted species.

- Later, in 1973 Project Tiger was started, with Dr Kailash Sankhala serving as its first director.
- The first tiger reserve in India was the Jim Corbett Tiger Reserve in Uttarakhand.
- Eight additional tiger reserves were created, totaling over 9115 square kilometers of forest area. This area has increased to 71,000 square kilometers, a significant improvement from its early days but still not enough forest cover for a developing nation like India with a stunning and extensive natural heritage.
- In India, there are currently 53 tiger reserves.

Objectives of Project Tiger in India

Project Tiger in India has specific objectives aimed at conserving and protecting the tiger population. These objectives include preserving tiger habitats, combating poaching and illegal trade, involving local communities, and conducting research and monitoring. Through

these efforts, Project Tiger strives to ensure the long-term survival and well-being of tigers in India. The following are the primary objectives of Project Tiger in India.

- **Conservation of Tiger Population:** The foremost objective of Project Tiger is to conserve and protect the population of tigers in India. It aims to ensure the survival and growth of the tiger species by safeguarding their natural habitats and implementing effective conservation measures.
- **Preservation of Tiger Habitats:** Project Tiger focuses on preserving the crucial habitats that support tiger populations. It aims to maintain and enhance these habitats to provide a conducive environment for tigers to thrive and breed.
- **Prevention of Poaching and Illegal Trade:** Another objective is to combat poaching and the illegal trade of tiger parts. Project Tiger works towards strengthening anti-poaching efforts, improving law enforcement, and raising awareness to curb poaching activities and the demand for tiger products.
- **Ecosystem Conservation:** Project Tiger recognizes the importance of tiger conservation in maintaining the ecological balance of ecosystems. By conserving tigers and their habitats, it helps protect the biodiversity and integrity of the natural environment.
- **Research and Monitoring:** Project Tiger focuses on conducting research, monitoring, and scientific studies related to tiger populations and their habitats. This helps in gaining a better understanding of tiger behaviour, ecology, and conservation requirements, leading to informed decision-making.

ELEPHANT – THE NATIONAL HERITAGE ANIMAL

The government of India in the year 2010 declared elephants as the national heritage animal of the country on the recommendations of the standing committee of the national board for wildlife. This was done to make sure that sufficient protection to elephants was provided before their numbers fall to panic levels like in the case of tigers.

A proposed National Elephant Conservation Authority (NECA) on the lines with NTCA has been proposed to be constituted by amending the Wildlife Protection Act 1972.

Project Elephant Objectives

- To ensure the Welfare of domesticated elephants
- Protection of elephants, their habitats and elephant corridors.
- Mitigation and prevention of human-elephant conflict.

Aims of Project Elephant

- Develop and promote scientific and planned management strategies for Elephant conservation.
- Prevent illegal trade of ivory and ensure elephant protection from hunters and poachers.
- Develop strategies to prevent unnatural causes of elephants' death in India.
- Ensure ecological restoration of the natural elephant habitats and their migratory routes.
- To mitigate and prevent the increasing conflict in elephant habitats between humans and elephants.
- Reduce and remove domestic livestock grazing, the pressure of humans and their activities in important elephant habitats.
- Promote scientific research on issues related to elephant conservation and educating the public on these issues.
- To facilitate veterinary care for proper breeding and health care of domesticated elephants and to facilitate Eco-development for the elephants.

SEA TURTLE PROJECT

- During each winter, a substantial segment of the global Olive Ridley Turtle population migrates to the coastal waters of India, predominantly along the eastern coast.
- With the aim of preserving Olive Ridley turtles and other endangered marine turtles, the Ministry of Environment and Forests, in collaboration with UNDP, initiated the Sea Turtle Conservation Project in November 1999.
- The Wildlife Institute of India, Dehradun, took on the role of the implementing agency.
- Implemented across ten coastal states of the country, with a specific focus on Orissa, the project establishes guidelines for development activities. Its primary objective is to secure turtle breeding areas and shield them from various disruptions.
- Additionally, the project allocates funds for development and monitoring. Utilizing satellite technology, it examines the nesting areas of Olive Ridley Turtles.

The project contributed to the preparation of:

- An inventory map of sea turtle breeding sites.
- Identification of nesting and breeding habitats along the shoreline and migratory routes taken by sea turtles.

- Development of guidelines to safeguard and minimize turtle mortality.
- Facilitation of national and international cooperative and collaborative action for sea turtle conservation.
- Formulation of guideline plans for tourism in sea turtle areas.
- Development of infrastructure and habitat.

OLIVE RED SEA TURTLE

Olive ridley turtles, characterized by their olive-colored carapace, are the world's smallest and most abundant sea turtles. Their conservation status and habitat span various dimensions, while they face threats from pollution, human consumption, plastic waste, and the impact of trawlers.

Conservation Status:

- Wildlife Protection Act, 1972: Schedule I
- IUCN Red List: Vulnerable
- CITES: Appendix I

Habitat:

- Found in the Pacific, Atlantic, and Indian oceans.
- Gahirmatha Marine Sanctuary in Odisha hosts the world's largest sea turtle rookery, serving as a breeding colony.

Threats:

- **Pollution and Sea Waste:** Oceans are contaminated with pollution and waste, affecting the turtles.
- **Human Consumption:** Extensive poaching for meat, shell, leather, and eggs poses a significant threat.
- **Plastic Garbage:** Growing amounts of plastics, discarded nets, polythene, and other debris contribute to environmental hazards.
- **Trawlers:** Overexploitation of marine resources by trawlers often violates regulations, leading to harmful consequences.

ECOTOURISM

Ecotourism is now defined as "responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education". Education is meant to be inclusive of both staff and guests.

Principle:

Ecotourism is about uniting conservation, communities, and sustainable travel. This means that those who implement, participate in and market ecotourism activities should adopt the following ecotourism principles:

- Build environmental and cultural awareness and respect.
- Minimize physical, social, behavioral, and psychological impacts.
- Provide positive experiences for both visitors and hosts.
- Provide direct financial benefits for conservation.
- Generate financial benefits for both local people and private industry.
- Deliver memorable interpretative experiences to visitors that help raise sensitivity to host countries' political, environmental, and social climates.
- Design, construct and operate low-impact facilities.
- Recognize the rights and spiritual beliefs of the Indigenous People in your community and work in partnership with them to create empowerment.

UNIT IV

ENVIRONMENT POLLUTION

Environmental pollution is the introduction of foreign and potentially harmful elements into the environment. The consequences are particularly important when they damage ecosystems and human societies, especially about health. Environmental pollution may be defined as unwanted material in the environment due to human activities. The agents that cause environmental pollution are called pollutants. It can be described as a chemical, biological, or physical substance unintentionally released into the environment which is directly or indirectly harmful to humans and other living organisms.

