MAHATMA PHULE KRISHI VIDYAPEETH

COLLEGE OF AGRICULTURE

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DEPARTMENT OF AGROMETEOROLOGY

Theory Notes

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VAC 121

Environmental Studies and Disaster Management

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INDEX

		Armed Forces, Police and Other organizations in disaster response & control	

Suggested Readings (VAC-121):

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Lecture No. 1

Topic: Introduction to Environmental Studies

Sub-topics/ Key Points: Definition, Scope and Importance; Multidisciplinary nature.

Definition, scope, and importance of environmental studies Environment

Definition:

The word environment is derived from the French word ***environner*** which means surrounding. Thus, Environment can be defined as the combined interaction of physical, chemical and biological conditions affecting an individual or community in the complex of social and cultural conditions.

Environmental science

- ✓ Environmental science is a systematic study of our environment under different micro climatic conditions and it is multi disciplinary in nature.
- ✓ Environmental science can also be defined as the application of scientific principles to understand environmental issues by studying the impact of interaction between different parameters of environment. Many times, environmental science is related to other sciences like ecology, environmental education and engineering.
- ✓ A relatively new field, environmental science has evolved from integrated use of many disciplines which include important topics of modern civilization and applied aspects of environmental science need the basic knowledge of physics, chemistry, biology, mathematics, engineering, anthropology, sociology, economics, management, ecology, etc.
- ✓ Environmental science integrates natural sciences, social sciences with environmental ethics, environmental impact and planning.
- ✓ Environmental science has emerged as a multi-disciplinary field of study to access the impact of interaction of living beings and micro environments in which they live.

Multidisciplinary nature of environmental studies

Environment consists of surroundings which includes abiotic and biotic environment. Environment refers to sum of all i.e. water, air and land, along with their inter-relationships among themselves and also other living organisms. Environment can be studied by interpreting the knowledge from all the disciplines. Global environment constitutes important segment i.e. atmosphere, hydrosphere and lithosphere. Nitrogen, oxygen and argon are major gases which account for 99% of air. Hydrosphere consist of sea, ocean, rivers, glaciers, lakes, reservoirs, polar ice caps, and shallow water ground bodies and about 70% of earth‘s surface covered with water .

Environmental science and biology

Biology mainly deals with life and environment factors have affect on living organisms. Interaction between living things and different components of environment will affect the efficiency and combined effect can be known as environmental biochemistry. Biological processes in nature profoundly influenced by chemical species existing and these processes will determine the nature of species, their degradation, and synthesis, both in the aquatic and soil environments. Study of such phenomena are the basis of biochemistry of environment.

Environmental science v/s chemistry

Chemistry deals with chemical processes occurring in nature. When these processes are studied in the shape of reaction which affects the existence of different species, with special reference to air, soil and water environment, this relationship is termed as environmental chemistry.

One of environmental chemistry‘s major challenges is the determination of the nature and quantity of specific pollutants in the environments

Relationship between environment and economics

Economic environment refers to all factors or forces, which contribute to economic impact on the man, his activities and his region. Resources such as agriculture, dairying, fisheries poultry, horticulture, floriculture and machinery help to improve economic condition. Economic conditions, internal and external factors such as export and import balances create favourable economic environment for fast development of the country.

Social system and environment

Social environment of the society indicate the mental makeup of man‘s activities and helps the individual to decide his occupation and use of resources for his development. Infrastructure such as roads, buildings, settlements, communication setup plantation of horticulture and cropped fields are major component which helps to create social environment. Using the combination of tools of modern technology indigenous technical knowledge (ITK) can help to fasten the change of physical environment into cultural environment.

Impact of population on environment

Work force is a major factor to fasten the role of individual in socio-economic environment of a country. Population density can have significant effect on natural environment. It can be observed that high population density have negative effects on environment.

The world population, which is growing at alarming rate (annually 1.7 %) has damaged the environment significantly. The growing trend which is likely to continue for another three to four decades, which may further damage physical, social and economic environment at both global and national level. On the other hand, negative growth rate of population in developed countries is likely to hamper the development. Many policy makers are considering the availability of young work force in India asset for development in this changed scenario.

Political climate and environment

Main political institutions such as Legislature, executive and judiciary which constitutes the political setup of any country can help to provide visionary leadership. Political decisions by policy makers can have a direct effect on development and control of various human activities, which includes formulation of laws related to increase the productivity, income and town planning. The executives are pillars of policy implementation decided by legislature. A stable and dynamic political setup is pre requisite for development of the nation. Stable government can guide the nation by taking firm decisions. In a democratic setup, the executive should function in public interest and within the boundaries of the constitution.

Importance

- ✓ To understand the trends of increasing world population is increasing at an alarming rate especially in developing countries and it's impacts on environment.
- ✓ The natural resources endowment in the earth is limited.
- ✓ The methods and techniques of exploiting natural resources are advanced.
- ✓ The resources are over-exploited and there is no foresight of leaving the resources to the future generations.
- ✓ The unplanned exploitation of natural resources lead to pollution of all types and at all levels.
- ✓ The pollution and degraded environment seriously affect the health of all living things on earth, including man.
- ✓ The people should take a combined responsibility for the deteriorating environment and begin to take appropriate actions to space the earth.

- ✓ Education and training are needed to save the biodiversity and species extinction.
- ✓ The urban area, coupled with industries, is major sources of pollution.
- ✓ The number and area extinct under protected area should be increased so that the wild life is protected at least in these sites.
- ✓ The study enables the people to understand the complexities of the environment and need for the people to adapt appropriate activities and pursue sustainable development, which are harmonious with the environment.
- ✓ The study motivates students to get involved in community action, and to participate in various environmental and management projects.
- ✓ It is a high time to reorient educational systems and curricula towards these needs.
- ✓ Environmental studies take a multidisciplinary approach to the study of human interactions with the natural environment. It integrates different approaches of the humanities, social sciences, biological sciences and physical sciences and applies these approaches to investigate environmental concerns.
- ✓ Environmental study is a key instrument for bringing about the changes in the knowledge, values, behaviors and lifestyles required to achieve sustainability and stability within and among countries.
- ✓ Earth‘s living components establish equilibrium with their environment. Environmental science helps to understand the scientific basis to establish different standards which help to keep the equilibrium in the ecosystem.
- ✓ Majority of environmental scientists are of the view that if environmental pollution i.e. air, water and soil continued at the present rate the change will be irreversible and may cause damage to ecological cycles and balances in the ecosystem which is may harm the life of living organisms on the earth.
- ✓ To maintain the ecological balance in the ecosystems, drastic changes have to be inculcated in the human behavior. There is well known fact that universe does not have infinite resources to support the future generation. Earth’s limited resources must be conserved and reused where ever possible. Policy makers at global level must devise new strategies to protect natural ecosystem, keeping balance with economic growth. Future growth of developing nations depends upon the development of sustainable conservation methods that protect the environment, while also meeting the basic needs of citizens.
- ✓ An environmental study is the subject in which we examine important issues relating to environment as they affect our lives. It is an exploratory description of issues. Each issue can be probed more deeply.
- ✓ Many a time development and economic growth cannot go hand on hand. Development activities are inversely related to environment because development leads to industrialization for employment which leads to depletion of natural resources and affect the standard of living of the citizens. Developing nations are compromised with environment for fast growth in different sectors to produce goods for domestic use and export which in turn pollute the environment at the expense of development.
- ✓ It is hard fact that consumption levels of the consumer life-style of human is directly related to environmental problems. Therefore, living habits attitude and ethical standards are the areas of concern to keep the ecological balance intact.
- ✓ The government and their agencies, the non-governmental organizations, the judiciary and now the corporate sector also express a great concern on matters relating natural environment and ecosystem. Many environmental problems such as depletion of ozone layer, global warming, destruction and extinction of species, decreasing water table, contamination and

depletion of ground water and problem of increasing population can be solved by educating the future generations about the impact of development activities on environment.

Objectives of Environment Education

The objectives of Environmental Education are classified as follows:

- ✓ **Knowledge:** to help social groups and individuals, gain a variety of experiences and acquire a basic understanding of the environment and its associated problems.
- ✓ **Awareness:** to help social groups and individuals acquire an awareness of and sensitivity to the total environment and its allied problems.
- ✓ **Attitudes:** to help social groups and individuals to acquire a set of values and promote a feeling of concern for the environment and provide motivation for actively participating in environmental improvement and protection.
- ✓ **Participation:** to provide social groups and individuals with an opportunity to be actively involved at all levels, working towards the resolution of environmental problems.
- ✓ **Skills:** to help social groups and individual to acquires the skills for identifying and solving environmental problems
- ✓ **Evaluation Ability:** to evaluate environmental measures and education programs in terms of ecological, economic, social and aesthetic factors.

Scope of environmental studies

Environmental studies discipline has multiple and multilevel scopes. This study is important and necessary not only for children but also for everyone. The scopes are summarized as follows:

- ✓ The study creates awareness among the people to know about various renewable and nonrenewable resources of the region. The endowment or potential, patterns of utilization and the balance of various resources available for future use in the state of a country are analysed in the study.
- ✓ It provides the knowledge about ecological systems and cause and effect relationships.
- ✓ It provides necessary information about biodiversity richness and the potential dangers to the species of plants, animals and microorganisms in the environment.
- ✓ The study enables one to understand the causes and consequences due to natural and main induced disasters (flood, earthquake, landslide, cyclones etc.,) and pollutions and measures to minimize the effects.
- ✓ It enables one to evaluate alternative responses to environmental issues before deciding an alternative course of action.
- ✓ The study enables environmentally literate citizens (by knowing the environmental acts, rights, rules, legislations, etc.) to make appropriate judgments and decisions for the protection and improvement of the earth.
- ✓ The study exposes the problems of over population, health, hygiene, etc. and the role of arts, science and technology in eliminating/ minimizing the evils from the society.
- ✓ The study tries to identify and develop appropriate and indigenous eco-friendly skills and technologies to various environmental issues.
- ✓ It teaches the citizens the need for sustainable utilization of resources as these resources are inherited from our ancestors to the younger generating without deteriorating their quality.
- ✓ The study enables theoretical knowledge into practice and the multiple uses of environment.

Lecture No. 2

Topic: Segments of Environment

Sub-topics/ Key Points: Spheres of Earth – Lithosphere, Hydrosphere, Atmosphere and Different Layers of Atmosphere.

Segments of Environment and Spheres of Earth

1. Introduction to Environment

The environment refers to the external conditions, resources, stimuli, etc., with which organisms interact. It consists of biotic (living) and abiotic (non-living) components that influence each other in maintaining ecological balance. The environment can be categorized into natural and human-made environments.

1.1 Components of the Environment:

- Biotic components: Living organisms such as plants, animals, and microorganisms.
- Abiotic components: Non-living elements including air, water, soil, sunlight, and temperature.
- Human-made environment: Includes infrastructure, buildings, transportation systems, and industries that modify the natural environment.

The environment is divided into four interdependent segments: lithosphere, hydrosphere, biosphere and atmosphere, which together form the Earth's life-supporting system**.**

Lithosphere (The Solid Earth)

1. Introduction

The lithosphere is the outermost rigid layer of the Earth, consisting of the crust and upper mantle. It forms the foundation of landmasses and ocean basins, providing a base for ecosystems, human settlements, and natural resources.

The lithosphere interacts with the atmosphere, hydrosphere, and biosphere, playing a crucial role in geological processes like plate tectonics, volcanic activity, and erosion.

2. Structure of the Lithosphere

The lithosphere is composed of two main layers:

2.1. Crust (Earth's Outer Layer)

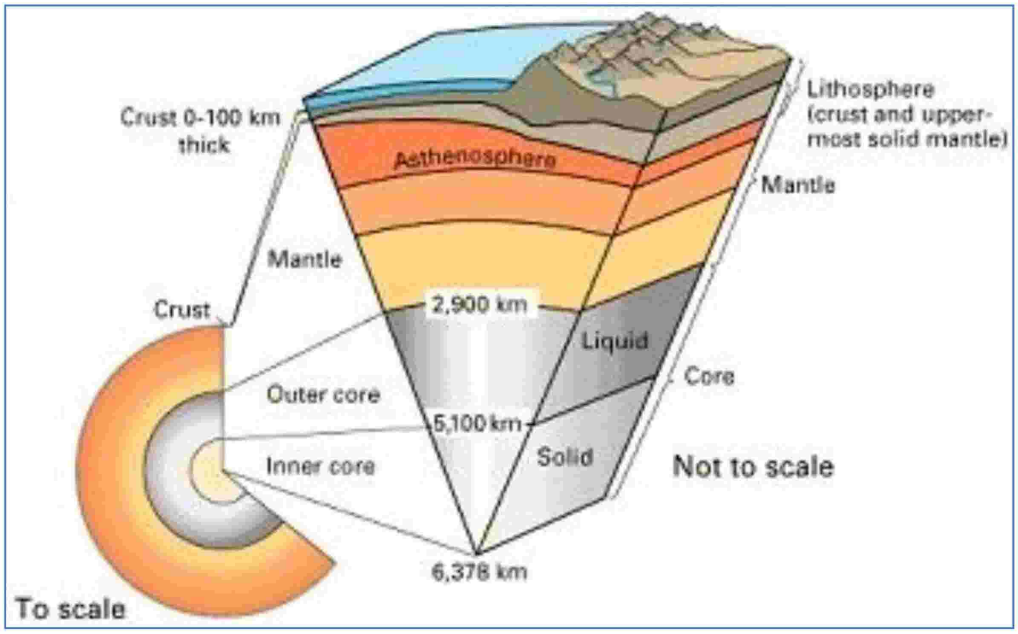
The crust is the thinnest and outermost layer of the Earth, made up of solid rock. It varies in thickness, composition, and density across different regions.

Types of Crust:

- Continental Crust:
  - Thickness: 35-70 km (thicker in mountain regions).
  - Composition: Mainly granite, silicon (Si), aluminum (Al) (often called SIAL layer).
  - Density: 2.7 g/cm³ (less dense than oceanic crust).
  - Older than oceanic crust (some parts are over 3.5 billion years old).
- Oceanic Crust:
  - Thickness: 5-10 km (thinner than continental crust).
  - Composition: Mainly basalt, silicon (Si), magnesium (Mg) (often called SIMA layer).
  - Density: 3.0 g/cm³ (denser than continental crust).
  - Younger than continental crust (formed in the last 200 million years due to seafloor spreading).

2.2. Upper Mantle (Rigid Mantle Portion)

- Extends from the crust to ~100 km depth.
- Composed of ultramafic rocks like peridotite.
- Rigid and brittle, moving along with the crust as a tectonic plate.
- The lithosphere "floats" on the asthenosphere, a semi-molten layer beneath it.



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3. Composition of the Lithosphere

The lithosphere is primarily composed of minerals and rocks, classified into three major types:

3.1. Types of Rocks in the Lithosphere

1. Igneous Rocks:
   - Formed by the solidification of molten magma.
   - Examples: Granite, Basalt, Obsidian.
   - Found in both oceanic and continental crust.
2. Sedimentary Rocks:
   - Formed by the accumulation and compression of sediments over time.
   - Examples: Sandstone, Limestone, Shale.
   - Cover 75% of Earth's surface, though only 5% of total crust volume.
3. Metamorphic Rocks:
   - Formed by the transformation of existing rocks due to high pressure and temperature.
   - Examples: Marble (from limestone), Slate (from shale), Schist.