Types of Environmental Pollutants

Pollutants are classified based on varied criteria:

- Form of persistence after release into the environment
- Those that remain in the environment in the condition in which they were added are Primary pollutants: plastic DDT
- Secondary pollutants are formed as a result of interactions between primary pollutants. The exchange of hydrocarbons and nitrogen oxides, for example, produces peroxyacetyl nitrate (PAN)

Nature of existence

- Naturally occurring substances that become pollutants when their concentration exceeds a certain threshold are quantitative pollutants—for example, Nitrogen oxide and Carbon dioxide
- Qualitative Pollutants are artificial and do not exist in nature. Herbicides, Fungicides, DDT, and similar pesticides are examples
- Disposal nature
- Waste products that microbial action degrades are biodegradable pollutants—for instance, sewage
- Pollutants that do not decompose due to microbial action are non-biodegradable—glass, Plastics, Heavy metal salts, DDT, Toxic compounds, etc

Origin

Nature

Anthropogenic

TYPES OF ENVIRONMENTAL POLLUTION

Environmental pollution may be of the following types:

Air pollution

Noise pollution

Water pollution

Soil pollution

Thermal Pollution

Radiation pollution

Air Pollution

Air pollution is a type of environmental pollution that can be described as the composition of any gaseous, liquid, or solid substance in the atmosphere. It includes noise and radioactive radiation with concentrations harmful to humans, other living organisms, property, and plants. In addition, it also interferes with normal environmental processes. Air pollutants are of two types:

Suspended particulate matter

Gaseous pollutants like NO_x, CO_2, etc

Cause of Air pollution:

Fossil fuels

- A major contributor to air pollution is sulfur dioxide, emitted during the combustion of fossil fuels like coal and petroleum in power plants and various industrial processes.
- Vehicles, powered by gasoline and diesel engines, burn petroleum, releasing pollutants such as PM, nitric oxide, NO2 (collectively known as NOx), carbon monoxide, organic compounds, and lead.
- Despite being essential for daily transportation needs, the overuse of these vehicles poses a threat to the environment by introducing harmful gases into the atmosphere.

Agricultural activities

- Agricultural practices contribute to air pollution through the release of ammonia, a hazardous chemical byproduct.
- The use of insecticides, pesticides, and fertilizers in farming introduces harmful chemicals into the air and water.
- Stubble burning, a common agricultural practice to clear fields for new crops, is another source of air pollution, generating hazardous pollutants during the burning process.

Waste on Landfills

- Landfills, where waste is buried or deposited, produce methane—a potent greenhouse gas that is both highly combustible and dangerous.
- Additionally, improper disposal of electronic waste (e-waste) leads to chemical leakage and the burning of wires, further contributing to air pollution.

Industrial Dust and Waste

- Industrial activities release pollutants such as carbon monoxide, hydrocarbons, organic compounds, and various chemicals into the air, adversely affecting air quality.
- Petroleum refineries also emit hydrocarbons and other pollutants, impacting both air and soil quality.

Mining Operations

- The extraction of minerals through mining operations involves the release of dust and chemicals into the air, leading to significant air pollution.
- This not only affects air quality but also contributes to health issues among workers and residents in the vicinity.

Indoor Pollution

- Household cleaning products and painting supplies release hazardous chemicals into the air, contributing to indoor pollution.
- This poses health risks to inhabitants and underscores the importance of proper ventilation.

Natural Factors

- Certain natural phenomena, such as volcanoes, forest fires, and dust storms, can contribute to air pollution.
- While these occurrences are nature-driven, they release pollutants into the air, impacting environmental quality.

Classification of Air Pollutants

Based on Persistence:

Primary Pollutants:

- Definition: These pollutants persist in the environment in the same form as when initially introduced.
- Examples: DDT, plastic, carbon monoxide (CO), carbon dioxide (CO_2), oxides of nitrogen and sulphur, etc.

Secondary Pollutants:

- Definition: Formed through interactions among primary pollutants.
- Example: Peroxyacetyl nitrate (PAN) results from the interaction of nitrogen oxides and hydrocarbons.

Based on Existence in Nature:

Quantitative Pollutants:

- Definition: Naturally occurring substances become pollutants when their concentrations exceed a certain threshold.
- Examples: Carbon dioxide, nitrogen oxide.

Qualitative Pollutants:

- Definition: Human-made substances not naturally found in the environment.
- Examples: Fungicides, herbicides, DDT, etc.

WATER POLLUTION

Adding certain substances to water, such as inorganic, heat, biological, organic, and radiological substances that degrade the water's consistency and render it unfit for human consumption leads to water pollution. One of the most severe environmental issues is water pollution. Effects of water pollution can be seen all around us—human activities such as agricultural, industrial, and domestic activities that all contribute to water pollution. For example, agricultural runoff containing unnecessary pesticides and fertilisers, industrial effluents containing hazardous chemicals, and sewage water retaining animal and human waste pollute our water**.**

Soil erosion, mineral leaching from rocks, and organic matter degradation are all-natural causes of water contamination. In addition, point and nonpoint sources can pollute oceans, rivers, estuaries, lakes, and groundwater sources**.**

- Point source pollution occurs when pollutants are discharged from a particular location, such as a drainpipe containing industrial effluents discharged directly into a water body
- Nonpoint sources include waste discharged from diffuse sources or over a broader area, such as drainage from farm fields, pasture lands, building sites, abandoned mines and dumps, and roads and streets

Sources

Types of Sources

Point Sources

It is directly attributable to one influence. Here pollutants travel now from source to water. Point sources are easy to regulate.

Diffuse or Nonpoint Source

- It comes from a variety of ill-defined and hazy sources. They are difficult to monitor since they differ spatially and temporally. The following are the primary sources of water pollution:
- Community wastewater: Discharges from commercial, residential, and industrial facilities linked to the public sewerage system are included. In sewage, food residues, animal and human excreta, detergents, cleaning agents, and other wastes are all present.
- Industrial Wastes: Industries emit inorganic and organic contaminants that can be particularly harmful to living things.
- Agricultural sources: Fertilisers are rich in phosphorus, nitrogen, and potassium, essential plant nutrients. Excess fertilisers can leach into groundwater or mix with surface water in reservoirs, rivers, and ponds due to drainage and runoff.
- Fungicides, insecticides, herbicides, rodenticides, nematicides, and soil fumigants are examples of pesticides. Metallic salts, organophosphates, chlorinated hydrocarbons, carbonates, acetic acid derivatives, thiocarbonates, and other chemicals are contained. Many pesticides are non-biodegradable, and their residues will last for years.
- During the rainy season, animal excreta such as urine, dung, wastes from piggeries, poultry farms, slaughterhouses, and so on enter the water through runoff and surface leaching.
- Thermal Pollution: Thermal and nuclear power stations are the primary sources. Water is used as a coolant in the power plants, and the hot waters are returned to the source. Fish and other marine creatures die when the temperature increases abruptly
- Underground water pollution: Many people rely on groundwater for residential, drinking, agricultural, and commercial worldwide. Groundwater is widely recognised as a clean and healthy source of water. However, water pollution of

groundwater is caused by human activities such as farmyard dumping, manures, excessive waste disposal, agricultural chemicals, and industrial effluents. In many parts of India, groundwater pollution is a product of seepage from municipal wastes and industrial waste effluents, drainage channels, and agricultural runoff.

- Marine Pollution: Oceans are the most significant drain for all toxins, both natural and man-made. Pollutants are discharged into the sea by rivers. Coastal cities' sewage and trash are also pumped into the sea. Grease, navigational discharges of tar, sewage, detergents, underwater oil mining, hazardous wastes, and oil spills are other causes of ocean contamination

SOIL POLLUTION

In the list of environmental pollution, soil pollution is defined as the introduction of substances into the soil that harms the soil's chemical, biological and physical properties and its productivity.

Sources of Soil Pollution

- Plastic bags: Low-density polyethylene (LDPE) plastic bags are almost indestructible, posing substantial environmental risks. Plastic, being non-biodegradable, remains in the soil and keeps on releasing its toxins
- Industrial sources: chemical residues fly ash, metallic and nuclear wastes. Many dyes, synthetic chemicals, acids, and other harmful substances find their way into the soil
- Agricultural sources: The soil is polluted by agricultural chemicals, particularly Fertilisers and pesticides. Excessive use of chemical fertilizers decreases the population of soil-borne species and the crumb structure of the soil, as well as its fertility and salt content.
- Radioactive wastes: Nuclear power plants and mining release radioactive elements into the water, entering the soil
- Other pollutants: Many air contaminants and water pollutants end up in the soil, and certain harmful chemicals are released into the ground during the weathering of some rocks

NOISE POLLUTION

Noise is described as "any unwanted sound by the recipient." It is simply sound without value. It is an unpleasant noise created by people or machines that can be annoying, distracting, intrusive, and physically painful. This type of environmental pollution is caused by home appliances, traffic on roads, transportation, etc.