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4. Tectonic Plates and Plate Movements

The lithosphere is divided into large pieces called tectonic plates that "float" on the semi-molten asthenosphere.

4.1. Major Tectonic Plates

- Pacific Plate (Largest)
- Eurasian Plate
- African Plate
- North American Plate
- South American Plate

- Antarctic Plate
- Indo-Australian Plate

4.2. Plate Boundaries and Movements

1. Divergent Boundaries:
    - Plates move apart, creating new crust (seafloor spreading).
    - Example: Mid-Atlantic Ridge.
2. Convergent Boundaries:
    - Plates move toward each other, causing subduction zones, mountain formation, and earthquakes.
    - Example: Himalayas (collision of Indian and Eurasian plates).
3. Transform Boundaries:
    - Plates slide past each other, causing earthquakes.
    - Example: San Andreas Fault (California, USA).

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5. Importance of the Lithosphere

5.1. Natural Resources

- ✔ Mineral Resources: Contains valuable minerals like gold, iron, copper, coal, and oil.
- ✔ Soil Formation: Supports agriculture and vegetation.
- ✔ Fossil Fuels: Provides coal, petroleum, and natural gas for energy production.

5.2. Habitat and Biodiversity

- ✔ Supports forests, grasslands, and deserts, providing homes for plants and animals.
- ✔ Influences ecosystem development through soil and climate conditions.

5.3. Geological Processes and Natural Hazards

- ✔ Mountain Formation: Due to tectonic uplift and volcanic activity.
- ✔ Earthquakes and Volcanoes: Occur along plate boundaries, impacting human settlements.

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6. Environmental Issues Related to the Lithosphere

6.1. Land Degradation

- Deforestation causes soil erosion and desertification.
- Overgrazing leads to loss of fertile topsoil.
- Urbanization and mining destroy natural landscapes.

6.2. Soil Pollution

- Use of chemical fertilizers and pesticides decreases soil fertility.
- Industrial waste dumping contaminates soil and groundwater.

6.3. Climate Change and Its Effects

- Melting glaciers and permafrost due to rising temperatures.
- Increased desertification affecting food production.

6.4. Natural Disasters

- Earthquakes and Tsunamis: Caused by tectonic activity, damaging cities and causing loss of life.
- Volcanic Eruptions: Release toxic gases and ash, affecting air quality and agriculture.

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7. Human Impact on the Lithosphere

- Mining Activities: Extraction of minerals leads to habitat destruction.

- Deforestation: Leads to soil erosion, landslides, and loss of biodiversity.
- Industrial Development: Causes land and air pollution.
- Construction of Dams & Infrastructure: Alters river courses and ecosystems.

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8. Conservation and Sustainable Management of the Lithosphere

- ✔ Afforestation & Reforestation to prevent soil erosion.
- ✔ Sustainable Agriculture (crop rotation, organic farming).
- ✔ Land Reclamation to restore degraded areas.
- ✔ Reducing Mining Impact by adopting eco-friendly techniques.
- ✔ Disaster Preparedness (earthquake-resistant buildings, early warning systems).

Hydrosphere (The Water Component of Earth)

1. Introduction

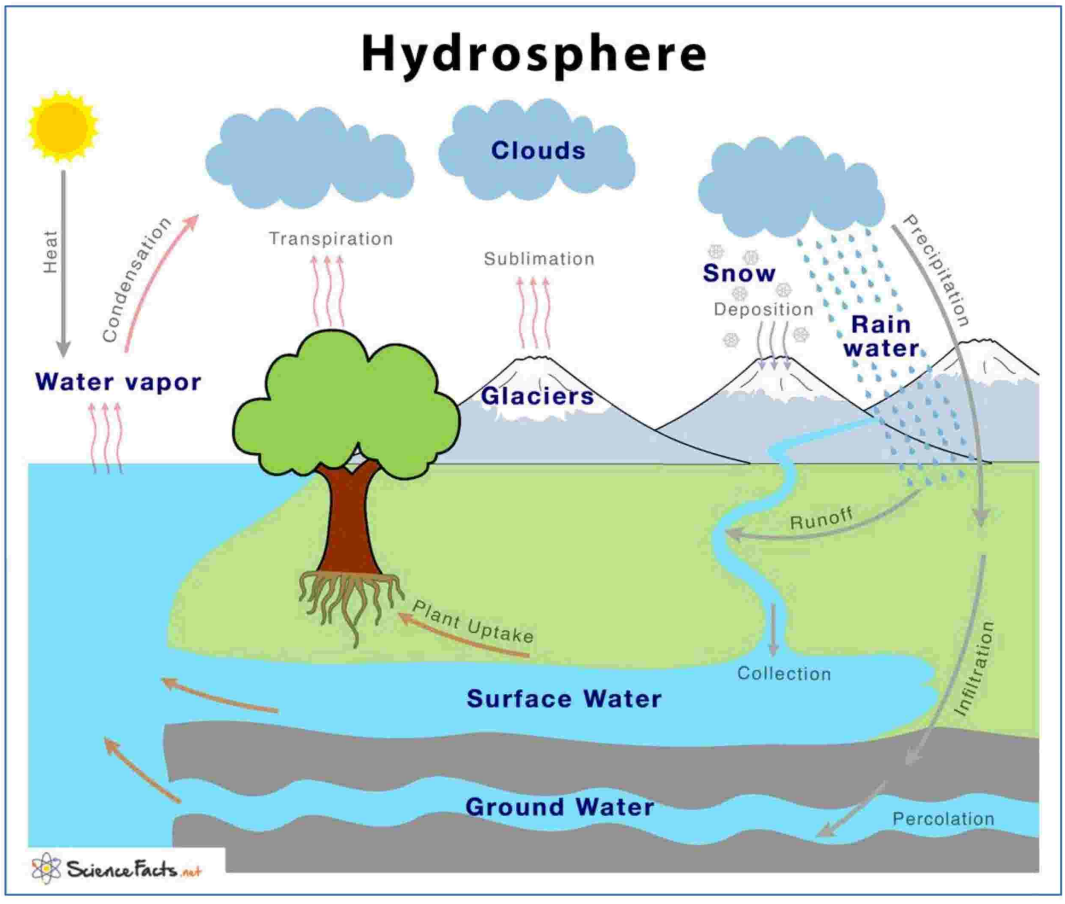
The hydrosphere includes all the water present on, under, and above the Earth's surface. It consists of oceans, seas, rivers, lakes, glaciers, groundwater, and atmospheric moisture (water vapor). Water in the hydrosphere exists in three states:

✓ **Liquid** – Oceans, rivers, lakes, groundwater.

✓ **Solid** – Glaciers, ice caps, sea ice.

✓ **Gas** – Water vapor in the atmosphere.

Water is essential for sustaining life, regulating climate, and shaping Earth's surface through processes like erosion, sedimentation, and weathering.



2. Distribution of Water on Earth

Water covers **about 71%** of the Earth's surface, but only a small portion is available for human use.

Water Source	Percentage of Total Water	Availability
Oceans & Seas	97.5%	Saline (not directly usable).
Glaciers & Ice Caps	1.74%	Freshwater but mostly locked in ice.
Groundwater	0.75%	Largest source of usable freshwater.
Lakes & Rivers	0.01%	Vital for drinking, agriculture, and industry.
Atmospheric Water Vapor	0.001%	Plays a role in the water cycle.

Thus, only about 2.5% of Earth's water is freshwater, and most of it is trapped in glaciers and underground sources.

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3. Major Components of the Hydrosphere

3.1. Oceans and Seas

- The largest component of the hydrosphere (~97.5% of Earth's water).
- Five major oceans:
    1. Pacific Ocean (largest and deepest).
    2. Atlantic Ocean.
    3. Indian Ocean.
    4. Southern Ocean.
    5. Arctic Ocean.
- Influence climate, weather patterns, and marine ecosystems.
- Store heat energy, regulating global temperatures.

3.2. Rivers and Lakes

- Provide freshwater for drinking, agriculture, and industries.
- Major Rivers: Amazon, Nile, Mississippi, Ganges, Yangtze.
- Major Lakes: Caspian Sea (largest by surface area), Lake Baikal (deepest), Great Lakes (North America).

3.3. Glaciers and Ice Caps

- Store about 69% of Earth's freshwater.
- Found in Antarctica, Greenland, and high mountain regions.
- Melting due to global warming leads to rising sea levels.

3.4. Groundwater

- Water stored beneath the Earth's surface in soil and rock layers.
- Accessed through wells, springs, and boreholes.
- Aquifers (underground water reservoirs) provide drinking water for many regions.

3.5. Water in the Atmosphere

- Exists as water vapor, clouds, and precipitation.
- Plays a crucial role in weather patterns and the water cycle.

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4. The Water Cycle (Hydrological Cycle)

The continuous movement of water within the hydrosphere is known as the **water cycle**. The main processes include:

1. Evaporation: Water from oceans, lakes, and rivers changes into vapor due to solar heat.
2. Transpiration: Plants release water vapor into the air through leaves.

3. Condensation: Water vapor cools and forms clouds.
4. Precipitation: Water falls as rain, snow, sleet, or hail.
5. Infiltration & Percolation: Water soaks into the ground, replenishing groundwater.
6. Runoff: Water flows over land into rivers, lakes, and oceans.

The water cycle ensures a constant supply of freshwater and regulates climate patterns.

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5. Importance of the Hydrosphere

5.1. Supports Life and Ecosystems

✓ Essential for all living organisms – plants, animals, and humans.

✓ Provides habitats for aquatic life (oceans, rivers, wetlands).

✓ Maintains biodiversity through marine and freshwater ecosystems.

5.2. Climate Regulation

✓ Oceans absorb heat and distribute it through ocean currents.

✓ Cloud formation and precipitation influence local and global climates.

5.3. Economic and Human Uses

✓ Drinking water supply (groundwater, lakes, rivers).

✓ Agriculture (irrigation for crops).

✓ Energy production (hydroelectric dams, geothermal power).

✓ Transportation and trade (shipping routes, ports).

5.4. Geological and Environmental Impact

✓ Shapes landforms through erosion, sedimentation, and deposition.

✓ Glaciers carve valleys and fjords over time.

✓ Groundwater movement forms caves and sinkholes.

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6. Environmental Issues Affecting the Hydrosphere

6.1. Water Pollution

- Industrial waste dumping (toxic chemicals in rivers and lakes).
- Agricultural runoff (pesticides, fertilizers causing eutrophication).
- Plastic pollution in oceans affecting marine life.

6.2. Climate Change and Global Warming

- Rising sea levels due to glacier melting.
- Ocean acidification harming coral reefs and marine ecosystems.
- Changes in rainfall patterns, causing droughts or floods.

6.3. Water Scarcity

- Overuse of groundwater leads to depletion of aquifers.
- Droughts reduce freshwater availability in dry regions.
- Unequal distribution causes water conflicts between nations.

6.4. Deforestation and Hydrological Imbalance

- Fewer trees mean less transpiration and reduced rainfall.
- Leads to desertification and drying up of water bodies.

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7. Conservation and Sustainable Management of Water Resources

✓ Rainwater Harvesting – Collecting and storing rainwater for future use.

✓ Afforestation – Planting trees to maintain the water cycle.

✓ Water Recycling and Wastewater Treatment – Reusing treated water.

✓ Reducing Water Wastage – Efficient irrigation methods (drip irrigation).

✓ Laws and Policies – Enforcing regulations on industrial pollution and sustainable usage.

Biosphere (The Life Zone of Earth)

1. Introduction

The biosphere is the part of Earth where life exists, including all living organisms (plants, animals, microorganisms) and their interactions with the lithosphere (land), hydrosphere (water), and atmosphere (air).

- It extends from the deep ocean trenches (~11 km below sea level) to the highest mountains (~8 km above sea level).
- The biosphere includes terrestrial (land), aquatic (water), and atmospheric ecosystems.

The biosphere is self-regulating and dynamic, ensuring the continuous flow of energy and cycling of nutrients necessary for sustaining life.

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2. Components of the Biosphere

The biosphere consists of **biotic (living) and abiotic (non-living) components**.

2.1. Biotic (Living) Components

1. Producers (Autotrophs) – Plants, algae, and some bacteria that produce their own food through photosynthesis or chemosynthesis.
    - Example: Green plants, cyanobacteria, phytoplankton.
2. Consumers (Heterotrophs) – Organisms that depend on others for food.
    - Herbivores (Primary consumers) – Eat plants (e.g., deer, rabbits).
    - Carnivores (Secondary/Tertiary consumers) – Eat other animals (e.g., lions, hawks).
    - Omnivores – Eat both plants and animals (e.g., humans, bears).
3. Decomposers (Saprotrophs) – Break down dead matter, returning nutrients to the ecosystem.
    - Example: Fungi, bacteria, earthworms.

2.2. Abiotic (Non-Living) Components

- Sunlight – Primary energy source for photosynthesis.
- Water – Essential for all biological processes.
- Air (Oxygen, Carbon Dioxide, Nitrogen) – Required for respiration and photosynthesis.
- Soil & Minerals – Provide nutrients for plants.
- Temperature & Climate – Influence the distribution of organisms.

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3. Layers of the Biosphere

3.1. Terrestrial Ecosystems (Land-Based Biomes)

- Forests: Tropical rainforests, temperate forests, boreal forests.
- Grasslands: Savannas, prairies, steppes.
- Deserts: Hot deserts (Sahara), cold deserts (Gobi).
- Tundra: Arctic and alpine tundra with minimal vegetation.

3.2. Aquatic Ecosystems (Water-Based Biomes)

- Freshwater: Rivers, lakes, wetlands.
- Marine: Oceans, coral reefs, estuaries.

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4. Importance of the Biosphere

4.1. Supports Life and Biodiversity

✓ Home to millions of species of plants, animals, and microorganisms.

✓ Maintains genetic diversity, crucial for adaptation and evolution.

4.2. Ecological Balance

✓ Plants absorb CO_2 and release O_2, maintaining atmospheric balance.

✓ Decomposers recycle organic matter, enriching the soil.

✓ Food chains and food webs ensure energy flow.

4.3. Climate Regulation

✓ Forests act as carbon sinks, reducing greenhouse gases.

✓ Oceans regulate global temperature by storing heat.

4.4. Provides Natural Resources

✓ Food – Crops, fish, livestock.

✓ Medicine – Herbal medicines, antibiotics (e.g., Penicillin from fungi).

✓ Raw Materials – Wood, fibers, minerals.

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5. Human Impact on the Biosphere

5.1. Deforestation and Habitat Destruction

- Loss of forests leads to climate change, desertification, and biodiversity loss.
- Habitat destruction endangers species (e.g., Amazon deforestation).

5.2. Pollution

- Air Pollution – Industrial emissions cause smog and respiratory diseases.
- Water Pollution – Chemical waste harms aquatic life.
- Soil Pollution – Pesticides and plastics degrade ecosystems.

5.3. Climate Change

- Global warming affects ecosystems and species migration.
- Rising sea levels threaten coastal habitats.

5.4. Overexploitation of Resources

- Overfishing disrupts marine food chains.
- Unsustainable agriculture depletes soil nutrients.