Sources of Noise Pollution

Engines, radio, electric fans, television, air conditioners, various home appliances, air coolers, and family disputes are all indoor noise sources. In addition, because of the higher concentration of factories, residents, and activities such as noise pollution, transportation is more prevalent in cities

Outdoor sources of noise pollution include indiscriminate use of loudspeakers, industrial activities, automobiles, rail traffic, aeroplanes, and activities such as those at the marketplace, religious, social, and cultural functions, sports, and political rallies. In rural areas, farm machines and pump sets are the primary sources of noise pollution. In addition, during festivals, marriage, and many other occasions, firecrackers contribute to noise pollution

THERMAL POLLUTION

The fall or rise in temperature of a natural aquatic environment caused by anthropogenic influence is thermal pollution.

Major Sources:

- Power plants: By dumping hot water from factories and power plants
- Deforestation of the shoreline: Removing trees and vegetation that shade streams, permitting sunlight to raise the temperature of these waters
- Water as a cooling agent: Release cold water, which lowers the temperature

Radiation Pollution

Radiation is an energy form that passes through space. Radioactive pollution is defined as the increase in the natural radiation levels caused by human activities. It is estimated that about 20% of the radiation we are exposed to is due to human activities. Radiation from the decay of radioactive nuclides is one of the most important causes of radiation emissions.

Radiations can be categorised into two groups

Non-ionising radiations: There are short-wave radiations, such as ultraviolet rays, emitted by the sun. They have a low penetrating ability and affect the cells and molecules they absorb

Ionising radiations: X-rays, gamma rays, and atomic radiations are examples of ionising radiations (radiations by radioactive elements). These have a high penetration power and cause macromolecules to break apart

Types of radiation particles

- A sheet of paper and human skin can also block alpha particles
- Beta particles can pass through the skin but are stopped by glass and metal
- Gamma rays can quickly penetrate human skin, killing cells along the way, and can only be prevented by a thick, solid, massive piece of concrete

Natural

Cosmic rays from space and terrestrial radiations from radionuclides found in the earth's crust, such as uranium-238, radium-224, potassium-40, thorium-232, carbon-14, etc.

Man-made

These include nuclear power plants (nuclear reactor accident at Chernobyl in 1986), nuclear weapons (atomic explosions in Nagasaki and Hiroshima), atomic material transportation, nuclear waste disposal, uranium mining, and radiation therapy.

NUCLEAR HAZARDS AND HUMAN HEALTH RISKS

Radiations are the waves of energy that travel and spread all around our environment. These radiations are useful as well harmful for us. Examples include visible light, radio waves, microwaves, infrared and ultraviolet lights, X-rays and gamma-rays, etc. The differences between these various types of radiation consist of some physical properties such as energy, frequency, and wavelength.

Radiation pollution refers to the increase in the natural radiation levels in our surroundings due to human activities. It is said that in today's world, about 20% of the radiation we are exposed to is due to human activities. The human activities that may release radiation involve activities with radioactive materials such as,

- Mining
- Handling and processing of radioactive materials
- Handling and storage of radioactive storage
- Use of radioactive reactions to generate energy (nuclear power plant)
- Use of radiation in medicine (e.g. X-rays) and research

Microwaves, cell phones, radio transmitters, wireless devices, computers, and other common commodities of today's life are also the sources of various types of radiation.

Radioactive radiation is, however, the most harmful radiation. Radio substances are present in nature. They undergo natural radioactive decay in which unistopes spontaneously give out fast-moving particles, high energy radiations, or both, at a fixed

rate until a new stable isotope is formed. The isotopes release energy either in the form of gamma rays or ionization particles i.e. alpha particles and beta particles.

The alpha particles are fast moving positively charged particles whereas beta particles are high speed negatively charged electrons. These ionization radiations have variable penetration power. Alpha particles can be interrupted by a sheet of paper while beta particles can be blocked by a piece of wood or a few millimetres of aluminium sheet. The gamma rays can pass through paper and wood but can be stopped by concrete wall, lead slabs or water.

Sources of Radioactivity

Various sources of radioactivity can be grouped into two broad categories.

i) Natural sources: Sources of natural radioactivity include cosmic rays from outer space, radioactive radon-222, soil, rocks, air, water, and food, which contain one or more radioactive substances.

ii) Anthropogenic sources: These sources are nuclear power plants, nuclear accidents, X-rays, diagnostic kits, test laborations etc. where radioactive substances are used.

Effects of Radiations:

- Genetic damage is caused by radiations, which induce mutations in the DNA, thereby affecting genes and chromosomes. The damage is often seen in the offspring's and may be transmitted up to several generations.
- Somatic damage includes burns, miscarriages, eye cataracts and cancer of bone, thyroid, breast lungs, and skin. Many scientists are of the view that due to body's ability to repair some of the damages, the adverse effects of radiation are observed beyond a threshold level. However, the other group believes that even a small dose of radiation over a period of time may cause adverse effects. They believe that the permissible limits of ionizing radiations should be further reduced.
- Damage caused by different types of radiations depends on the penetration power and the presence of the sources inside or outside the body. Alpha particles lack penetration power but they have more energy than beta. They will be, therefore, dangerous when they enter the body by inhalation or through food.
- Alpha particles cannot penetrate the skin to reach internal organs whereas beta particles can damage the internal organs.

- A greater threat is posed by radioisotopes with intermediate half-lives as they have a long time to find entry inside the human body.
- Radioisotopes enter the environment during the mining of uranium. The radioactivity in the earth's crust enters the crops grown there and ultimately reaches human beings.
- Radionuclides enter the water bodies or the groundwater coming in contact with the contaminated soil or rock.
- Eg. Radioactive Iodine (I131) accumulates in thyroid gland and causes cancer. Similarly, Strontinum-90 accumulates in the bones and causes leukemia or cancer of the bone marrow.

Control of Radiation:

- Siting of nuclear power plants should be carefully done after studying long-term and short-term effects.
- Proper disposal of wastes from the laboratory involving the use of radioisotopes should be done.
- Workers in nuclear plants should be provided with nuclear reactors, laboratories, transport, and careless handling and use of radioactive fuels should be checked.
- Level of radiation pollution should be monitored regularly in risk areas.
- Disposal of radioactive wastes should be done with special attention.

SOLID WASTE MANAGEMENT:

The term solid waste management mainly refers to the complete process of collecting, treating and disposing of solid wastes. Waste management process, the wastes are collected from different sources and are disposed of. This process includes collection, transportation, treatment, analysis and disposal of waste. It needs to be monitored so that strict regulations and guidelines are followed.

Sources of Solid Wastes

Solid domestic garbage

Solid waste material from various industries

Solid agricultural waste

Plastics, glass, metals, e-waste, etc.

Medical waste

Construction waste, sewage sludge

Disposal of Waste

The process of waste handling and disposal varies in different countries. In India, the processes differ according to the source of solid waste. They can be classified as:

Municipal Solid Waste

Hazardous Solid Waste

Municipal solid waste can further be divided into biodegradable, recyclable and hazardous domestic wastes. The biodegradable waste includes rotten food, vegetable peel and mostly wet kitchen waste. Recyclable waste includes plastic and hazardous wastes include, bulb, batteries, etc. The industry generated waste from chemical factories, medical waste from hospitals are considered as Hazardous Solid Waste and they need special settings to dispose of them. In any region, solid waste management is very important for the safe disposal of wastes and to reduce environmental pollution and avoid any health hazards that it may cause. Landfills are the most common method of disposing of solid wastes.