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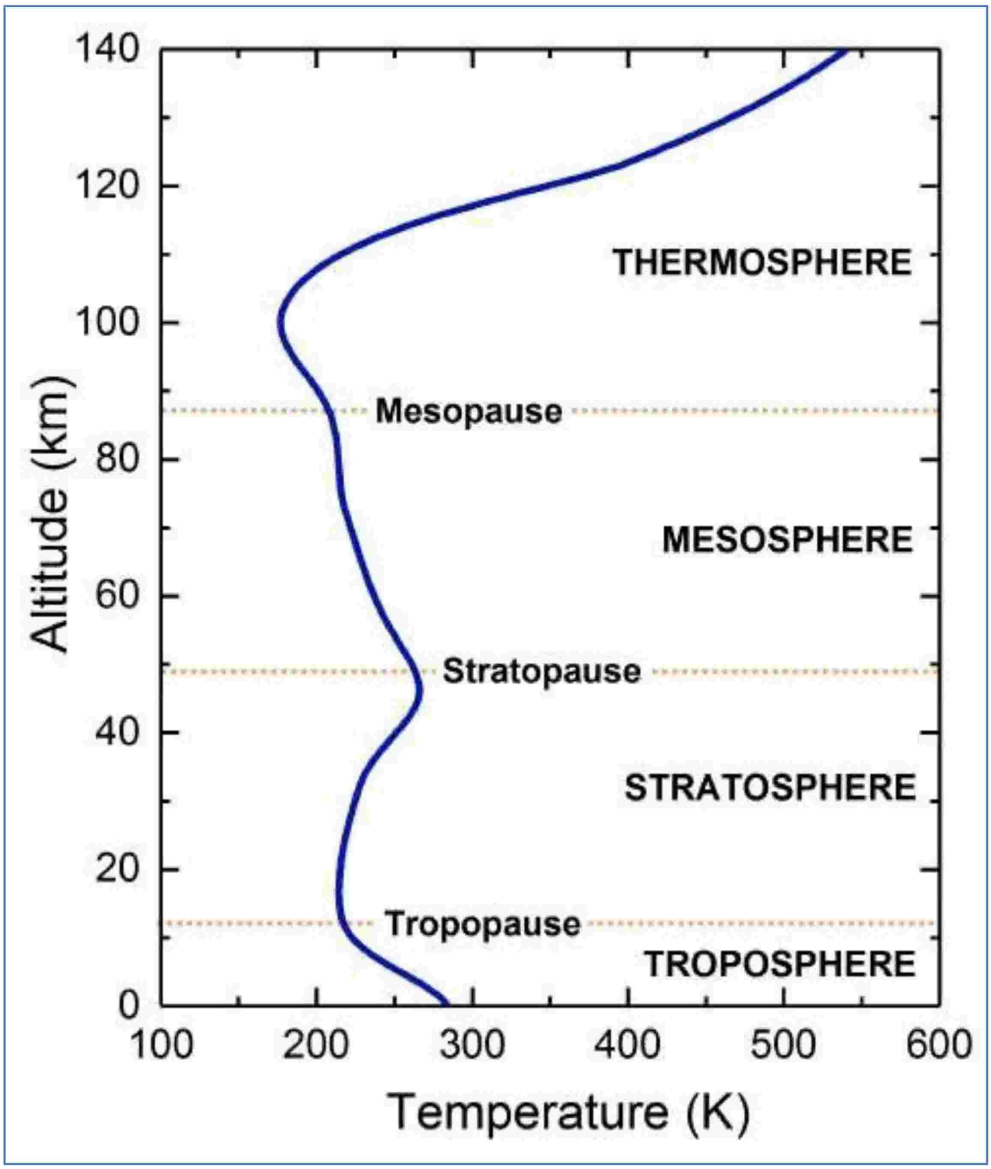
6. Conservation and Sustainable Management

✓ Afforestation & Reforestation – Restoring forests to absorb CO_2.

✓ Wildlife Protection – Establishing national parks and reserves.

✓ Sustainable Agriculture – Organic farming, crop rotation.

✓ Pollution Control – Reducing plastic use, waste treatment.



Atmosphere (The Gaseous Envelope of Earth)

1. Introduction

The atmosphere is the layer of gases surrounding the Earth, essential for supporting life, regulating climate, and protecting the planet from harmful solar radiation.

✓ Extends from Earth's surface to outer space (~10,000 km).

✓ Held in place by gravity.

✓ Composed of various gases, including oxygen, nitrogen, carbon dioxide, and water vapor.

✓ Plays a crucial role in weather, climate, and the water cycle.

2. Composition of the Atmosphere

The atmosphere is a **mixture of gases**, with varying concentrations at different altitudes.

Gas	Percentage in Dry Air	Importance
Nitrogen (N_2)	78.08%	Essential for plant growth (Nitrogen Cycle).
Oxygen (O_2)	20.95%	Supports respiration in living organisms.
Argon (Ar)	0.93%	Inert gas with minimal biological impact.

Carbon Dioxide (CO_2)	0.04%	Essential for photosynthesis and traps heat (Greenhouse Effect).
Water Vapor (H_2O)	Varies (0-4%)	Regulates temperature, forms clouds, and drives weather patterns.
Other Gases	Trace amounts	Includes neon, helium, methane, ozone, etc.

Layers of the Atmosphere

The Earth's atmosphere is divided into five distinct layers based on temperature variations, pressure, composition, and function. These layers play crucial roles in sustaining life, regulating climate, and enabling technological advancements like aviation, satellite communication, and space exploration.

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1. Troposphere (0–12 km Above Earth's Surface)

Key Characteristics:

- The lowest and densest layer, containing about 75% of the atmosphere's total mass and nearly all its water vapor.
- The layer where weather phenomena such as clouds, rain, storms, and hurricanes occur.
- Temperature decreases with altitude at an average lapse rate of 6.5°C per km due to the decrease in heat radiated from the Earth's surface.
- The tropopause is the boundary between the troposphere and the stratosphere, marking a region of stable temperature.

Importance:

- ✔ Essential for life as it contains the air we breathe.
- ✔ Supports weather and climate systems.
- ✔ Hosts air traffic for commercial flights (lower troposphere).
- ✔ Controls the hydrological (water) cycle.

Environmental Issues:

- Global Warming: Increase in greenhouse gases (CO_2, CH_4) traps heat, causing climate change.
- Air Pollution: Accumulation of pollutants like sulfur dioxide (SO_2), nitrogen oxides (NOx), and particulate matter affects air quality.

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2. Stratosphere (12–50 km Above Earth's Surface)

Key Characteristics:

- Extends from the tropopause to the stratopause.
- Contains the ozone layer (located at ~15-35 km), which absorbs 97-99% of harmful UV radiation from the Sun.
- Temperature increases with altitude due to the absorption of UV radiation by ozone molecules.
- Very stable atmosphere with minimal weather disturbances, making it ideal for jet airliners flying at 10–15 km altitude.

Importance:

✔ Ozone layer protection prevents harmful ultraviolet radiation, reducing the risk of skin cancer and genetic damage.

✔ Provides a stable flying zone for long-haul commercial and military aircraft.

✔ Helps in studying stratospheric circulation patterns that influence climate.

Environmental Issues:

- Ozone Depletion: Chlorofluorocarbons (CFCs) and halons break down ozone, leading to ozone holes (notably over Antarctica).
- Effects of UV Radiation: Increased exposure can lead to skin cancer, cataracts, and weakened immune systems.

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3. Mesosphere (50–85 km Above Earth's Surface)

Key Characteristics:

- Extends from the stratopause to the mesopause.
- The coldest atmospheric layer, with temperatures dropping to -90°C due to minimal heat absorption.
- The layer where meteoroids burn up, producing streaks of light known as meteors ("shooting stars").
- Very low atmospheric pressure (less than 1% of sea-level pressure).

Importance:

✔ Protects Earth from meteoroids and space debris by burning them up.

✔ Plays a role in atmospheric tides and waves that influence climate.

✔ The region where noctilucent clouds (extremely high-altitude, ice-crystal clouds) form.

Environmental Issues:

- Space debris: Increasing human activities in space can lead to the accumulation of artificial debris, affecting mesosphere interactions.

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4. Thermosphere (85–600 km Above Earth's Surface)

Key Characteristics:

- Extends from the mesopause to the thermopause (~600 km).
- Temperature increases drastically, reaching up to 1500°C or more, due to direct exposure to solar radiation.
- Contains the ionosphere (extends from 80 km to ~1000 km), where solar radiation ionizes atmospheric gases, creating charged particles (ions).
- Auroras (Northern and Southern Lights) occur in this layer due to interactions between charged particles from the Sun and Earth's magnetic field.

Importance:

✔ Ionosphere facilitates radio wave transmission, allowing long-distance communication via reflection of radio signals.

✔ Protects Earth by absorbing X-rays and extreme UV radiation.

✔ Hosts various satellites, including weather and communication satellites.

✔ The layer where the International Space Station (ISS) orbits (~400 km altitude).

Applications in Technology & Science:

- Satellite operations: GPS, weather forecasting, and military surveillance satellites operate here.
- Space research: Scientists study atmospheric drag and space weather to understand the Sun's influence on Earth.

Environmental Issues:

- Solar storms and geomagnetic disturbances can disrupt communication systems and electrical grids.
- Space debris accumulation poses a significant threat to spacecraft and operational satellites.

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5. Exosphere (600 km and Beyond)

Key Characteristics:

- The outermost layer of Earth's atmosphere, transitioning into outer space.
- Composed of extremely thin gases like hydrogen, helium, oxygen, and carbon dioxide.
- Virtually no atmospheric pressure or defined boundary, gradually merging with interplanetary space.
- Molecules move at high speeds, and some escape Earth's gravity into space.

Importance:

✔ Region of satellite operations: GPS, geostationary communication satellites, and space telescopes operate here.

✔ Provides insights into the behavior of atmospheric particles in space.

✔ Helps scientists understand planetary atmospheres and conditions in space.

Environmental Issues:

- Space debris and satellite congestion: The increase in satellites and defunct space equipment increases the risk of collisions.
- Radiation exposure: Due to the lack of atmospheric shielding, astronauts and equipment are exposed to higher levels of cosmic and solar radiation.

Comparison of Atmospheric Layers

Layer	Altitude Range	Temperature Tren	Key Features
Troposphere	0–12 km	Decreases	Weather, clouds, life-supporting gases
Stratosphere	12–50 km	Increases	Ozone layer, jet streams, aircraft flights
Mesosphere	50–85 km	Decreases	Meteors burn, coldest layer
Thermosphere	85–600 km	Increases	Auroras, ionosphere, satellites, ISS
Exosphere	600 km+	No specific trend	Merges with space, satellites, sparse gases

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4. Functions and Importance of the Atmosphere

4.1. Supports Life

✓ Provides oxygen for respiration and carbon dioxide for photosynthesis.

✓ Maintains a stable climate, preventing extreme temperature variations.

4.2. Protection from Harmful Radiation

✓ The ozone layer absorbs UV radiation, preventing skin cancer and genetic damage.

✓ Protects from harmful cosmic rays and solar wind.

4.3. Regulates Temperature and Climate

✓ The Greenhouse Effect helps maintain Earth's temperature.

✓ Circulates heat through winds, ocean currents, and atmospheric movements.

4.4. Weather and Water Cycle

✓ Essential for cloud formation, precipitation, and wind patterns.

✓ Drives the hydrological (water) cycle, ensuring the availability of freshwater.

4.5. Enables Communication and Technology

✓ The Ionosphere reflects radio waves, enabling long-distance communication.

✓ Hosts satellites for GPS, television, and weather forecasting.

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5. Environmental Issues Affecting the Atmosphere

5.1. Air Pollution

✓ Industrial emissions, vehicle exhaust, and deforestation release pollutants.

✓ Major pollutants: CO_2, SO_2, NO_2, and particulate matter.

✓ Leads to smog, acid rain, and respiratory diseases.

5.2. Ozone Layer Depletion

✓ Caused by CFCs (chlorofluorocarbons) used in refrigerants and aerosols.

✓ Leads to the formation of an ozone hole, increasing UV radiation exposure.

5.3. Global Warming and Climate Change

✓ Increased greenhouse gases (CO_2, CH_4, N_2O) trap heat, causing rising temperatures.

✓ Results in melting glaciers, rising sea levels, and extreme weather patterns.

5.4. Acid Rain

✓ Caused by sulfur dioxide (SO_2) and nitrogen oxides (NOx) mixing with water vapor.

✓ Damages forests, soils, and aquatic ecosystems.

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6. Conservation and Sustainable Management

✓ Reducing Fossil Fuel Use – Promoting renewable energy sources (solar, wind, hydro).

✓ Controlling Industrial Pollution – Installing filters in factories and power plants.

✓ Promoting Afforestation – Planting trees to increase oxygen levels.

✓ Reducing Ozone-Depleting Substances – Using eco-friendly refrigerants (HCFCs, HFCs).

✓ Encouraging Public Transport & Electric Vehicles – Reducing carbon emissions.

Lecture No. 3 - 5

Topic: Natural Resources

Sub-topics/ Key Points: Classification of resources: Forest, water, mineral, food, energy, land, and soil resources

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Natural Resources

Introduction to Natural Resources

Any material which can be transformed in a way that it becomes more valuable and useful can be termed as resource. In other words, it is possible to obtain valuable items from any resources. Resource, therefore, are the means to attain given ends. The aspect of satisfaction is so important that we consider a thing or substance a resource, as so long it meets our needs. Life on this planet depends upon a large number of things and services provided by the nature, which are known as Natural Resources. Thus water, air, soil, minerals, coal, forests, crops and wild life are all examples of natural resources. In the case of humans, a resource is any form of energy of matter essential for the fulfillment of physiological, socio-economic and cultural needs, both at the individual level and that of the community.

The five basic ecological variables - energy, matter, space, time and diversity are sometimes combinedly called natural resources.

Classification of natural resources

Depending upon availability of natural resources can be divided into two categories such as (1) Renewable and (2) Nonrenewable resources.

Renewable resources

- ✓ Renewable resources are in a way inexhaustible resources. They have the ability to replenish themselves by means such as recycling, reproduction and replacement. Examples of renewable resources are sunlight, animals and plants, soil, water, etc.
- ✓ Perpetual harvest

Non-Renewable Resources

- ✓ Non renewable resources are the resources that cannot be replenished once used or perished. Examples of non renewable resources are minerals, fossil fuels, etc.
- ✓ No-replacement
- ✓ Ex. Species of wildlife

Based on origin

Biotic resources

These are living resources (e.g. forest, agriculture, fish and wild life) that are able to reproduce or replace them and to increase.

Abiotic resources

These are non-living resources (e.g. petrol, land, minerals etc.) that are not able to replace themselves or do so at such a slow rate that they are not useful to consider them in terms of the human life times.

Based on Continual Utility they are classifies as:

- ✓ Renewable
- ✓ Nonrenewable
- ✓ Cyclic resource

Based on Utility they are classifies as:

- ✓ some as raw materials
- ✓ some as energy resources

Problems associated with natural resources

The unequal consumption of natural resources:

- ✓ A major part of natural resources today are consumed in the technologically advanced or _developed 'world, usually termed _the west'. The _developing nations'of _the east', including India and China, also over use many resources because of their greater human population. However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases.
- ✓ Energy from fossil fuels is consumed in relatively much greater quantities in developed countries. Their per capita consumption of food too is much greater as well as their waste of enormous quantities of food and other products, such as packaging material, used in the food industry. The USA for example with just 4% of the world's population consumes about 25% of the world's resources.
- ✓ Producing animal food for human consumption requires more land than growing crops. Thus countries that are highly dependent on non-vegetarian diets need much larger areas for pastureland than those where the people are mainly vegetarian.