Effects of Poor Solid Waste Management

Due to improper disposal of solid waste particularly by waste management organizations, the collected wastes gets heap up and become a problem for both the environment and also for the public. By dumping of huge garbage, drives biodegradable materials to decay and decompose under abnormal, uncontrolled and unhygienic conditions. After a few days of decomposition, it becomes a breeding ground for different types of disease-causing insects as well as infectious organisms. A foul smell is produced and it also spoils the aesthetic value of the area. The solid wastes collected from different industries include toxic metals, chemicals, and other hazardous wastes. When these wastes are released into the environment, they can produce biological and physicochemical problems to the environment, the chemicals may drain into the soil and pollute the groundwater and also alter the productivity of the soils in that particular area.

In rare cases, the hazardous wastes may get mixed up with the ordinary garbage and other combustible wastes causing the disposal process even harder and risky. By burning the paper and other scraps along with the hazardous wastes, dioxins and poisonous gasses are produced and released into the air which results in causing various diseases including chronic disease, skin infections, cancer, etc.

CLIMATE CHANGE

Climate change refers to enduring alterations in temperature and weather conditions over an extended period. These shifts in weather patterns can stem from natural phenomena like variations in the solar cycle or result from human activities. Since the 1800s, human-induced factors, particularly the utilization of fossil fuels like coal, oil, and gas, have been the primary contributors to climate change. Since the 1800s, human-induced factors, particularly the utilization of fossil fuels like coal, oil, and gas, have been the primary contributors to climate change. The combustion of fossil fuels releases greenhouse gas emissions, creating a metaphorical blanket around the Earth. This "blanket" traps solar heat, leading to a gradual increase in temperatures.

Greenhouse gas emissions, including carbon dioxide and methane, are notably generated through activities such as driving cars that use gasoline or heating buildings with coal. Additionally, clearing land and forests can release carbon dioxide, while garbage landfills are significant sources of methane emissions. The major contributors to greenhouse gas emissions encompass energy production, industrial activities, transportation, buildings, agriculture, and land use.

Climate change has evolved beyond higher temperatures; it is now causing far-reaching consequences such as severe droughts, water scarcity, intense fires, rising sea levels, widespread flooding, polar ice melting, destructive storms, and diminishing biodiversity.

This multifaceted phenomenon underscores the complex interactions within Earth's systems, emphasizing the urgent need for comprehensive mitigation and adaptation strategies.

Factors Contributing to Climate Change Natural Factors:

Continental Drift:

The gradual movement of landmasses due to plate displacement, occurring over millions of years. Influences climate through changes in physical features, landmass position, ocean currents, and winds. Ongoing drift, exemplified by the rising Himalayan range.

Variation of Earth's Orbit:

Earth's orbit fluctuations affecting seasonal sunlight distribution over thousands of years. Three types of orbital variations: eccentricity, tilt angle changes, and precession, collectively causing Milankovitch cycles. Milankovitch cycles linked to glacial and interglacial periods.

Plate Tectonics:

Adjustments in Earth's plates due to temperature changes in the core. Influences global and local climate patterns and atmospheric conditions. Examples include the Isthmus of Panama's formation, impacting ocean circulation.

Volcanic Activity:

Eruptions release gases and dust, temporarily blocking sunlight and cooling the climate. Lasting effects from emitted gases and ashes contribute to long-term climate influence. Sulphur oxide emissions lead to the formation of persistent sulphuric acid droplets.

Ocean Currents:

Crucial component of the climate system, driven by horizontal winds. Temperature differences in water influencing regional climate. Plays a significant role in controlling global heat and moisture transfer.

Anthropogenic Factors:

Greenhouse Gases:

Human-induced increase in greenhouse gas emissions since the Industrial Revolution. Carbon dioxide concentration up by 30%, mainly from fossil fuel use and deforestation. Greenhouse gases trap infrared radiation, leading to global temperature rise.

Change in Land Use:

Industrial-era land-use changes, with deforestation replacing forests with agriculture. Albedo changes due to deforestation impact planetary surface temperatures. Tropical deforestation affects evapotranspiration rates, leading to desertification.

Atmospheric Aerosols:

Aerosols scatter and absorb solar and infrared radiation, impacting climate. Natural sources include volcanic eruptions and biogenic sources. Anthropogenic aerosols from industrial activities, burning of biomass, and vehicle emissions.

Impacts of Climate change:

Higher Temperatures:

Global surface temperatures rise due to increased greenhouse gas concentrations. Each decade since the 1980s has been warmer, with 2011-2020 recorded as the warmest. Elevated temperatures contribute to heat-related illnesses, intensify heat waves, and accelerate wildfires. The Arctic warms at least twice as fast as the global average.

Severe Storms:

Destructive storms become more frequent and intense, driven by rising temperatures. Increased moisture leads to extreme rainfall, flooding, and intensified storms. Warming

oceans influence cyclone, hurricane, and typhoon frequency and size. Resulting storms cause fatalities, economic losses, and community destruction.

Increased Drought:

Climate change alters water availability, exacerbating water scarcity in many regions. Water-stressed areas face heightened risks of agricultural and ecological droughts. Droughts lead to sand and dust storms, affecting ecosystems and reducing available farmland. Desertification expands, posing a threat to water availability for communities.

Oceans Warming and Rising:

Oceans absorb emitted heat, causing increased warming and rising sea levels. Melting ice sheets contribute to rising sea levels, endangering coastal communities. Carbon dioxide absorption leads to ocean acidification, harming marine life and coral reefs. Oceans play a crucial role in regulating Earth's climate.

Changes in the Landscape:

Landscape changes contribute to shifts in landmass positioning and affect flora and fauna. Polar habitats are threatened by melting ice due to global warming. Alterations in land mass and habitat threaten various species, disrupting ecosystems.

Rise in the Level of Sea:

Global warming causes glacier melting, contributing to the rise in sea levels. Coastal areas face increased risks of floods and natural disasters. Coastal ecosystems and wetlands are eroded, impacting biodiversity.

Ocean Acidification:

Increased atmospheric carbon dioxide leads to ocean absorption, causing acidification. Aquatic species like planktons, mollusks, and corals lose their habitats. Disruption in marine ecosystems affects biodiversity and fisheries.

Imbalance in the Ecosystem:

Weather pattern changes disrupt local environments, threatening indigenous species. Ecosystems face devastation, impacting biodiversity and natural habitats. Shifts in climate conditions challenge the survival of numerous species.

Natural Disasters:

Climate change contributes to droughts, floods, hurricanes, and storms worldwide. Altered rainfall patterns and increased solar radiation affect local species. Forest fires, extreme weather, and invasive pests pose threats to ecosystems. Species face challenges in adapting, leading to potential extinctions.

Species Extinction:

Rising temperatures increase the risk of species extinction. Climate change intensifies species loss, surpassing historical rates. Forest fires, extreme weather, and diseases contribute to the threat. One million species are at risk of extinction in the coming decades.

Not Enough Food:

Global hunger and malnutrition increase due to climate change and extreme weather events. Fisheries, crops, and livestock face destruction, impacting billions. Ocean acidification threatens marine resources crucial for human sustenance. Changes in snow and ice cover disrupt food supplies in Arctic regions.

More Health Risks:

Climate change emerges as a severe health threat, causing air pollution, diseases, and extreme weather events. Environmental factors claim approximately 13 million lives annually. Changing weather patterns spread diseases, impacting mental health and well-being.

Poverty and Displacement:

Climate change amplifies poverty factors, leading to displacement and increased vulnerability. Floods destroy urban slums, displacing populations and eroding livelihoods. Outdoor work becomes challenging in extreme heat conditions. Weather-related events displace millions annually, making them susceptible to poverty.

Strategies to mitigate climate change:

Carbon Sequestration

Carbon capture and storage, commonly known as CCS or carbon sequestration, involves technologies designed to combat global warming. These methods capture CO_2 at power plants, industrial sites, or directly from the air, storing it underground indefinitely. Carbon sequestration refers to the long-term storage of carbon dioxide or other carbon forms to reduce or delay global warming. It's proposed as a method to slow the accumulation of greenhouse gases from fossil fuel combustion in the atmosphere and oceans.

Carbon Sink

A carbon sink is a natural or man-made reservoir accumulating and storing carbon-containing compounds for an indefinite period, reducing CO_2 concentrations in the atmosphere. The two primary global carbon sinks are vegetation and the ocean. "Blue carbon" refers to carbon fixed by ocean ecosystems, including mangroves and seagrasses.

Since the Kyoto Protocol, which promotes CO_2 sinks as carbon offsets, public awareness of their importance has grown. Efforts to enhance natural sequestration in soils and oceans, along with artificial initiatives like carbon capture and storage, are ongoing.

Carbon Credit

A carbon credit permits the emission of a specific amount of CO_2 or greenhouse gases. Under a "cap-and-trade" program, polluters are given credits, allowing emissions up to a set limit. This limit decreases regularly, encouraging companies to reduce emissions. Unsold credits can be sold to other companies. Carbon credits incentivize emission reduction and offer economic benefits.

Carbon Offsetting

Carbon offsetting is a quick way for businesses to achieve emission reductions, often bringing additional benefits like job opportunities and community development at project sites. Credible offsets must meet quality criteria, ensuring additionality, retirement from the carbon market to avoid double counting, and addressing permanence and leakage issues.

Carbon Tax

Carbon Tax is a pollution tax imposing fees on fossil fuel production, distribution, and use based on emitted carbon. It is an alternative to the 'cap and trade' method. This tax aims to reduce fossil fuel usage, providing incentives for alternative energy. Phased implementation starts with a low amount, gradually increasing to promote industry and technology development.

Geo-Engineering

Geoengineering, a form of climate engineering, seeks to modify the Earth's climate. The goal is to mitigate environmental damage, make the planet more habitable, and address climate change effects. Proposals include space-based solutions like parasols and mirrors, stratosphere whitening with aerosols, whitewashing roofs, and ocean iron filings to promote carbon-consuming algae.

Measures to mitigate climate change:

- Improving Energy Efficiency and Conservation:
- Implementing energy-efficient technologies and practices.
- Establishment of a Bureau of Energy Efficiency to monitor and enhance energy conservation initiatives.
- Reforms to the Power Sector:

- Adopting cleaner and more sustainable power generation methods.
- Modernizing power infrastructure for increased efficiency and reduced emissions.
- Promoting Hydro and Renewable Energy:
- Encouraging the development and utilization of hydroelectric power.
- Promoting renewable energy sources like solar, wind, and geothermal for cleaner power generation.
- Promotion of Clean Coal Technologies
- Investing in research and development for cleaner coal combustion.
- Coal Washing and Efficient Utilization:
- Implementing coal washing processes to reduce impurities and emissions.
- Implementing technologies to minimize the flaring of natural gas during oil extraction.
- Encouraging practices that capture and utilize flared gases.
- Cleaner, Less Carbon-Intensive Transportation Fuel:
- Promoting cleaner fuels such as biofuels and electric vehicles.
- Encouraging the use of fuel-efficient and low-emission transportation technologies.
- Encourage the Use of Mass Rapid Transit Systems:
- Developing and expanding mass rapid transit systems to reduce reliance on individual vehicles.

GLOBAL WARMING

Global warming, driven by increased greenhouse gases, intensifies climate change with rising temperatures, sea level, and extreme weather events. The Kyoto Protocol, established in 1997, advocated emission reduction commitments for industrialized nations. Control measures include renewable energy adoption, afforestation, and sustainable practices, promoting a collective effort to mitigate climate change.

The effects of global warming are diverse and impact the global climate system:

Many effects of global warming are diverse and impact the global climate system:

Rising temperatures: Global warming leads to higher average temperatures, affecting weather patterns, causing heat waves, and contributing to the melting of glaciers and polar ice caps.

Changes in precipitation: Global warming alters rainfall patterns, leading to more intense rainfall events in some regions and increased risk of droughts in others. This can have significant implications for agriculture, water availability, and ecosystems.

Sea-level rise: As global temperatures rise, glaciers and ice sheets melt, and the thermal expansion of seawater occurs. These factors contribute to rising sea levels, which can result in coastal erosion, increased flooding, and the loss of coastal habitats.

Extreme weather events: Global warming intensifies extreme weather events such as hurricanes, cyclones, and heavy rainfall events. These events can cause devastating impacts on human settlements, infrastructure, and ecosystems.

Shifts in ecosystems: Changes in temperature and precipitation patterns can lead to shifts in ecosystems, including alterations in plant and animal distribution, disruptions in migration patterns, and the potential loss of biodiversity.

Control measures to bring down the level of greenhouse gases which cause global warming with context to the Kyoto Protocol:

To address global warming and reduce the emission of greenhouse gases, the Kyoto Protocol was adopted in 1997 as an international agreement under the United Nations Framework Convention on Climate Change (UNFCCC). The key control measures established by the Kyoto Protocol include:

Binding emission reduction targets: The Kyoto Protocol sets binding emission reduction targets for developed countries (known as Annex I countries) during the commitment period (2008-2012). These targets aimed to collectively reduce greenhouse gas emissions by an average of 5.2% below 1990 levels.

Cap-and-trade system: The Kyoto Protocol introduced a cap-and-trade system called the Clean Development Mechanism (CDM). This mechanism allows developed countries to invest in emission reduction projects in developing countries and earn emission reduction credits, which can be used to meet their own reduction targets.

Promotion of renewable energy and energy efficiency: The Kyoto Protocol encourages the adoption of renewable energy sources and energy-efficient technologies to reduce greenhouse gas emissions. It promotes sustainable development practices and the transfer of clean technologies to developing countries.

Carbon sinks and sequestration: The Kyoto Protocol recognizes the role of carbon sinks, such as forests and land-use practices, in absorbing carbon dioxide from the atmosphere. It provides provisions for countries to account for emissions and removals associated with these sinks.

Compliance mechanisms: The Kyoto Protocol establishes compliance mechanisms to ensure that countries meet their emission reduction targets. This includes regular reporting, review processes, and financial penalties for non-compliance.

OZONE LAYER DEPLETION:

Ozone-depleting substances (ODS) are compounds that significantly damage the Earth's ozone layer, a vital component of the stratosphere responsible for shielding life on the planet from harmful ultraviolet (UV) radiation. These substances, predominantly human-made, have been widely used in various industrial and consumer applications, including refrigeration, air conditioning, insulation, and aerosol propellants. ODS typically contain chlorine or bromine atoms, which are released into the atmosphere upon their usage. Once in the atmosphere, these atoms can catalytically destroy ozone molecules, leading to the formation of the infamous ozone hole—a region of significantly depleted ozone concentrations, primarily observed over Antarctica. The discovery of ODS and their adverse effects on the ozone layer prompted international action, culminating in the landmark Montreal Protocol in 1987, which aimed to phase out the production and consumption of these harmful substances. Despite significant strides in ODS reduction, ongoing vigilance and global cooperation remain essential to safeguarding the ozone layer and mitigating the risks posed by ozone depletion to human health and the environment.