Planning land use:

- ✓ Land is a major resource, needed for not only for food production and animal husbandry, but also for industry and growing human settlements. These forms of intensive land use are frequently extended at the cost of _wild lands', our remaining forests, grasslands, wetlands and deserts. This demands for a pragmatic policy that analyses the land allocation for different uses.
- ✓ Land as a resource is now under serious pressure due to an increasing _land hunger' - to produce sufficient quantities of food for an exploding human population. It is also affected by degradation due to misuse. Land and water resources are polluted by industrial waste and rural and urban sewage. They are increasingly being diverted for

short-term economic gains to agriculture and industry. Natural wetlands of great value are being drained for agriculture and other purposes. Semi-arid land is being irrigated and overused.

- ✓ The most damaging change in land use is demonstrated by the rapidity with which forests have vanished during recent times, both in India and in the rest of the world. Forests provide us with a variety of services. These include processes such as maintaining oxygen levels in the atmosphere, removal of carbon dioxide, control over water regimes, and slowing down erosion and also produce products such as food, fuel, timber, fodder, medicinal plants, etc. In the long term, the loss of these is far greater than the short-term gains produced by converting forested lands to other uses.

The need for sustainable lifestyles:

Human standard of living and the health of the ecosystem are indicators of sustainable use of resources in any country or region. Ironically, both are not in concurrence with each other. Increasing the level of one, usually leads to degradation of other. Development policies should be formulated to strike a balance between the two.

- ✓ The quality of human life and the quality of ecosystems on earth are indicators of the sustainable use of resources. There are clear indicators of sustainable lifestyles in human life.
- ✓ Increased longevity
- ✓ An increase in knowledge
- ✓ An enhancement of income. These three together are known as the **'Human development index'**. The quality of the ecosystems have indicators that are more difficult to assess.
- ✓ A stabilized population.
- ✓ The long term conservation of biodiversity.
- ✓ The careful long-term use of natural resources.
- ✓ The prevention of degradation and pollution of the environment.

Overpopulation that brings over exploitation:

Almost all natural resources are under pressure due to the growing human population. Overexploitation of these resources often results. Due to overexploitation to support the ever-growing population, resources such as arable land, fresh water, fossil fuels, coral reefs, and wilderness forests are at record low levels. There is an incredible decline in quality of life as a result of this competition for the vital resources that sustain life. Farmers have converted forests and grasslands into cropland because of intensive agricultural methods. Due to modern-day pressures, natural resources are depreciating, especially forests, wild life, and fertile land, as land is converted into fields for farming, crop-production, and livestock raising. As a result of agricultural waste, fertilizers, and pesticides polluting marine and freshwater environments, a number of natural crop species and aquatic life are also endangered.

Climate change:

Human activities and overpopulation are generating greenhouse gases and carbon footprints in the atmosphere, causing severe changes to climate patterns that threaten biodiversity as well as many other natural resources. As global warming and climate change alter the favorable conditions for survival, species that have adapted to particular environments are highly affected. A profound consequence of global warming and climate change is the destruction of habitats to a degree that threatens biodiversity and the survival of species. Wildlife such as mountain gorillas and rock rabbits may soon become extinct due to global warming because they require cool temperatures high in the mountains.

Environmental pollution:

In addition to being destroyed, a large portion of natural resources is under immense threat from pollution produced by industries and manufactured utilities as well as agricultural products. There are long-term cumulative impacts of soil, air, and water pollution on natural resources and the quality of the environment where they occur. Consequently, serious pollution has reduced the value of natural resources since it is harsh for the sustainability of both biotic and abiotic components. Natural processes such as water chemistry, soil composition, ocean

water, underground water and rock composition are affected by pollution. Acidic lakes, for instance, are unsupportive of aquatic life. Land use and development Lands that are converted into urban settings, housing development projects, commercial centers, industrial sites, parking lots, highway systems, and so on, deprive wildlife and other living organisms of natural habitats. In addition to destroying millions of acres of habitat, this method has also caused much deforestation.

FOREST RESOURCES

A forest can be defined as a biotic community predominant of trees, shrubs or any other woody vegetation usually in a closed canopy. It is derived from latin word ***foris*** means **outside**. Forest is important renewable resources. Forest vary in composition and diversity and can contribute substantially to the economic development of any country. Plants along with trees cover large areas, produce variety of products and provide food for living organisms, and also important to save the environment. It is estimated that about 31% of world area is covered by forest. Among all continents, Russia has the largest forest area in the world, covering 815 million hectares, or one-fifth of the world's forests. The next four countries with the largest forest areas are Brazil, Canada, China, and the United States, each with more than 100 million hectares. India's Forest Cover accounts for 24.62% (80.91 million ha) of the total geographical area of the country as of 2023. 17 States and Union Territories had more than 33% of their area under forest cover. Madhya Pradesh had the largest forest cover, followed by Arunachal Pradesh, Chhattisgarh, Odisha and Maharashtra. The top five States in terms of forest cover as a percentage of their total geographical area were Mizoram (84.53%), Arunachal Pradesh (79.33%), Meghalaya (76%), Manipur (74.34%) and Nagaland (73.90%). Scientists estimate that India should ideally have 33% of its land under forests.

Forest Functions:

I. Protective and ameliorative functions.
II. Productive functions
III. Recreational and educational functions
IV. Development functions

Watershed protection

- ✓ Reducing the rate of surface run-off of water by increasing infiltration from rate.
- ✓ Preventing flash floods and soil erosion
- ✓ Producing prolonged gradual run-off and thus safeguarding against drought.

Erosion control

- ✓ Holding soil (by preventing rain from directly washing soil away)

Land bank

- ✓ Maintaining soil nutrients and structure.
- ✓ Atmospheric regulation
- ✓ Absorption of solar heat during evapotranspiration
- ✓ Maintaining carbon dioxide levels for plant growth
- ✓ Maintaining the local climatic conditions

Productive Functions

- ✓ **Local use –** Consumption of forest produce by local people who collect it for

sustenance

- ✓ **Food:** (consumptive use) gathering plants, fishing, hunting from the forest. Fodder for cattle
- ✓ Fuel wood and charcoal for cooking and heating
- ✓ Poles for building homes in rural and wilderness areas
- ✓ Timber for house hold articles and construction
- ✓ Fiber for weaving baskets, ropes, nets, strings, etc.,
- ✓ Sericulture for silk
- ✓ Apiculture for rearing bees for honey (bees as pollinators)
- ✓ Medicinal plants for traditional medicines, investigating them as potential source for new modern drugs Market use (productive use) Most of the products used for consumptive purposes and good source of income for supporting their livelihood of forest dwelling people.
- ✓ Minor forest products (NTFPs): Fuel wood, fruits, gum, fiber, etc which are collected and solid in local markets as a source of income for forest dwellers
- ✓ Major timber extraction for construction, industrial uses, paper pulp etc. Timber extraction is done in India by the forest department, but illegal logging continues in many of the forests of India and the world.

Recreational and Educational Functions:

- ✓ Eco tourism

Developmental Functions

- ✓ Employment functions
- ✓ Revenue

Regulative function:

Regulation of environmental equilibrium is successfully achieved by forests. For example, regulation of Carbon-di-oxide (CO2), Oxygen (O2) ,water (H2O) and minerals is very essential for a healthy environment. Solar energy is absorbed, retained and released by forests. During photosynthesis by green plants, starch is formed from carbondioxide and water in the presence of sunlight and it is stored . In this process, Carbon-di-oxide (CO2) is taken in and Oxygen (O2) is released to maintain equilibrium in atmosphere and aid in reducing the global temperature. An increase in global temperature poses a threat to human beings throughout the world.

One acre of forest absorbs 4 tons of Carbon-di-oxide (CO_2) and releases 8 tons of Oxygen (O_2), thereby regulating carbon cycle, flood and drought. It is the forest which helps in economic development and maintenance of land value.

Significance of forests

Forest can provide prosperity of human being and to the nations. Important uses of forest can be classified as under

- ✓ Commercial values
- ✓ Ecological significance
- ✓ Aesthetic values Life and
- ✓ economy of tribal

Commercial values

Forests are main source of many commercial products such as wood, timber, pulpwood etc. About 1.5 billion people depend upon fuel wood as an energy source. Timber obtained from the forest can used to make plywood, board, doors and windows, furniture, and agriculture implements and sports goods. Timber is also a raw material for preparation of paper, rayon and film.

- ✓ Forest can provide food, fibre, edible oils and drugs.
- ✓ Forest lands are also used for agriculture and grazing.
- ✓ Forest is important source of development of dams, recreation and mining.

Life and economy of tribal

Forest provides food, medicine and other products needed for tribal people and play a vital role in the life and economy of tribes living in the forest.

Ecological uses

- ✓ Forests are habitat to all wild animals, plants and support millions of species. They help in reducing global warming caused by greenhouse gases and produces oxygen upon photosynthesis.
- ✓ Forest can act as pollution purifier by absorbing toxic gases. Forest not only helps in soil conservation but also helps to regulate the hydrological cycle.

Aesthetic values

- ✓ All over the world people appreciate the beauty and tranquility of the forest because forests have a greatest aesthetic value. Forest provides opportunity for recreation and ecosystem research.

Over exploitation of forests

Forests contribute substantially to the national economy. With increasing population increased demand of fuel wood, expansion of area under urban development and industries has lead to over exploitation of forest .At present international level we are losing forest at the rate of 1.7 crore hectares annually. Overexploitation also occurs due to overgrazing and conversion of forest to pastures for domestic use.

Deforestation

- ✓ Forest are burned or cut for clearing of land for agriculture, harvesting for wood and timber, development and expansion of cities .These economic gains are short term where as long term effects of deforestation are irreversible
- ✓ Deforestation rate is relatively low in temperate countries than in tropics. If present rate of deforestation continues we may losses 90% tropical forest in coming six decades 3. For ecological balance 33% area should be under forest cover but our nation has only 24.62% forest cover.

Causes of deforestation

Forest area in some developed area has expanded. However in developing countries area under forest is showing declining trend particularly in tropical region. Main causes of deforestation are

Shifting cultivation or jhum cultivation

This practice is prevalent in tribal areas where forest lands are cleared to grow subsistence crops. It is estimated that principle cause of deforestation in tropics in Africa, Asia

and tropical America is estimated to be 70, 50, and 35% respectively. Shifting cultivation which is a practice of slash and burn agriculture are posses to clear more than 5 lakh hectares of land annually. In India, shifting cultivation is prevalent in northeast and to limited extent in M.P, Bihar and Andhra Pradesh and is contributing significantly to deforestation.

Commercial logging

It is a important deforestation agent. It may not be the primary cause but definitely it acts as secondary cause, because new logging lots permits shifting cultivation and fuel wood gatherers access to new logged areas.

Need for fuel wood

Increased population has lead to increasing demand for fuel wood which is also acting as an important deforestation agent, particularly in dry forest.

Expansion for agribusiness

With the addition of cash crops such as oil palm, rubber, fruits and ornamental plants, there is stress to expand the area for agribusiness products which results in deforestation.

Development projects and growing need for food

The growing demand for electricity, irrigation, construction, mining, etc. has lead to destruction of forest. Increased population needs more food which has compelled for increasing area under agriculture crops compelling for deforestation.

Raw materials for industrial use

Forest provides raw material for industry and it has exerted tremendous pressure on forest. Increasing demand for plywood for backing has exerted pressure on cutting of other species such as fir to be used as backing material for apple in J&K and tea in northeast states.

Other

1. Agriculture: Conversion of forests to agricultural land to feed growing numbers of people.
2. Commercial logging: (which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forest for agriculture. Cutting of trees for fire wood and building material, the heavy lopping of foliage for fodder and heavy grazing of saplings by domestic animals like goals.
3. The cash crop economy: Raising cash crops for increased economy.
4. Mining.
5. Increase in population: The needs also increase and utilize forests resources.
6. Urbanization & industrialization.
7. Mineral exploration.
8. Construction of dam reservoirs.
9. Infrastructure development.
10. Forest fires.
11. Human encroachment & exploitation.
12. Pollution due to acid rain

Major effects of deforestation

Deforestation adversely and directly affects and damages the environment and living beings .Major causes of deforestation are

- ✓ Soil erosion and loss of soil fertility
- ✓ Decrease of rain fall due to affect of hydrological cycle

- ✓ Expansion of deserts
- ✓ Climate change and depletion of water table
- ✓ Loss of biodiversity ,flora and fauna
- ✓ Environmental changes and disturbance in forest ecosystems
- ✓ Food problems
- ✓ Ecological imbalance
- ✓ Increasing CO_2
- ✓ Floods leading to soil erosion
- ✓ Destruction of resources
- ✓ Heavy siltation of dams
- ✓ Changes in the microclimate
- ✓ Loss of biodiversity
- ✓ Desiccation of previously moist forest soil
- ✓ Heavy rainfall and high sunlight quickly damage the topsoil in clearings of the tropical rainforests. In such circumstance, the forest will take much longer to regenerate and the land will not be suitable for agricultural use for quite some time.
- ✓ Where forests are replanted, their replacement can mean a loss of quality
- ✓ Loss of future markets for ecotourism. The value of a forest is often higher when it is left standing than it could be worth when it is harvested.
- ✓ Some indigenous peoples‘ way of life and survival are threatened by the loss of forests. Fewer trees results an insecure future for forest workers
- ✓ Deforestation can cause the climate to become extreme in nature. The occurrence and strength of floods and droughts affecting the economy.
- ✓ The stress of environmental change may make some species more susceptible to the effect of insects, pollution, disease and fire
- ✓ Most humid regions changes to desert
- ✓ Environmental pollution
- ✓ Global warming

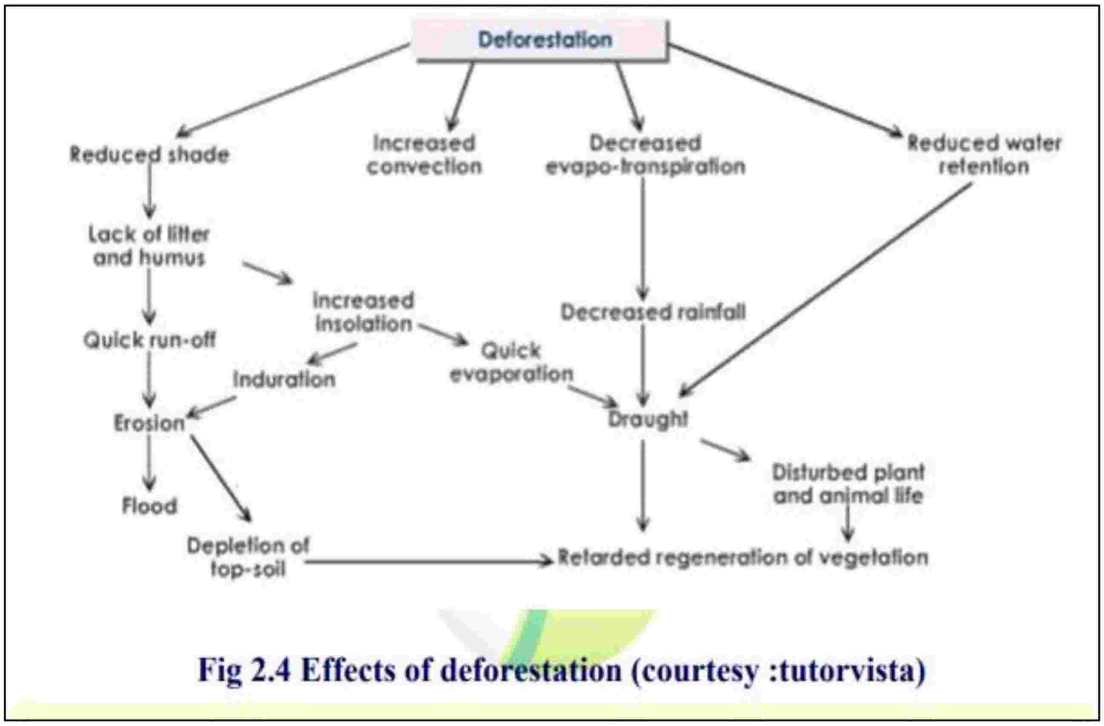


Fig 2.4 Effects of deforestation (courtesy :tutorvista)

Case studies

1.Jhum cultivation

Jhum Agriculture or shifting agriculture has destroyed large number of hectare of forest tracts in North-Eastern states and Orissa. Jhum agriculture is subsidence agriculture in which tract of forest land is cleared by cutting trees and it is used for cultivation. After few years, when productivity of the land decreases, cultivators abandon the land and clear next tract. As a result of this practise, combined with increasing population there is rapid deforestation as more and more cultivators clear forest to cultivate land. Also, with increase in population there is cultivators are forced to return to previous tracts of land in relatively shorter durations, not allowing the land to regain its productivity.