Ozone Layer

Ozone, a natural gas, represents an oxygen allotrope formed by three oxygen atoms intricately bound together. Designated as O_3, ozone exists in two atmospheric layers. In the troposphere, ozone is considered "bad" as it leads to air pollution and smog formation, adversely affecting respiratory health. Conversely, ozone in the stratosphere is deemed "good" because it acts as a protective shield against the sun's harmful Ultraviolet (UV) rays, crucial for Earth's life. The ozone layer holds significant importance due to the efficient ultraviolet light absorption facilitated by the ozone molecule's configuration and chemical properties, essentially acting as a natural sunscreen. This protective mechanism prevents the disruption of lower-altitude oxygen by ultraviolet light, simultaneously blocking a substantial portion of ultraviolet radiation from reaching the Earth's surface. This shielding effect contributes significantly to reducing the risks of mutation and harm to both plant and animal life. Excessive exposure to UV rays has the potential to induce skin cancer and harm various organisms. Therefore, the ozone layer serves as a crucial

protective barrier, safeguarding life on Earth from the detrimental effects of excessive ultraviolet radiation.

Ozone Depletion

The progressive reduction in thickness of the Earth's ozone layer in the upper atmosphere, brought about by the emission of chemical compounds containing chlorine or bromine from industrial or other human activities, is referred to as ozone layer depletion. Ozone-depleting substances with chlorine include chlorofluorocarbons, carbon tetrachloride, hydrochlorofluorocarbons, and methyl chloroform. Substances containing bromine that contribute to ozone depletion include halons, methyl bromide, and hydrobromofluorocarbons. In response to the alarming issue of ozone layer depletion, the Montreal Protocol was introduced in 1987. This international agreement aimed to prohibit the usage, production, and import of ozone-depleting substances. Its primary objective is to curtail the concentration of these harmful substances in the atmosphere, thereby safeguarding and preserving the Earth's ozone layer.

Sources of Ozone Depletion

Chlorofluorocarbons (CFCs):

- Chlorofluorocarbons, abbreviated as CFCs, consist of chlorine, fluorine, and carbon.
- Widely employed for various purposes, including refrigerants, aerosol propellants, foaming agents in plastic manufacturing, fire extinguishing agents, and solvents for cleaning electronic and metallic components, CFCs are extensively utilized.
- Approximately two-thirds of CFC usage involves refrigerants, while the remaining one-third is utilized as blowing agents in foam insulation products.
- Their versatility arises from properties such as non-corrosiveness, non-inflammability, low toxicity, and chemical stability.
- Unlike some other chemicals, CFCs cannot be removed from the atmosphere through conventional processes like photodissociation, rain-out, and oxidation.

Nitrogen Oxides:

- Nitrogen oxides are primarily generated through thermonuclear weapon explosions, industrial emissions, and the use of agricultural fertilizers.
- Nitrous oxide (N2O) results from anaerobic denitrification of nitrates and aerobic nitrification of ammonia in solids.
- Gradually reaching the stratosphere's middle layer, N2O undergoes photolytic destruction to produce nitric oxide, contributing to ozone depletion.

Other Substances:

- Halons and HBFCs: Hydrobromo fluorocarbons, containing bromine and used in fire extinguishers, and methyl bromide, a widely used pesticide, contribute to ozone depletion.
- Bromine reacts with ozone to produce bromine monoxide (BrO) and oxygen (O2), initiating a series of reactions that lead to ozone destruction.
- Particles of Sulphuric Acid: These particles release chlorine from molecular reservoirs and convert reactive nitrogen to inert forms, preventing the formation of chlorine reservoirs.
- Carbon Tetrachloride: An inexpensive and highly toxic solvent.
- Methyl Chloroform: Used as a cleaning solvent and propellant in various consumer products.

Role of Polar Stratospheric Clouds in Ozone Depletion:

- ✓ Polar stratospheric clouds (PSCs) play crucial roles in stratospheric ozone depletion, particularly in high latitudes during winter and spring, contributing to phenomena like the Antarctic ozone hole.
- ✓ These clouds act as sites for heterogeneous reactions, converting stable chlorine reservoir species into radicals that catalytically destroy ozone.
- ✓ The depletion of the ozone layer is influenced by strong polar fronts, the presence of polar stratospheric clouds, and the release of chlorofluorocarbons.
- ✓ Initially considered insignificant, Type I PSCs are now recognized as sites of harmful ozone destruction over Antarctica and the Arctic.
- ✓ These clouds' surfaces serve as catalysts, converting less reactive forms of man-made chlorine into active free radicals (e.g., ClO, chlorine monoxide).
- ✓ In a series of chain reactions, these radicals contribute to the destruction of ozone molecules as spring sunlight returns.

Additionally, cloud formation has a dual impact by removing gaseous nitric acid from the stratosphere, preventing its combination with ClO to form less reactive chlorine forms.

Environment effect of ozone depletion:

Effects on Human and Animal Health: Potential risks associated with increased ultraviolet (UV) radiation include a rise in the incidence and severity of eye diseases, skin cancer, and infectious diseases. Experimental evidence indicates damage to the cornea and lens of the eye due to UV radiation. UV-B radiations pose a significant risk for the

development of non-melanoma skin cancer (NMSC), particularly in susceptible populations with lighter skin.

Effects on Terrestrial Plants: UV-B radiation influences the physiological and developmental processes of plants. Indirect effects, such as changes in plant form, biomass distribution, timing of developmental phases, and secondary metabolism, may be as crucial as, or even more critical than, the direct damaging effects of UV-B.

Effects on Aquatic Ecosystems: Solar UV-B radiation impacts the orientation mechanisms and motility of phytoplankton, resulting in reduced survival rates. Additionally, developmental damage has been observed in various aquatic organisms, including fish, shrimp, crab, and amphibians.

Effects on Bio-geochemical Cycles: Increased UVB radiation can influence terrestrial and aquatic biogeochemical cycles, altering the sources and sinks of greenhouse gases and chemically important trace gases like carbon dioxide, carbon monoxide, carbonyl sulfide, ozone, and potentially other gases.

Effects on Air Quality: Diminished stratospheric ozone and heightened UV-B radiation penetrating the lower atmosphere lead to increased photodissociation rates of key trace gases, impacting the chemical reactivity of the troposphere. This alteration can intensify the production and destruction of ozone (O3) and related oxidants like hydrogen peroxide (H_2O_2), known for their harmful effects on human health, terrestrial plants, and outdoor materials.

Effects on Materials: Solar UV radiation negatively affects synthetic polymers, naturally occurring bio-polymers, and other commercially important materials. Any elevation in solar UV-B content due to partial ozone depletion accelerates the photodegradation rates of these materials, thereby limiting their outdoor lifespan.

ACID RAIN

Acid rain is precipitation that has unusually high levels of hydrogen ions (low pH). The water droplets are acidic because of atmospheric pollution. It is known to have harmful effects on aquatic animals, plants and infrastructure. The term “acid rain” was coined in 1872 by Robert Angus Smith.

Acid rain refers to precipitation, such as rain, snow, or fog, containing elevated levels of acidic compounds, primarily sulfuric acid (H_2SO_4) and nitric acid (HNO_3). This environmental challenge arises when these acidic pollutants interact with water vapor in the atmosphere

Acid Rain: With a typical pH range of 4-5, acid rain negatively impacts aquatic life, plants, freshwater, and structures. It manifests in two forms:

- **Wet Deposition:** Acid combines with water, leading to wet forms like acid rain, sleet, snow, and fog.
- **Dry Deposition:** Involving dust and gases, it results in dry forms settling on surfaces like vehicles, buildings, and trees.

Causes of Acid Rain:

- **Fossil Fuel Combustion:** Burning coal, oil, and natural gas in power plants, industries, and vehicles releases sulfur dioxide and nitrogen oxides.
- **Industrial Processes:** Manufacturing, chemical production, and metal smelting contribute pollutants to the atmosphere.
- **Transportation:** Vehicle emissions, especially from diesel engines, significantly contribute to nitrogen oxide emissions.
- **Agriculture:** The use of nitrogen-based fertilizers releases nitrogen oxides into the air.
- **Natural Sources:** While human activities are primary contributors, natural sources like volcanoes can release sulfur dioxide.