Chipko movement

The Chipko movement or Chipko Andolan is a social-ecological movement that practised the Gandhian methods of satyagraha and non-violent resistance, through the act of hugging trees to protect them from being felled. The modern Chipko movement started in the early 1970s in the Garhwal Himalayas of Uttarakhand,with growing awareness towards rapid deforestation. The landmark event in this struggle took place on March 26, 1974, when a group of peasant women in Reni village, Hemwalghati, in Chamoli district, Uttarakhand, India, acted to prevent the cutting of trees and reclaim their traditional forest rights that were threatened by the contractor system of the state Forest Department. Their actions inspired hundreds of such actions at the grassroots level throughout the region. By the 1980s the movement had spread throughout India and led to formulation of people-sensitive forest policies, which put a stop to the open felling of trees in regions as far reaching as Vindhyas and the Western Ghats.

Western himalayan region.

Over the last decade, there has been widespread destruction and degradation of forest resources in Himalayas, especially western Himalayas. This has resulted in various problems such as erosion of top soil, irregular rainfall, changing weather patterns and floods. Construction of roads on hilly slopes, have not only undermined their stability, but also damaged protective vegetation and forest cover. Tribes in these areas are increasingly facing shortage of firewood and timber, due large scale tree cutting. Increased traffic volumes on these roads leads to increased pollution in the area.

Timber extraction

There has been unlimited exploitation of timber for commercial use. Due to increased industrial demand; timber extraction has significant effect on forest and tribal people.

Logging

Poor logging results in degraded forest and may lead to soil erosion especially on slopes. New logging roads permit shifting cultivators and fuel wood gatherers to gain access to the logging area. Loss of long term forest productivity Species of plants and animals may be eliminated Exploitation of tribal people by contractor.

Mining

Major effects of mining operations on forest and tribal people are:

- ✓ Mining from shallow deposits is done by surface mining while that from deep deposits is done by sub-surface mining. It leads to degradation of lands and loss of top soil. It is estimated that about eighty thousands hectare land is under stress of mining activities in India
- ✓ Mining leads to drying up perennial sources of water sources like spring and streams in mountainous area.
- ✓ Mining and other associated activities remove vegetation along with underlying soil mantle, which results in destruction of topography and landscape in the area. Large scale deforestation has been reported in Mussorie and Dehradun valley due to indiscriminating mining.
- ✓ The forested area has declined at an average rate of 33% and the increase in non- forest area due to mining activities has resulted in relatively unstable zones leading to landslides.
- ✓ Indiscriminate mining in forests of Goa since 1961 has destroyed more than 50000 ha of forest land. Coal mining in Jharia, Raniganj and Singrauli areas has caused extensive deforestation in Jharkhand.
- ✓ Mining of magnetite and soapstone have destroyed 14 ha of forest in hilly slopes of Khirakot, Kosi valley and Almora.
- ✓ Mining of radioactive minerals in Kerala, Tamilnadu and Karnataka are posing similar threats of deforestation.
- ✓ The rich forests of Western Ghats are also facing the same threat due to mining projects for excavation of copper, chromites, bauxite and magnetite.

Effects of dams on forests and tribal people

- ✓ Pandit Jawaharlal Nehru referred dam and valley projects as ―Temples of modern India‖. These big dams and rivers valley projects have multi-purpose uses. However, these dams

are also responsible for the destruction of forests. They are responsible for degradation of catchment areas, loss of flora and fauna, increase of water borne diseases, disturbance in forest ecosystems, rehabilitation and resettlement of tribal peoples.

- ✓ India has more than 1550 large dams, the maximum being in the state of Maharashtra (more than 600), followed by Gujarat (more than 250) and Madhya Pradesh (130).
- ✓ The highest one is Tehri dam, on river Bhagirathi in Uttaranchal and the largest in terms of capacity is Bhakra dam on river Satluj in Himachal Pradesh. Big dams have been in sharp focus of various environmental groups all over the world, which is mainly because of several ecological problems including deforestation and socio- economic problems related to tribal or native people associated with them.
- ✓ The Silent valley hydroelectric project was one of the first such projects situated in the tropical rain forest area of Western Ghats which attracted much concern of the people.
- ✓ The crusade against the ecological damage and deforestation caused due to Tehri dam was led by Shri. Sunder Lal Bahaguna, the leader of Chipko Movement.
- ✓ The cause of Sardar Sarovar Dam related issues have been taken up by the environmental activitist Medha Patkar, joined by Arundhati Ray and Baba Amte. For building big dams, large scale devastation of forests takes place which breaks the natural ecological balance of the region.
- ✓ Floods, droughts and landslides become more prevalent in such areas. Forests are the repositories of invaluable gifts of nature in the form of biodiversity and by destroying them (particularly, the tropical rain forests), we are going to lose these species even before knowing them. These species could be having marvellous economic or medicinal value and deforestation results in loss of this storehouse of species which have evolved over millions of years in a single stroke.

Forest conservation and management

Forest is one of the most valuable resources and thus needs to be conserved. To conserve forest, following steps should be taken.

1. Conservation of forest is a national problem; thus it should be tackled with perfect coordination between concerned government departments.
2. People should be made aware of importance of forest and involved in forest conservation activities.
3. The cutting of trees in the forests for timber should be stopped.
4. A forestation programmes should be launched
5. Grasslands should be regenerated.
6. Forest conservation Act should be strictly implemented to check deforestation.
7. Awards should be instituted for the deserving.

WATER RESOURCES

'Water is the driver of Nature' - Leonardo daVinci

Introduction

Water is an indispensable resource for life on earth. Approximately 70.8 % surface of earth is covered with water in the form of oceans. Out of this, about 97% is not fit for human consumption, about 2% is locked as a glacier and only less than 1% available as fresh water that can be used for human consumption and other uses.

- ✓ Water is a very important source and essential for life because it has very unique characteristic such as
- ✓ Water exists as liquid over a wide range of temperature 0-1000C with highest specific heat and latent heat of vaporizations.
- ✓ Water is excellent solvent and act as carrier of nutrient and helps to distribute them to the cells in the body, regulates the body temperature and support structure and can dissolve various pollutant and can act as carrier of large number of microorganisms
- ✓ It is responsible for hydrological cycle which acts as resource of water to the earth. It is estimated that about 1.4 inch thick layer of water evaporates and majority of water returns to earth through hydrological cycle.

Water Use

More than 99% of earth water is unavailable for use; only 1% water is available for people, animal, plants and earth. There is an uneven distribution of water resources, tropical rainforest are receive maximum rainfall where as desert receive only little rainfall.

Due to its unique properties water is of multiple uses for all living organisms. Water is absolutely essential for all the living organisms. One can survive for weeks without food but cannot survive more than a few days without water. Since the earliest days of mankind water availability was the major factor to decide the place of human settlements. Water dissolves nutrients and distributes them in different parts of plants and regulates the temperature and removes the waste.

Fresh water crisis

On global scale water availability is not a problem itself, but it‘s availability in right form, right time and right place is a problem. Irregularities in duration and intensity of rainfall cause floods and droughts. Out of the total water reserves of the world, about 97% is salty water (marine) and only 3% is fresh water.

Due to increased demands overuse of groundwater for drinking, irrigation and domestic purposes has lead to rapid depletion of groundwater in various regions leading to lowering of water table.

Pollution of many of the groundwater aquifers has made them unfit for consumption. Rivers and streams have long been used for discharging the wastes. due to industrialization river water are being polluted because industrial residues are pushed into the river. Civilizations have grown and flourished on the banks of rivers, but being over populated due to fast growth are polluting the natural resources of water.

Problems associated with water resources

- ✓ These are some problems associated with use of water
- ✓ Water Scarcity (precipitation/evapotranspiration balance, temporal availability, per capita availability)
- ✓ Floods and droughts (spatio-temporal distribution; regular floods related to heavy winter or spring rains, increasing damage level due to shifting land use (settlements in flood zones) recurrent summer droughts coinciding with peak demand periods for agriculture and tourism)
- ✓ Groundwater availability and quality (aquifer size and access, yield, saltwater intrusion,

pollution of shallow aquifers)

- ✓ Watershed degradation (deforestation, land use, increasing impervious (sealed) areas due to urbanization the main concern here is land use change (primarily deforestation and urbanization) and its effects on runoff patterns (flooding) and water quality including erosion/sediments with subsequent problems such as reservoir siltation/capacity loss)
- ✓ Coastal interaction (salinity intrusion in groundwater and estuaries, coastal pollution due to pollution runoff)

Over-Exploitation of Water Groundwater

About 9.86% of the total fresh water resources are in the form of groundwater and **it is about 35-50 times that of surface water supplies.**

Effects of extensive and reckless groundwater usage:

1. Subsidence
2. Lowering of water table
3. Water logging

Surface water

Surface water mainly comes directly from rain or snow covers. The various surface sources are natural lakes and ponds, rivers and streams, artificial reservoirs. Availability of surface water decides the economy of the country. On one side surface water availability affects the productivity, but on the other side water sources may cause floods and drought. Due to unequal distribution, water may lead to national (interstate) or international disputes. Sharing of surface water due to these disputes is affecting productivity of different agro eco-zone and creating problems for government.

Recently many water conflicts at national and international levels relating to sharing of surface water are catching the headlines of newspaper.

Major Water Conflicts

Some of the major water conflicts that have become thorn in relations between states and countries are,

Water conflict in the middle east

Countries involved are Sudan, Egypt and Turkey. It also affects countries which are water starved viz. Saudi Arabia, Kuwait, Syria, Israel and Jordan.

The Indus water treaty

This Indus water treaty dispute between India and Pakistan is lingering since long.

The Cauvery water dispute

It involves two major states of India viz. Tamilnadu and Karnataka.

The Satluj-Yamuna link canal dispute

The dispute is between two Northern states viz. Punjab and Haryana and UP, Rajasthan as well as Delhi has also interest in it .

In traditional water management, innovative arrangements ensure equitable distribution of water, which are democratically implemented. These disputes can be solved amicably through _Gram Panchayats‖, if transparency is maintained. But disputes between countries or states sometimes attain war like situation and are difficult to solve.

Dams - Benefits and Problems

Water is a precious resource and its scarcity is increasing at global level. There is a pressure to utilise surface water resources efficiently for different purposes. According to World Commission on Dam Report -2001 there are 45000 large dams spread over 140 countries

Major benefits of dams

The major benefits of dams are

1. Hydroelectricity generation
2. Year round water supply to ensure higher productivity
3. Equal water distribution by transferring water from area of excess to area of deficit
4. Helps flood control and protects soil
5. Assure irrigation during dry periods
6. River valley projects provide inland water navigation ,employment opportunities and can be used to develop fish hatcheries and nurseries
7. River valley projects have tremendous potential for economic upliftment and will help to raise the standard of living and can help to improve the quality of life

Disadvantages/problems

Although dams have proved very useful over the centuries but recent past big dams has created lot of human as well as environmental issues

1. Submergence of large areas may lead to loss of fertile soil and displacement of tribal people
2. Salt left behind due to evaporation increase the salinity of river water and makes it unusable when reaches down stream
3. Siltation and sedimentation of reservoirs not only makes dams use less but also is responsible for loss of valuable nutrients
4. Loss of non-forest land leads to loss of flora and fauna
5. Changes in fisheries and the spawning grounds
6. Stagnation and water logging near reservoir leads to breeding of vectors and spread of vector-borne diseases
7. Growth of aquatic weeds may lead to microclimatic changes.

MINERAL RESOURCES

'God sleeps in the minerals, awakens in plants, walks in animals, and thinks in man' - ArthurYoung

Introduction

Minerals are essential for the formation and functioning of organisms, plant animals and human beings. In the modern era, human life needs variety of minerals to sustain industry based civilization. Mineral resources are broadly defined as elements, chemical compounds, and mixtures which are extracted to manufacture sustainable commodity. India has rich mineral resource base to provide suitable base for industrial development in the country. Sufficient reserve of nuclear energy minerals is available in India.

India‘s reserves, as well as production are adequate in petroleum, ores of copper, lead, zinc, tin, graphite, mercury, tungsten, and in the minerals required for fertilizer industry such as sulphur, potassium and phosphorus.

Exploitation of Minerals

Depending on their use, mineral resources can be divided into several broad categories such as elements for metal production and technology, building materials, minerals for the chemical industry and minerals for agriculture. When usually we think about mineral resources we often think of metals but the predominant mineral resources are not metallic. The picture of annual world consumption of some elements is as under:

- ✓ Sodium and iron are used at a rate of about 0.1 to 1.0 billion metric tons per year. Nitrogen, sulphur, potassium and calcium are primarily used as fertilizers at a rate of about 10 to 100 million metric tons per year.
- ✓ Zinc, copper, aluminium and lead are used at a rate of about 3 to 10 million metric tonsper year;
- ✓ Gold and silver are used at a rate of about 10 thousand metric tons per year.
- ✓ Out of all the metallic minerals, iron consumption is 95% of the metals consumed

Thus, with the exception of iron, the non-metallic minerals are consumed at much greater rates than the elements used for their metallic properties.

1. **Environmental degradation**: The mining of mineral resources can result in the destruction of habitats, deforestation, soil erosion, and water pollution, affecting the biodiversity and ecosystem services.
2. **Health hazards**: Mining and processing of mineral resources can release toxic substances and dust particles into the air and water, leading to respiratory problems, cancers, and other health problems.
3. **Social conflicts**: The exploitation of mineral resources can result in social conflicts between different stakeholders, including local communities, mining companies, and the government, over issues such as land rights, compensation, and environmental impacts.
4. **Economic instability**: The over-dependence on mineral resources can lead to economic instability, as the demand and prices of minerals are subject to fluctuations in the global market.

Therefore, it is essential to adopt sustainable practices in the use and exploitation of mineral resources, such as:

1. **Recycling**: Recycling of metals and other materials reduces the need for mining and extraction of new mineral resources.
2. **Conservation**: Adopting conservation measures such as reducing energy consumption and using alternative sources of energy reduces the demand for mineral resources.
3. **Responsible mining practices**: Mining companies should adopt responsible mining practices such as reducing waste generation, minimizing environmental impacts, and engaging with local communities.
4. **Policies and regulations**: Governments should enact policies and regulations to ensure sustainable use and exploitation of mineral resources, such as imposing environmental standards, enforcing labor laws, and protecting the rights of local communities.

Uses of Minerals

Due to increased population, there is increased demand of minerals by the industry, transport, agriculture and defense preparation. Depletion of almost all known and easily accessible deposits is anticipated in near future. Moreover, there may be shortage of some crucial elements such as mercury, tin, copper, gold, silver and platinum. The limited resource of phosphorus, which is an essential component of chemical fertilizers, is another area of concern.

The use of mineral resources has significant benefits, including:

1. **Economic development**: The use of mineral resources contributes significantly to a country's economic development by creating employment opportunities, generating revenue, and contributing to exports.
2. **Infrastructure development**: The construction of buildings, roads, and other infrastructure requires the use of mineral resources.
3. **Energy production**: Mineral resources such as coal, oil, and natural gas are used as sources of energy for electricity generation, transportation, and heating.
4. **Manufacturing**: Mineral resources are used in the production of a wide range of products, including automobiles, electronic devices, construction materials, and machinery.

S.No	Mineral	Uses
	A. Metallic	
1	Aluminium	Building materials, electrical wiring, utensils, aircraft, rockets
2	Beryllium	Refractories, copper alloys
3	Chromium	Refractory, metallurgy, chemicals
4	Cobalt	Alloys, radiography, catalysts, therapeutics
5	Columbium	Stainless steel, nuclear reactors
6	Copper	Alloys, electrical products
7	Gold	Monetary purposes, jewellery, dentistry
8	Iron	Steel, building materials, numerous industrial uses
9	Lead	Batteries, paints, alloys, public health fittings, gasoline
10	Magnesium	Structural refractories
11	Manganese	Alloy steels, disinfectants
12	Uranium	Nuclear bombs, electricity generation, tinting glass
	B. Non-Metallic	
1	Asbestos	Roofing, insulation, ceramics, textiles, gasoline, solid propellants.
2	Corundum	Abrasives
3	Feldspar	Ceramic flux, artificial teeth
4	Fluorspar	Flux, refrigerants, propellants, acid
5	Nitrates	Fertilizers, chemicals
6	Phosphates	Fertilizers, chemicals
7	Sulphur	Fertilizers, acid, iron and steel industry

Environmental Impacts of Mineral Extraction

Extracting and use of mineral resources can affect the environment adversely. Environmental affect may depend on factors such as mining procedures, ore quality, climate, size of operation, topography, etc. Some of major environmental impacts of mining and processing operations areas under

1. Degradation of land.
2. Pollution of surfaces and ground water resources.
3. Effect on growth of vegetation due to leaching out effect of minerals.
4. Surface water pollution and groundwater contamination lead to occupational health hazards etc.
5. Deforestation affects flora and fauna.

The extraction and use of mineral resources can have a number of negative environmental effects, including:

Greenhouse gas emissions: The extraction and processing of raw materials is responsible for about half of the world's greenhouse gas emissions.

Water stress: The extraction and processing of raw materials is responsible for more than 90% of the world's water stress.

Biodiversity loss: The extraction and processing of raw materials is responsible for more than 90% of the world's land-use-related biodiversity loss.

Habitat destruction: The extraction of minerals can destroy habitats, which can affect species populations, ranges, and biodiversity.

Soil erosion: The extraction of minerals can lead to soil erosion.

Water pollution: The extraction of minerals can lead to water pollution.

Air pollution: The extraction of minerals can lead to air pollution.

Sinkholes: The extraction of minerals can cause sinkholes.

Seismic activity: The use of hydraulic fracking to remove oil and gas can increase seismic activity in some regions.

Conservation of Minerals

Conservation of minerals can be done in number of ways and these are as follows,

- ✓ Industries can reduce waste by using more efficient mining and processing methods. In some cases, industries can substitute plentiful materials for scarce ones.
- ✓ Some mineral products can be recycled. Aluminum cans are commonly recycled. Although bauxite is plentiful, it can be expensive to refine. Recycling aluminum products does not require the large amounts of electric power needed to refine bauxite.
- ✓ Products made from many other minerals, such as nickel, chromium, lead, copper, and zinc, can also be recycled**.**
- ✓ Strict laws should be made and enforced to ensure efficient management of mining resources.

Case Study

- ✓ Aravilli mountains which covers about 10% of geographical area is rich source of minerals wealth. This mountain range play important role in control of climate and act as mini water shed. On the request of environmentalist, Honourable Supreme Court has passed the order tostop these mines in Rajasthan
- ✓ Marble mining near Rajsamant Lake has lead to drying up of lake. Marble mining was stoppedon December 2002.
- ✓ Recently, mining in Goa has attained the attention of the press and media and ultimately government has to take the decision to stop this mining.

FOOD RESOURCES

'A house is not a home unless it contains food and fire for the mind as well as the body'- - Benjamin Franklin

Introduction

Food is essential for growth and development of living organisms. These essential materials are called nutrients and these nutrients are available from variety of animals and plants. There are thousands of edible plants and animals over the world, out of which only about three dozen types constitute major food of humans.

Food sources

The majority of people obtain food from cultivated plants and domesticated animals. Although some food is obtained from oceans and fresh waters, but the great majority of food for human population is obtained from traditional land-based agriculture of crops and livestock.

Food crops

It is estimated that out of about 2,50,000 species of plants, only about 3,000 have been tried as agricultural crops. Under different agro-climatic condition, 300 are grown for food and only 100 are used on a large scale.

Some species of crops provide food, whereas others provide commercial products like oils, fibres, etc. Raw crops are sometimes converted into valuable edible products by using different techniques for value addition .At global level, only 20 species of crops are used for food. These, in approximate order of importance are wheat, rice, corn, potatoes; barley, sweet potatoes, cassavas, soybeans, oats, sorghum, millet, sugarcane, sugar beets, rye, peanuts, field beans, chick-peas, pigeon- peas, bananas and coconuts. Many of them are used directly, whereas other can be used by changing them by using different techniques for enhancing calorific value.

Livestock

Domesticated animals are an important food source. The major domesticated animals used as food source by human beings are _ruminants' (e.g. cattle, sheep, goats, camel, reindeer, llama, etc.).

Ruminants convert indigestible woody tissue of plants (cellulose) which are earth's most abundant organic compound into digestible food products for human consumption.

Milk, which is provided by milking animals, is considered to be the complete food. Other domestic animals like sheep, goat, poultry and ducker can be used as meat.

Aquaculture

Fish and seafood contributes 17 million metric tonnes of high quality protein to provide balance diet to the world. Presently aquaculture provides only small amounts for world food but its significance is increasing day by day.

World Food Problems

As per estimates of Food and Agriculture Organization (FAO), about 840 million people remain chronically hungry and out of this 800 million are living in the developing world. In last decade, it is decreasing at the rate of 2.5 million per year, but at the same time world's population is increasing. Target of cutting half the number of world's chronically hungry and undernourished people by 2015 will difficult to meet, if the present trend continues. Due to inadequate purchasing power to buy food, it is difficult to fulfill minimum calorific requirement of human body per day .Large number of people are in India are poor which can be attribute to equitable distribution of income .

Food insufficiency can be divided into two categories into under-nourishment and malnourishment. Both of these insufficiencies are global problems.

Under-nourishment

The FAO estimates that the average minimum daily caloric intake over the whole world is about 2,500 calories per day. People who receive less than 90% of their minimum dietary intake on a long-term basis are considered undernourished. Those who receive less than 80% of their minimum daily caloric intake requirements are considered _seriously' undernourished. Children in this category are likely to suffer from stunted growth, mental retardation, and other social and developmental disorders. Therefore, Under-nourishment means lack of sufficient calories in available food, resulting in little or no ability to move or work.

Malnourishment

Person may have excess food but still diet suffers from due to nutritional imbalance or inability to absorb or may have problem to utilize essential nutrients. If we compare diet of the developed countries with developing countries people in developed countries have processed food which may be deficient in fibre, vitamins and other components where as in the diet of developing countries, may be lack of specific nutrients because they consume less meat ,fruits and vegetables due to poor purchasing power .

Malnourishment can be defined as lack of specific components of food such as proteins, vitamins, or essential chemical elements.

The major problems of malnutrition are:

- ✓ Marasmus: a progressive emaciation caused by lack of protein and calories.
  Kwashiarkor: a lack of sufficient protein in the diet which leads to a failure of neural development and therefore learning disabilities.
- ✓ Anemia: it is caused by lack of iron in the diet or due to an inability to absorb iron from food.
- ✓ Pellagra: it occurs due to the deficiency of tryptophan and lysine, vitamins in the diet.

Every year, food problem kill as many people as were killed by the atomic bomb dropped on Hiroshima during World War II. This shows that there is drastic need to increase food production, equitably distribute it and also to control population growth. Although India is the third largest producer of staple crops, it is estimated that about 300 million Indians are still undernourished. India has only half as much land as USA, but it has nearly three times population to feed. Our food problems are directly related to population. Balanced diet.

Supply of adequate amount of different nutrient can help to improve malnutrition and its ill effects. Cereals like wheat and rice can supply only carbohydrate which are rich in energy supply, are only fraction of nutrition requirement. Cereal diet has to be supplemented with other food that can supply fat, protein and minor quantity of minerals and vitamins. Balanced diet will help to improve growth and health.

Changes Caused by Agriculture and Overgrazing

From centuries, agriculture is providing inputs to large number of industries involved in production, processing and distribution of food. Accordingly, agriculture has significant effect on environment. The effects of agriculture on environment can be classified as local, regional, and global level. The agriculture also makes impact on the usage of land generally as follows:

1. Deforestation
2. Soil Erosion
3. Depletion of nutrients
4. Impact related to high yielding varieties (HYV)
5. Fertilizers related problems include micronutrient imbalance, nitrite pollution and eutrophication.
6. Pesticide related problems include creating resistance in pests and producing new pests, death of non-target organisms, biological magnification.
7. Some other problems include water logging, salinity problems and such others.

The carrying capacity of land for cattle depends upon micro climate and soil fertility. If carrying capacity is exceeded than land is overgrazed. Because of overgrazing the agricultural land gets affected as follows, Reduction in growth and diversity of plant species Reduce plant cover leads to increased soil erosion Cattle trampling leads to land degradation

Effects of Modern Agriculture

For sustainable production modern techniques are used to enhance productivity of different cropping systems under different agro-eco-zones. Adoption of modern agricultural **practices has both positive and negative effects on environment. Effects of modern agriculture are briefly discussed under different heads as under:**

Soil erosion

Raindrops bombarding bare soil result in the oldest and still most serious problem of agriculture. The long history of soil erosion and its impact on civilization is one of devastation. Eroded fields record our failure as land stewards.

Irrigation

Adequate rainfall is never guaranteed for the dry land farmer in arid and semiarid regions, and thus irrigation is essential for reliable production. Irrigation ensures sufficient

water when needed and also allows farmers to expand their acreage of suitable cropland. In fact, we rely heavily on crops from irrigated lands, with fully one-third of the world's harvest coming from that 17% of cropland that is under irrigation. Unfortunately, current irrigation practices severely damage the cropland and the aquatic systems from which the water is withdrawn.

Agriculture and the loss of genetic diversity

As modern agriculture converts an ever-increasing portion of the earth's land surface to monoculture, the genetic and ecological diversity of the planet erodes. Both the conversion of diverse natural ecosystems to new agricultural lands and the narrowing of the genetic diversity of **crops contribute to this erosion.**

Fertilizer-pesticide problems

For photosynthesis apart from water, sunshine and CO2, plants need micro and macro nutrients for growth. These nutrients are supplied in the shape of fertilizers. There is lot of potential to increase food productivity by increasing fertilizer use. On one hand application of artificial chemical fertilizers increases the productivity at faster rate as compare to organic fertilizers, on the other hand application of fertilizers can be a serious problem of pollution and can create number of problems. Excessive level of nitrates in ground water has created problems in developed countries. These are:

1. Accumulated phosphorous as a consequence of use of phosphoric fertilizer are posing serious threat as residues in domestic water supply and for ecology of river and other water bodies. Increased level of phosphates in different water results in eutropication.
2. Effect of chemical fertilizer is long term, therefore leads to net loss of soil organic matter.

To control insects, pests, diseases and weeds which are responsible for reduction in productivity different chemicals are used as insecticides, pesticides and herbicides. Successful control of insects, pests and weeds increases productivity and reduces losses and provide security for harvest and storage. Applications of these synthetic chemicals have great economic values and at the same time cause number of serious problems such as:

- ✓ Affects human health which includes acute poisoning and illness caused by higher doses and accidental exposes
- ✓ As long term effect, cause cancer, birth defects, Parkinson‘s disease and other regenerative diseases.
- ✓ Long term application of pesticides can affect soil fertility.
- ✓ Danger of killing beneficial predators.
- ✓ Pesticides resistance and pest resurgence

Water Logging

High water table or surface flooding can cause water logging problems .Water logging may lead to poor crop productivity due to anaerobic condition created in the soil. In India, deltas of Ganga, Andaman and Nicobar Islands and some areas of Kerala are prone to frequent water logging.

Salinity

Due to adoption of intensive agriculture practices and increased concentration of soluble salts leads to salinity. Due to poor drainage, dissolved salts accumulate on soil surface

and affects soil fertility. Excess concentration of these salts may form a crust on the surface which may injurious to the plants. The water absorption process is affected and uptake of nutrient is disturbed. According to an estimate, in India, 7 million hectare of land is saline and area is showing in increasing trends due to adoption of intensive agriculture practises.

Case Studies

1. A study on birth defects in water birds, in Kesterson wildlife refuge in California, indicated that these defects where due to high concentration of selenium.
2. Recent reports from cotton growing belt of Punjab which covers Abohar, Fazalka and part of Bathinda indicates that over use of pesticides for control of insect pest in cotton to enhance productivity has not only affected soil health, but also caused cancer in human being.
3. Diclofenac is the drug for veterinary use to treat the livestocks which have strong residual nature, which leads to high persistence throughout the foodchain .Due to biomagnification it becomes more dangerous to the vultures as they are consumers of diclofenac treated cattle. Diclofenac is responsible for bringing three South Asian species of Gyps vultures to the brink of extinction. It has been banned in India since 2006.

ENERGY RESOURCES

Energy consumption of a nation is usually considered as an index of its development, because almost all the development activities are directly or indirectly dependent upon energy. Power generation and energy consumption are crucial to economic development as economy of any nation depends upon availability of energy resources. There are wide disparities in per capita energy use of developed and the developing nations. With increased speed of development in the developing nations energy needs are also increasing.