Consequences of Acid Rain:

- **Effects on Humans:** Acid rain pollutants generate harmful PM2.5, reducing visibility and causing respiratory and skin irritation, leading to health issues.
- **Effects on Soil:** Acid rain depletes soil nutrients, impacting fertility, particularly in regions with strong buffering capacity like alkaline soils in India.
- **Effects on Aquatic Life:** pH changes harm fish, frogs, and aquatic organisms, affecting reproductive cycles, ecosystem productivity, and microbial populations in acidic lakes.
- **Effects on Buildings and Monuments:** Acid rain damages historical structures and artworks, dissolving limestone and marble. Iconic landmarks like the Taj Mahal suffer from acid rain-related deterioration known as “Marble Cancer.”

UNIT-V

SOCIAL ISSUES AND THE ENVIRONMENT SUSTAINABLE DEVELOPMENT

Definition: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It balances economic growth, environmental protection, and social equity.

Economic Growth: Promotes economic opportunities and improves living standards while ensuring that growth does not deplete natural resources.

Environmental Protection: Focuses on conserving natural resources, reducing pollution, and protecting ecosystems to ensure long-term ecological balance.

Social Equity: Ensures that development benefits are distributed fairly, reducing inequalities and improving the quality of life for all, particularly marginalized communities.

Sustainable Development Goals

N**o Poverty**

- End poverty in all its forms everywhere.
- Eradicating extreme poverty, reducing inequality, and ensuring basic needs are met for all individuals.

Zero Hunger

- End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
- Ensuring all people have sufficient, nutritious food and supporting sustainable agricultural practices.

Good Health and Well-being

- Ensure healthy lives and promote well-being for all at all ages.
- Reducing maternal and child mortality, combating diseases, and improving health services and mental health support.

Quality Education

- Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- Providing access to quality education and vocational training, and improving educational infrastructure.

Gender Equality

- Achieve gender equality and empower all women and girls.
- Eliminating gender discrimination, violence, and ensuring equal opportunities and representation.

Clean Water and Sanitation

- Ensure availability and sustainable management of water and sanitation for all.
- Improving water quality, sanitation facilities, and water resource management.

Affordable and Clean Energy

- Ensure access to affordable, reliable, sustainable, and modern energy for all.
- Expanding access to clean energy sources and increasing energy efficiency.

Decent Work and Economic Growth

- Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.
- Enhancing economic growth, improving working conditions, and reducing unemployment.

Industry, Innovation, and Infrastructure

- Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
- Developing infrastructure, supporting industrial growth, and encouraging innovation and technology.

Reduced Inequalities

- Reduce inequality within and among countries.
- Addressing disparities in income and opportunities and promoting equitable social and economic policies.

Sustainable Communities

- Make cities and human settlements inclusive, safe, resilient, and sustainable.
- Improving urban planning, reducing environmental impact, and ensuring access to safe and affordable housing.

Responsible Consumption and Production

- Ensure sustainable consumption and production patterns.
- Reducing waste, promoting resource efficiency, and encouraging sustainable practices across industries.

Climate Action

- Take urgent action to combat climate change and its impacts.
- **Focus:** Reducing greenhouse gas emissions, enhancing climate resilience, and promoting climate adaptation measures.

Life Below Water

- Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
- Reducing marine pollution, protecting marine ecosystems, and promoting sustainable fishing practices.

Life on Land

- Protect, restore, and promote sustainable use of terrestrial ecosystems, manage forests sustainably, combat desertification, and halt and reverse land degradation and biodiversity loss.
- Preserving ecosystems, managing forests, combating desertification, and protecting biodiversity.

Peace, Justice, and Strong Institutions

- Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.
- Strengthening institutions, promoting rule of law, and fostering peaceful societies.

Partnerships for the Goals

- Strengthen the means of implementation and revitalize the global partnership for sustainable development.
- Enhancing global cooperation, mobilizing resources, and fostering partnerships to achieve the SDGs.

WATER CONSERVATION

Water conservation involves strategies and practices to manage and use water resources efficiently, ensuring that water is available for future generations while minimizing waste and environmental impact. Here's a summary of key aspects of water conservation:

Importance of Water Conservation

- **Resource Scarcity:**
    - Freshwater is a limited resource, and many regions face water shortages due to overuse and environmental factors.
    - Population growth and industrial activities increase the demand for water, exacerbating scarcity.

- **Environmental Impact:**
    - **Ecosystem Health:** Conserving water helps maintain natural habitats and ecosystems, which rely on balanced water availability.
    - **Pollution Control:** Reducing water usage limits the volume of wastewater and pollutants that need to be treated.
- **Economic Benefits:**
    - **Cost Savings:** Efficient water use reduces water bills and the costs associated with water treatment and infrastructure maintenance.
    - **Sustainable Agriculture:** Water conservation supports sustainable farming practices, improving crop yields and reducing costs.

Resettlement and Rehabilitation of People

Resettlement: The process of relocating people from their original place of residence to a new area. This often occurs due to development projects, natural disasters, or conflict.

Rehabilitation: The process of restoring or improving the well-being of displaced individuals or communities, including their social, economic, and psychological recovery.

Planning and Assessment:

- Identify the needs of displaced populations, including housing, livelihoods, and social services.
- Assess potential new locations and ensure they can support the resettled population.

Community Engagement:

- Involve affected communities in the planning and decision-making processes to ensure their needs and preferences are considered.
- Engage with local stakeholders and address concerns regarding resettlement impacts.

Implementation:

- **Relocation:** Provide logistical support for moving to new locations, including transport and temporary housing.
- **Infrastructure Development:** Build or upgrade necessary infrastructure such as housing, schools, and healthcare facilities in the new location.

Rehabilitation Support:

- Facilitate access to employment opportunities, vocational training, and economic support to restore livelihoods.
- Provide services to support social integration, including community-building activities and psychological support.
- Ensure access to legal rights, property titles, and administrative services for the resettled individuals.

DISASTER

Disaster Management: The process of preparing for, responding to, recovering from, and mitigating the impacts of natural and man-made disasters to reduce their effects on people and property.

Phases of Disaster Management

- **1. Mitigation:**
  - Reduce the severity and impact of disasters through proactive measures.
  - Implementing building codes, land-use planning, environmental protection, and public awareness programs.
- **2. Preparedness:**
  - Ensure readiness to respond effectively to disasters.
  - Developing emergency plans, conducting drills and training, setting up early warning systems, and stockpiling essential supplies.
- **3. Response:**
  - Provide immediate assistance to affected populations and manage the crisis.
  - Mobilizing emergency services, providing medical care, distributing relief supplies, and coordinating with local and national agencies.
- **4. Recovery:**
  - Restore affected communities to normalcy and improve resilience.
  - Rebuilding infrastructure, providing financial and emotional support, and evaluating recovery efforts to enhance future preparedness.
- **5. Prevention:**
  - Avoid or minimize the potential for disasters to occur.
  - Implementing policies and practices to address underlying risks, such as improving urban planning and environmental management

FLOODS

Definition and Types of Floods

Floods occur when water overflows onto normally dry land. They can be caused by various factors and can be classified into several types:

- **Flash Floods:** Sudden and intense floods caused by heavy rainfall over a short period, often leading to rapid and dangerous increases in water levels.
- **River Floods:** Occur when rivers overflow their banks due to prolonged rainfall or snowmelt, often affecting larger areas.
- **Coastal Floods:** Result from storm surges, high tides, or tsunamis impacting coastal regions.
- **Urban Floods:** Caused by inadequate drainage systems in cities, leading to water accumulation and flooding.