- ✓ The very original form of energy technology probably was the fire, which produced heat and the early man used it for cooking and heating purposes.
- ✓ Wind and hydropower has also been used. Invention of steam engineers replaced the burning of wood by coal and coal was further replaced by oil.
- ✓ The oil producing has started twisting arms of the developed as well as developing countries by dictating the prices of oil and other petroleum products.
- ✓ Energy resources are primarily divided into two categories viz. renewable and non-renewable sources.
- ✓ Renewable energy resources must be preferred over the non-renewable resources.

It is inevitable truth that now there is an urgent need of thinking in terms of alternative sources of energy, which are also termed as non-conventional energy sources which include:

a. Solar energy needs equipment's such as solar heat collectors, solar cells, solar cooker, solar water heater, solar furnace and solar power plants .
b. Wind energy
c. Hydropower, Tidal energy, ocean thermal energy, geothermal energy, biomass, biogas, biofuels etc.

The non renewable energy sources include coal, petroleum, natural gas, nuclear energy.

Energy Scenario

Energy is a key input in the economic growth and there is a close link between the availability of energy and the future growth of a nation. Power generation and energy consumption are crucial to economic development.

In India, energy is consumed in a variety of forms such as fuel wood; animal waste and agricultural residues are the traditional sources of energy. These non-commercial fuels are gradually getting replaced by commercial fuels i.e. coal, petroleum products, natural gas and electricity.

Out of total energy, commercial fuels account for 60% where as the balance 40% is coming from non-commercial fuels. Of the total commercial energy produced in the form of power or electricity,

- ✓ 69% is from coal (thermal power), 25% is from hydel power,
- ✓ 4% is from diesel and gas,
- ✓ 2% is from nuclear power, and
- ✓ Less than 1% from non- conventional sources like solar, wind, ocean, biomass, etc.

Petroleum and its products are the other large sources of energy. In a developing country like India, in spite of enhanced energy production, there is still shortage due to increased demand of energy. In spite of the fact that there is a phenomenal increase in power generating capacity, still there is 30% deficit of about 2,000 million units.

Policy makers are in the process of formulating an energy policy with the objectives of ensuring adequate energy supply at a minimum cost, achieving self-sufficiency in energy supplies and protecting environment from adverse impact of utilizing energy resources in an injudicious manner. The main features of this policy are

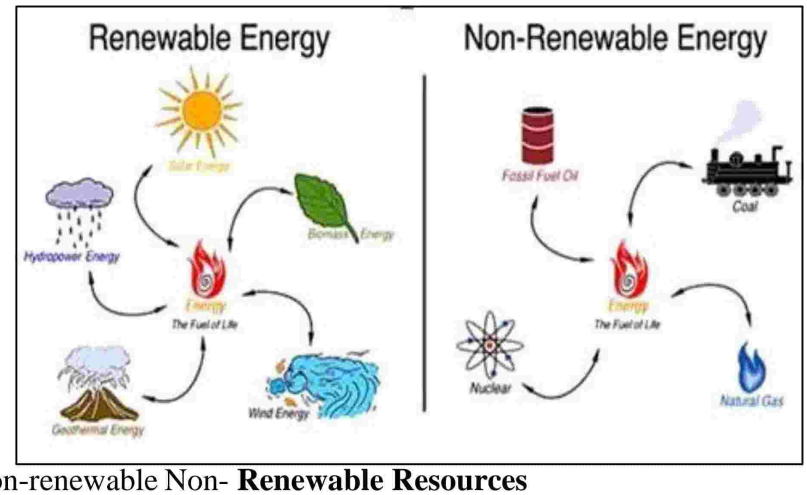
1. Accelerated exploitation of domestic conventional energy resources, viz., oil, coal, hydro and nuclear power;
2. Intensification of exploration to achieve indigenous production of oil and gas;
3. Efficient management of demand of oil and other forms of energy;
4. To formulate efficient methods of energy conservation and management;
5. Optimization of utilization of existing capacity in the country
6. Development and exploitation of renewable sources of energy to meet energy requirements of rural communities;
7. Organization of training for personnel engaged at various levels in the energy sector.
8. Government private partnership to exploit natural energy resources

Renewable Resources

The resources that can be replenished through rapid natural cycles are known as renewable resource. These resources are able to increase their abundance through reproduction and utilization of simple substances.

Examples of renewable resources are plants (crops and forests),and animals who are being replaced from time to time because they have the power of reproducing and maintain life cycles. Some examples of renewable resources though they do not have life cycle but can be recycled are wood and wood-products, pulp products, natural rubber, fibres (e.g. cotton, jute, animal wool, silk and synthetic fibres) and leather.

In addition to these resources, water and soil are also classified as renewable resources. Solar energy although having a finite life, as a special case, is considered as a renewable resource in as much as solar stocks is inexhaustible on the human scale.



Renewable & non-renewable Non- **Renewable Resources**

- ✓ The resources that cannot be replenished through natural processes are known as non-renewable resources.
- ✓ These are available in limited amounts, which cannot be increased. These resources include fossil fuels (petrol, coal etc.), nuclear energy sources (e.g. uranium, thorium, etc). metals (iron, copper, gold, silver, lead, zinc etc.), minerals and salts (carbonates, phosphates, nitrates etc.).
- ✓ Once a non-renewable resource is consumed, it is gone forever. Then we have to find a substitute for it or do without it.
- ✓ Non-renewable resources can further be divided into two categories, viz. Recyclable and non-recyclable

Difference between Renewable and Non-renewable resources

Renewable Resources	**Non-renewable resources**
(1) It can be used again and again throughout its life.	(1) It cannot be used again and again as it is limited.
(2)These are energy resources which cannot be exhausted.	(2) These are energy resources which can be exhausted.
(3) It is environment friendly as the amount of carbon emission is low.	(3) It is not environment friendly as the amount of carbon emission is high.
(4) Unlimited in quantity	(4) Limited in quantity
(5) Total cost of these resources is low.	(5) Total cost is comparatively high
(6) These resources are pollution free.	(6) These resources are not pollution free.
(7) The maintenance cost of these resources is very high	(7) Maintenance cost of these resources is low.

(8) It is sustainable	(8) It is exhaustible
(9) The rate of renewable is greater than the rate of consumption	(9) The rate of renewable is lower than that the rate of consumption.
(10) Cause no harm to life existing on the planet earth.	(10) Adversely affect the health of humans by emitting smoke, radiations etc.
(11) Example - Sunlight, Wind, Water	(11) Example - Coal, Petroleum, Batteries

Use of Alternate Energy Sources

There is a need to develop renewable energy sources which are available and could be utilized (solar or wind) or the sources which could be created and utilized (bio-mass). The main renewable energy sources for India are solar, wind, hydel, waste and bio-mass. Bio-mass are resources which are agriculture related like wood, bagasse, cow dung, seeds, etc.

Hydel energy

India has a total hydro energy potential of about 1.5 lakh MW, of which only about 20 % is installed. Small hydro plant potential is about 15000 MW and most of it is in the northern and eastern hilly regions.

Wind energy

The wind power potential of India is about 45,000 MW out of which capacity of 8748 MW has been installed in India till 2008. India is one of the leading countries in generating the power through wind energy.

Gujarat, AP, Karnataka, MP and Rajasthan are states having more than 5000 MW potential each. These potentials could be improved if the technology of putting turbines in sea is embraced. There are wind farms on sea generating as high as 160 MW of power.

Geothermal energy

Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels.

Ocean thermal energy conversion (OTEC)

Ocean Thermal Energy Conversion (OTEC) uses the difference between cooler deep and warmer shallow or surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity. A heat engine gives greater efficiency and power when run with a large temperature difference. In the oceans the temperature difference between surface and deep water is greatest in the tropics, although still a modest 20 to 25 °C. It is therefore in the tropics that OTEC offers the greatest possibilities. OTEC has the potential to offer global amounts of energy that are 10 to 100 times greater than other ocean energy options such as wave power

Biomass energy

Biomass is the oldest means of energy used by humans along with solar energy. As soon as the fire was discovered, it was used widely among humans mainly for heat and light. Fire was generated using wood or leaves, which is basically a biomass. The biomass could be used to generate steam or power or used as a fuel. Power is generated using rice husk in Andhra Pradesh, while several bagasse based plants are there. India has a potential of 3500 MW from bagasse. Other fast growing plants could be planned over a huge area, so that it

provides biomass for generating power. Organic waste such as dead plant and animal material, animal dung, and kitchen waste can be converted by the anaerobic digestion or fermentation into a gaseous fuel called biogas. Biogas is a mixture of 65% methane (CH_4) and of 35% CO_2 and may have small amounts of hydrogen sulphide (H_2S), moisture and siloxanes. It is a renewable energy resulting from biomass. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, much like natural gas, and used to power motor vehicles.

Bio-fuels

India has more than 50 million hectare of wasteland, which could be utilized for cultivating fuel plants. Jatropha is one of the options which can be planted on arid lands and be used for production of bio fuels.

Solar energy

India being a tropical country has potential to use solar energy on commercial bases. According to estimates, 35 MW of power could be generated from one sq km. With such potential, solar energy has bright future as energy source for the development of the country. Initial cost is the biggest limitation which has led to the low realization of its potential. For solar energy to become one of the front runners, it will require lot of research, cheap technology and low capital.

Problems Relate To the Use of Energy

Resources Fossil fuel:

- ✓ Global warming
- ✓ Acid rains
- ✓ Dangers posed by leaded fuels ,Oil spills
- ✓ Water pollution caused by poorly managed coal mines
- ✓ Air pollution.

Alternate energy resources:

- ✓ The initial cost of establishment of alternate energy generation is costlier than conventional resources.
- ✓ Maintenance of these structures is difficult.
- ✓ It requires more space.
- ✓ Energy supply is unpredictable during natural calamities.

Case Study

Importance of the energy resources in present economy and as a base for our future can be underlined by the fact that recent confrontations between some powerful nations of the world have primarily been attributed driven by objective to secure their energy supplies. Examples of this have been the two gulf wars. It was the hunger for energy resources that drove Iraq to lead an offensive over Kuwait and also reason for second Gulf war has been attributed to energy security by defence experts. In recent times, world has witnessed a confrontation at South China Sea between India, Vietnam and China over the issue of exploring natural gas and petroleum under the sea bed.

LAND RESOURCES

A nation that destroys its soils destroys itself '- Franklin D. Roosevelt

Land as a Resource

Land area constitutes about 1/5 of the earth surface. To meet out the challenging demand of food, fibre and fuel for human population, fodder for animals and industrial raw material for agro based industries, efficient management of land resources will play critical role. Soil, water, vegetation and climate are basic natural resources for agricultural growth and development.

Land Degradation

Due to increasing population, the demands for arable land for producing food, fibre and fuel wood is also increasing. Hence there is more and more pressure on the limited land resources which are getting degraded due to over-exploitation. Nearly 56% of total geographical area of the country is suffering due to land resource degradation. Out of 17 million hectare canal irrigated area, 3.4 million hectare is suffering from water logging and salinity. Soil erosion, water logging, salinization and contamination of the soil with industrial wastes like fly-ash, press mud or heavy metals all cause degradation of land.

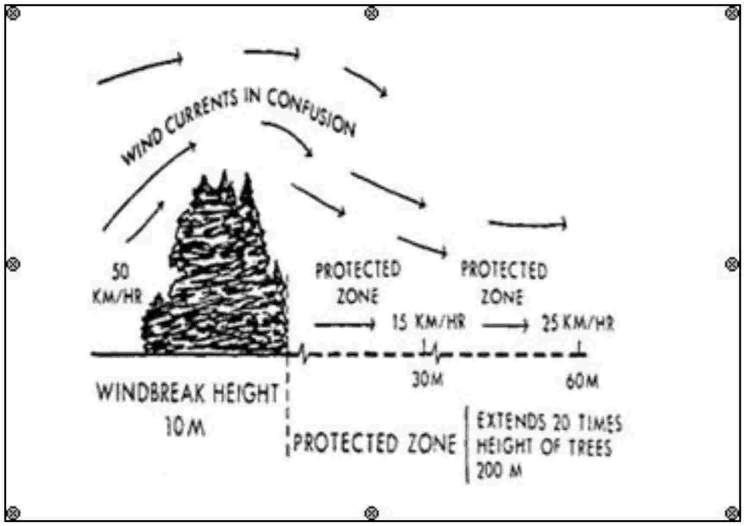
Soil Erosion

Soil erosion refers to loss or removal of superficial layer of soil due to the action of wind, water and human factors. In other words, it can be defined as the movement of soil components, especially surface-litter and top soil from one place to another. It has been estimated that more than 5000 million tonnes topsoil is being eroded annually and 30% of total eroded mass is getting loosed to the sea .It results in the loss of fertility. It basically is of two types, viz. geologic erosion and accelerated erosion. Various factors which affect soil erosions include soil type, vegetation cover, slope of ground, soil mismanagement and intensity and amount of rainfall. Wind is also responsible for the land erosion through saltation, suspension and surface creep.

In order to prevent soil erosion and conserve the soil the following conservation practices are employed,

Conservational till farming, Contour farming and Terracing Strip cropping and alley cropping Wind breaks or shelterbelts

Terracing



Shelterbelts

Conservational tillage (USDA,2007)

Salinization

It refers to accumulation of soluble salts in the soil. Concentration of soluble salts increases due to poor drainage facilities. In dry land areas, salt concentration increases where poor drainage is accompanied by high temperature. High concentration of salts affects the process of water absorption hence affects the productivity.

Water Logging

Excessive utilization of irrigation may disturb the water balance which can lead to water logging due to rise of water table .Anaerobic condition due to poor availability of oxygen in water logged soils may affect respiration process in plants which will ultimately affect the productivity of water logged soil. Desertification

Desertification is a process whereby the productive potential of arid or semiarid lands falls by ten percent or more. Desertification is characterized by devegetation and depletion of groundwater, salinization and severe soil erosion.

Causes of desertification

✓ Deforestation Overgrazing

- ✓ Mining and quarrying

Shifting Cultivation

Shifting cultivation is a practice of slash and burn agriculture adopted by tribal communities and is a main cause for soil degradation particularly tropical and sub tropical regions. Shifting cultivation which is also popularly known as _Jhum Cultivation‘ has lead to destruction of forest in hilly areas .It is responsible for soil erosion and other problems related to land degradation in mountainous areas.

Man induced Landslides

Human race has exploited land resources for his own comfort by constructing roads, railway tracks, canals for irrigation, hydroelectric projects, large dams and reservoirs and mining in hilly areas. Moreover productive lands under crop production are decreasing because of development activities. These factors are affecting the stability of hill slopes and damage the protective vegetation cover. These activities are also responsible to upset the balance of nature and making such areas prone to landslides.

CONSERVATION AND EQUITABLE USE OF NATURAL RESOURCES

Role of an Individual

Natural resources like forests, water, soil, food, minerals and energy resources play an important role in the economy and development of a nation. Humans can play important role in conservation of natural resources. A little effort by individuals can help to conserve these resources which are a gift of nature to the mankind. Brief description of role of individual to conserve different types of natural resources is given below:

Roles to conserve water

- ✓ To minimise the evaporation losses irrigate the crops, the plants and the lawns in the evening, because water application during day time will lead to more loss of water due to higher rate of evapo-transpiration.
- ✓ Improve water efficiency by using optimum amount of water in washing machine, dishwashers and other domestic appliances, etc.
- ✓ Install water saving toilets which use less water per flush.
- ✓ Check for water leaks in pipes and toilets and repair them promptly. Don‘t keep water taps running while they are not in use.
- ✓ Recycle water of washing of cloths for gardening.
- ✓ Installing rainwater harvesting structure to conserve water for future use. **Energy conservation for future use**
- ✓ Turn off all electric appliances such as lights, fans, televisions, computers, etc when not in use.
- ✓ Clean all the lighting sources regularly because dust on lighting sources decreases lighting levels up to 20-30%
- ✓ Try to harvest energy from natural resources to obtain heat for example drying the cloths in sun and avoid drying in washing machine.
- ✓ Save liquid petroleum gas (LPG) by using solar cookers for cooking.
- ✓ Design the house with provision for sunspace to keep the house warm and to provide more light.