Causes of Floods

- **Heavy Rainfall:** Intense or prolonged rainfall can overwhelm rivers, streams, and drainage systems.
- **Snowmelt:** Rapid melting of snow and ice in mountainous regions can increase river flow and cause flooding downstream.
- **Storm Surges:** High winds and low pressure from storms can push seawater onto land, causing coastal flooding.
- **Dam or Levee Failure:** Structural failures can lead to sudden and severe flooding downstream.

Flood Prevention and Mitigation Measures

- **Infrastructure Improvements:** Construct and maintain levees, dams, and flood walls to protect against floodwaters.
- **Drainage Systems:** Improve urban drainage systems to efficiently manage stormwater and prevent urban flooding.
- **Floodplain Restoration:** Restore wetlands and natural floodplains to enhance their capacity to absorb and mitigate floodwaters.

EARTH QUAKE

Earthquake: A sudden release of energy in the Earth's crust that creates seismic waves, causing the ground to shake. This release of energy is typically caused by:

- **Tectonic Plate Movements:** Most earthquakes occur along tectonic plate boundaries due to the movement and interaction of Earth's plates.
- **Fault Lines:** Fractures in the Earth's crust where blocks of rock have moved relative to each other. Stress builds up along these faults until it is released as an earthquake.
- **Volcanic Activity:** Earthquakes can also occur in volcanic regions due to magma movement and volcanic activity.

Impacts and Effects

- **Structural Damage:** Earthquakes can cause significant damage to buildings, bridges, roads, and infrastructure. The extent of damage depends on the earthquake's magnitude, depth, and the construction quality.
- **Ground Shaking:** The shaking of the ground can lead to landslides, ground ruptures, and soil liquefaction (where saturated soil loses its strength).
- **Casualties and Injuries:** Earthquakes can result in loss of life and injuries due to building collapses, falling debris, and other hazards.
- **Economic Disruption:** The aftermath of an earthquake can disrupt local economies, requiring extensive repair and recovery efforts.

ENVIRONMENTAL PROTECTION ACT 1986

. Purpose and Objectives

- The Environmental Protection Act (EPA) is designed to provide a framework for protecting and improving the environment. It aims to ensure a healthy environment for current and future generations through comprehensive legislation.
- Key goals include preventing pollution, managing natural resources sustainably, and enforcing environmental regulations to safeguard ecosystems and public health.

Key Provisions

- **Pollution Control:** Establishes standards and regulations to control pollution of air, water, and soil. This includes setting limits on emissions and discharges from industrial processes and vehicles.
- **Waste Management:** Provides guidelines for the handling, treatment, and disposal of solid and hazardous waste to minimize environmental contamination and health risks.

- **Environmental Impact Assessments (EIAs):** Requires projects and developments to undergo EIAs to assess potential environmental impacts and ensure that mitigation measures are in place.
- **Enforcement and Compliance:** Authorizes regulatory agencies to enforce environmental laws, conduct inspections, and impose penalties for violations. It also establishes mechanisms for reporting and addressing non-compliance.

CLEAN WATER ACT (CWA)

- The Clean Water Act (CWA) aims to restore and maintain the integrity of the nation's waters by preventing point and nonpoint source pollution, providing for water quality standards, and protecting aquatic ecosystems.
- **Key Provisions:**
    - **Regulation of Discharges:** Requires permits for the discharge of pollutants into waters, setting limits on the types and amounts of pollutants that can be released.
    - **Water Quality Standards:** Establishes standards for water quality to protect aquatic life, human health, and recreational uses.
    - **Wetlands Protection:** Provides provisions for the protection and restoration of wetlands and other vital water resources.

CLEAN AIR ACT (CAA)

The Clean Air Act (CAA) aims to protect and enhance air quality by regulating emissions from stationary and mobile sources, and by setting air quality standards for pollutants.

Key Provisions:

- **National Ambient Air Quality Standards (NAAQS):** Establishes standards for key air pollutants, such as particulate matter, ozone, and carbon monoxide, to protect public health and the environment.
- **Emission Limits:** Sets limits on emissions from industrial facilities, vehicles, and other sources to reduce air pollution.
- **State Implementation Plans (SIPs):** Requires states to develop and implement plans to achieve and maintain air quality standards.

WILDLIFE PROTECTION ACT:

Purpose and Objectives

- The Wildlife Protection Act is designed to safeguard wildlife and their habitats from exploitation and destruction, ensuring the conservation of biodiversity and the protection of endangered species.
- The Act aims to protect wildlife species, their habitats, and ecosystems from illegal activities such as poaching and habitat destruction. It also seeks to promote conservation efforts and sustainable management of wildlife resources.

Key Provisions

- **Protected Species:** Establishes a list of protected species, including both flora and fauna, categorizing them into different schedules based on their level of protection. Schedule I includes the most endangered species, while other schedules cover various levels of protection.
- **Prohibition of Hunting:** Bans hunting, capturing, and trading of protected wildlife species, with specific exceptions for scientific research, management, and conservation purposes under regulated conditions.
- **Protected Areas:** Designates and manages protected areas such as national parks, wildlife sanctuaries, and biosphere reserves to provide safe habitats for wildlife and promote conservation.

FOREST CONSERVATION ACT:

Purpose and Objectives

- The Forest Conservation Act (FCA) aims to protect and conserve forest lands by regulating their diversion for non-forest uses. It seeks to ensure sustainable management of forests and prevent their degradation due to deforestation and encroachment.
- The Act focuses on maintaining forest cover, preserving biodiversity, and managing forest resources responsibly to support ecological balance and environmental sustainability.

Key Provisions

- **Forest Land Diversion:** Requires prior approval from the central government for the diversion of forest land for non-forest purposes, such as industrial development, mining, or infrastructure projects.
- **Procedure for Approval:** Establishes a process for seeking approval, including submission of detailed project reports, environmental impact assessments (EIAs), and compliance with mitigation measures.
- **Compensatory Afforestation:** Mandates compensatory afforestation (planting trees in other areas) to offset the loss of forest cover due to land diversion, ensuring that the total forest area is maintained.

Forest Management and Protection

- **Management Plans:** Requires the development and implementation of forest management plans to ensure sustainable use and conservation of forest resources. These plans include strategies for protection, regeneration, and utilization of forest areas.
- **Protection Measures:** Provides guidelines for preventing illegal activities such as logging, encroachment, and forest fires. It emphasizes the role of forest departments and local communities in safeguarding forest areas.

ENVIRONMENTAL ETHICS:

Definition: Environmental ethics is a branch of philosophy that explores the moral relationship between humans and the natural environment. It examines how humans should interact with nature and the ethical principles that guide environmental decision-making.

Scope: It includes issues related to conservation, resource management, pollution, animal rights, and the broader impact of human activities on ecosystems and the planet.

Principles of Environmental Ethics

- **Sustainability:** Advocates for the responsible use of natural resources to ensure that future generations can meet their needs. It emphasizes balancing current development with long-term environmental health.
- **Intergenerational Justice:** Calls for fairness to future generations by maintaining or improving environmental conditions rather than depleting resources and causing environmental degradation.
- **Intrinsic Value:** Recognizes that natural entities, such as species, ecosystems, and landscapes, have value beyond their economic or practical utility to humans.

Application to Environmental Issues

- **Conservation:** Guides efforts to preserve biodiversity, protect endangered species, and maintain ecological balance by considering the ethical implications of human impact on natural systems.
- **Pollution Control:** Addresses the moral responsibility to reduce pollution and minimize harm to air, water, and soil, advocating for cleaner technologies and sustainable practices.
    - **Animal Rights:** Examines the ethical treatment of animals, including issues related to habitat destruction, industrial farming, and wildlife conservation.