- ✓ Avoid misuse of vehicles for transportation and if possible share car journey to minimize use of petrol/diesel. For small distances walk down or just use bicycles.
- ✓ Minimize the use air conditioner to save energy

Protect soil health

- ✓ Use organic manure/compost to maintain soil fertility
- ✓ To avoid soil erosion does not irrigate the plants by using fast flow of water.
- ✓ Use sprinkler irrigation to conserve the soil.
- ✓ Design landscape of lawn in large area which will help to bind soil to avoid erosion. Provide vegetation cover by growing of ornamental plant, herbs and trees in your garden.
- ✓ Use vegetable waste to prepare compost to use in kitchen gardening.

Promote sustainable agriculture

- ✓ Diversify the existing cropping pattern for sustainability of agriculture Cultivate need based crop
- ✓ Maintain soil fertility
- ✓ Make optimum use of fertilizers, pesticides and other chemicals for production and processing of agriculture products
- ✓ Save grains in storage to minimise the losses
- ✓ Improve indigenous breeds of milch animals for sustainable dairy production systems. Adopt post harvest technologies for value addition

Equitable Use of Resources for Sustainable Life Style

In last 50 years, the consumption of resource in the society has increased many folds. There is a big gap in the consumers lifestyle between developed and developing countries. Urbanization has changed the life style of middle class population in developing countries creating more stress on the use of natural resources. It has been estimated that More Developed Countries (MDC) of the world constitute only 22% of world‘s population but they use 88% of natural resources. These countries use 73% of energy resources and command 85% of income and in turn they contribute very big proportion of pollution. On the other hand less developed countries (LDCs) have moderate industrial growth and constitute 78% of world‘s population and use only 12% of natural resources, 27% of energy and have only 15% of global income.

There is a huge gap between rich and poor. In this age of development the rich have gone richer and the poor is becoming more poorer.. This has lead to unsustainable growth. There is an increasing global concern about the management of natural resources. The solution to this problem is to have more equitable distribution of resources and income. Two major causes of unsustainability are over population in poor countries and over consumption of resources by rich countries. A global consensus has to be reached for balanced distribution of natural resources.

For equitable use of natural resources more developed countries/rich people have to lower down their level of consumption to bare minimum so that these resources can be shared by poor people to satisfy their needs. Time has come to think that it is need of the hour that rich and poor should make equitable use of resources for sustainable development of mankind.

Lecture No. 6 - 7

Topic: Concept of an Ecosystem

Sub-topics/ Key Points: Concept, Structure, Function and Energy flow in ecosystems .

Ecosystem is the basic functional unit in ecology.

Ecosystem is a specific & recognizable landscape form such as-
Forest, Grassland, Desert, Wetland or Coastal area

Nature of ecosystem based on its geographical features like-
Hills, Mountains, Plains, Rivers, Lakes, Islands

-Also controlled by climatic condition.
-Features create conditions support community of plants & animals to live in these specific conditions.
-All living organism interact with their abiotic environments.
-Living community in any area together with non-living components of environment i.e. soil, air & water the constitute of ecosystem

1. Concept of an Ecosystem

An ecosystem is a functional unit of nature where living organisms interact with each other and their physical environment. These interactions lead to the exchange of energy and cycling of nutrients, ensuring the survival of different species.

Key Features of an Ecosystem:

1. Self-Sustaining Unit:
    - An ecosystem functions independently by maintaining energy flow and nutrient cycles.
    - Example: A forest ecosystem supports trees, herbivores like deer, carnivores like tigers, and decomposers like fungi, all interacting for survival.
2. Dynamic Nature:
    - Ecosystems constantly change due to natural disturbances (storms, floods) and human impacts (deforestation, pollution).
    - Example: The Great Barrier Reef is changing due to climate change and coral bleaching.
3. Interdependence:
    - Organisms depend on each other for food, shelter, and survival.
    - Example: In a grassland ecosystem, grasses provide food for herbivores (e.g., antelopes), which are prey for carnivores (e.g., lions).

Term “Ecosystem” was coined by A. G. Tansley (1935).

Definition: The ecosystem is the basic functional unit of organism and their environment, interacting with each other and with their own components. (E. P. Odum)

-The system resulting from the integration of all living and non-living factors of the environment.
(A. G. Tansley)

Structure and function of Ecosystem

Two major aspects of ecosystem

-Structure of Ecosystem includes quantity & distribution of non living materials, composition of biological community & range of conditions of existence.

-While function of Ecosystem means energy flow, nutrient cycles & ecological regulation.

2. Structure of an Ecosystem

Ecosystems consist of biotic (living) and abiotic (non-living) components.

Two major components- 1. Abiotic 2. Biotic

1. Abiotic- Also known as non- living component – Three parts

a) Inorganic substances- Includes Water, Minerals & Gases

b) Organic substances- Includes Nucleic acid, Amino acid, Carbohydrates, Protein & Lipids.

C) Physical factors- Includes Climatic, Edaphic & Topographic factors These are

i) Light- Provide solar energy for heating.

ii) Rainfall- Determine type terrestrial ecosystem i.e. evergreen forest, scrub, grassland, desert.

iii) Wind- Control weather, transpiration, pollination.

iv) Humidity- Inversely related to transpiration.

v) Temp.- Four life zones on basis of temp. range-

Tropical-Hot throughout year

Subtropical-Hot during summer & cold during winter

Temperate- Pleasant summer & cold winter with occasional snow

Arctic or Alpine- Snow throughout year except for brief summer

vi) Topography- Plain, slope, valley

vii) Soil- Texture, PH, fertility determine type of vegetation

Abiotic Components (Non-living Elements)

These include:

1. Physical Factors:
   - Light, temperature, humidity, wind, rainfall.
   - Example: In a desert ecosystem, low rainfall and high temperature limit plant growth.
2. Chemical Factors:
   - Oxygen, carbon dioxide, nitrogen, minerals, and pH.
   - Example: Coral reef ecosystems require a specific pH and salinity to survive.

2. Biotic Components (Living Organisms)

These are classified into three major groups:

a) Producers (Autotrophs)

- Convert solar energy into chemical energy through photosynthesis.
- Examples: Green plants, algae, and cyanobacteria.
- Example: Phytoplankton in an aquatic ecosystem are primary producers that support fish populations.

b) Consumers (Heterotrophs)

They obtain energy by consuming other organisms.

Types of consumers:

1. **Primary Consumers (Herbivores):** Eat plants.
    - Example: Cows, rabbits, deer, caterpillars.
2. **Secondary Consumers (Carnivores):** Eat herbivores.
    - Example: Frogs eat insects, snakes eat mice.
3. **Tertiary Consumers (Top Carnivores):** Eat secondary consumers.
    - Example: Eagles, sharks, lions.
4. **Omnivores:** Consume both plants and animals.
    - Example: Bears, humans, crows.

c) Decomposers (Saprotrophs)

- Break down dead organic matter, recycling nutrients back into the ecosystem.
- Examples: Bacteria, fungi, earthworms.
- Example: Mushrooms growing on dead logs decompose organic matter into humus.

2. Biotic component (Living component)

Category is trophic structure of ecosystem, living organisms are distributed on their nutritional relationship.

A) Autotrophic component- Known as Producer

Organism fix light energy, use simple inorganic substances & build up complex substances -Mainly constituted by green plants, photosynthetic & chemosynthetic bacteria.

B) Heterotrophic component- Known as Consumers

-In this category utilization, rearrangement & decomposition of complex materials.

i) Microconsumers- Known as Decomposers, Saprotrophs & Osmotrophs.

- Organisms break down complex compounds of dead or living protoplasm
- Absorb some decomposition products.
- Release inorganic nutrients in environment .
- Making them available to autotrophs i. e. plant, Spirogyra.
- e. g. bacteria, fungi.

ii) Macro consumers- These are phagotrophs include animals.

Further classified into:-

a) Herbivores- Animals which directly obtain food from plants by eating their parts.

- Also called as First order consumers or Primary consumers.
- Transform vegetable matter into animals matter.
- Hence called Key industry animals.

- e. g. Herbivorous fish, grasshopper, field mouse, rabbit, goat, deer, horse, cow, buffalo etc.

b) Carnivores- Also called Omnivores.

- Animals which catch hold of their preys & feed on their flesh.

i) Primary carnivores or Second order consumers-Predator animals which prey upon herbivores. e. g. Toad, Frog, Spider.

ii) Secondary carnivores or Third order consumers-Predator animals whichfeed on primary carnivores. e. g. Snake on Frog, Wolf preying upon Fox.

c) Tertiary carnivores or Top carnivores-Which prey upon other carnivores but are not themselves eaten by others.

- They constitute the terminal & end of predator or grazing food chain.

-e. g. Lion, Tiger

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3. Functions of an Ecosystem

Function of Ecosystem

1. Production:

-Organic matter produced every year on earth by photosynthesis.
-Same amount oxidized back in CO2 & H2O during respiration.
-Excess prod. of organic matter is responsible for build of Oxygen & evolution & continued survival of higher forms of life.

2. Consumption:

-Transfer of material & transformation of energy from one tropic level to another through process of eating & being eaten.
-Produce food for their own maintenance, multiplication & movement.
-Store food used for creation of energy for different processes.

3. Decomposition:

-Process by which complex organic materials are broken into simple components that can utilized by plant.

Ecosystems perform essential processes for maintaining life.

1. Energy Flow

- Energy flows in one direction from the Sun → Producers → Consumers → Decomposers.
- Example: A lake ecosystem where algae (producers) are eaten by small fish (primary consumers), which are consumed by bigger fish (secondary consumers), and finally, decomposers break down dead fish.

2. Nutrient Cycling (Biogeochemical Cycles)

- Essential nutrients like carbon, nitrogen, phosphorus, and water are recycled.
- Example: In the nitrogen cycle, bacteria convert atmospheric nitrogen into usable forms for plants, which are then consumed by animals.

3. Ecological Regulation

- Maintains a balance between populations and resource availability.
- Example: If predators like wolves are removed from a forest, deer populations may increase excessively, leading to overgrazing and habitat destruction.

4. Energy Flow in an Ecosystem

Living organisms store energy for survival, life processes and used when required.
Energy enters ecosystem from solar radiation.
Plant convert this into chemical energy through photosynthesis.
Energy passes from lower trophic level to higher.
Flow of energy is always unidirectional. It is never reversed.
Energy is governed by two laws of thermodynamics.
1 st law of thermodynamics:-"Energy can neither be created nor destroyed. It may be transformed from one kind of energy to another."
2 nd law of thermodynamics:-"Transformation of energy from one to another is never cent percent."

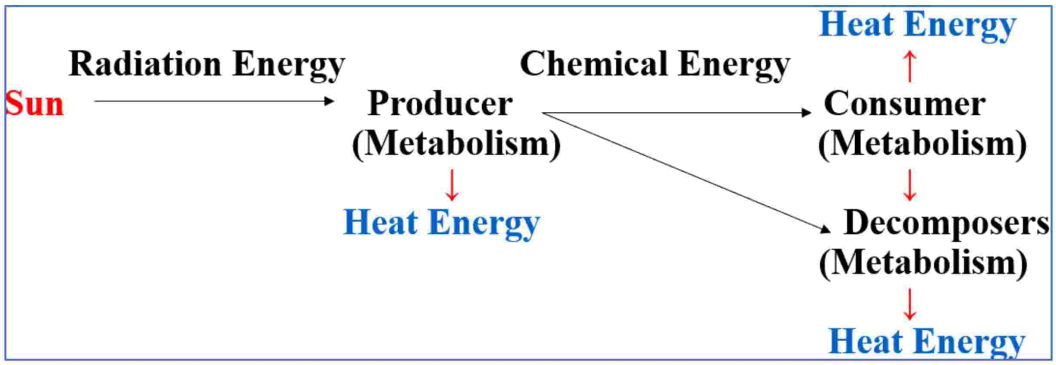


Fig. Energy flow in an Ecosystem

-Most of plant biomass is broken down by herbivore in releasing energy for its activities through respiration.

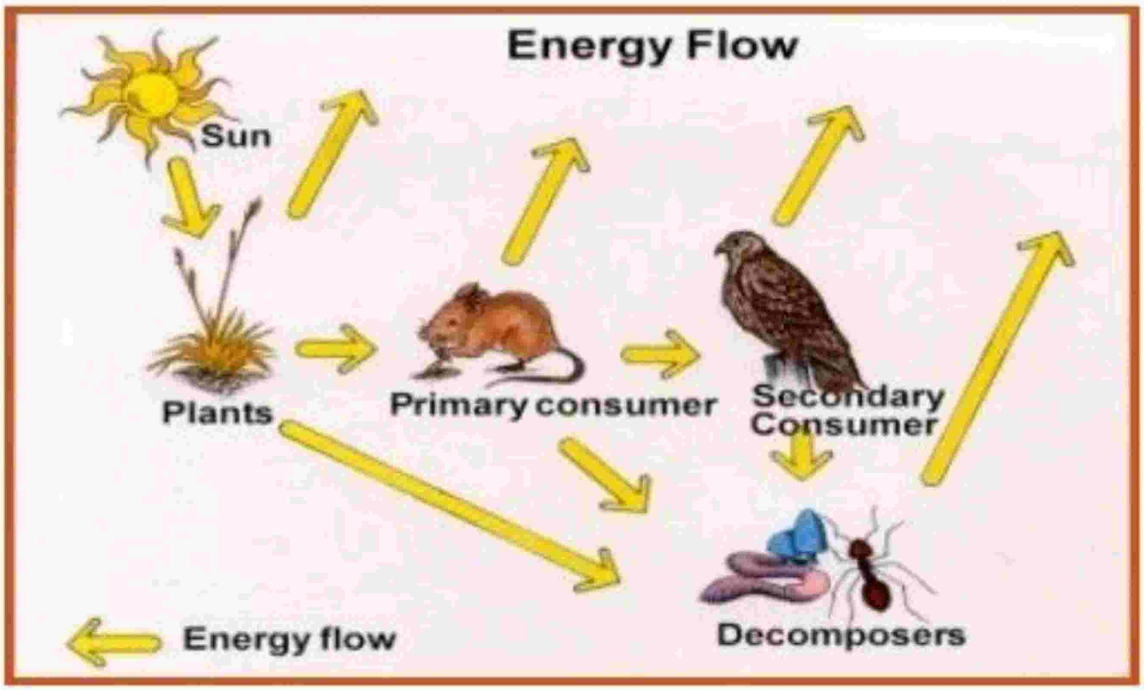
-Only about 10% of this organic food is stored in flesh.

-It is often known as 'ten per cent law'.

-Law was first propounded by Lindeman (1942).

-Ten per cent law in terms of energy may be depicted as-

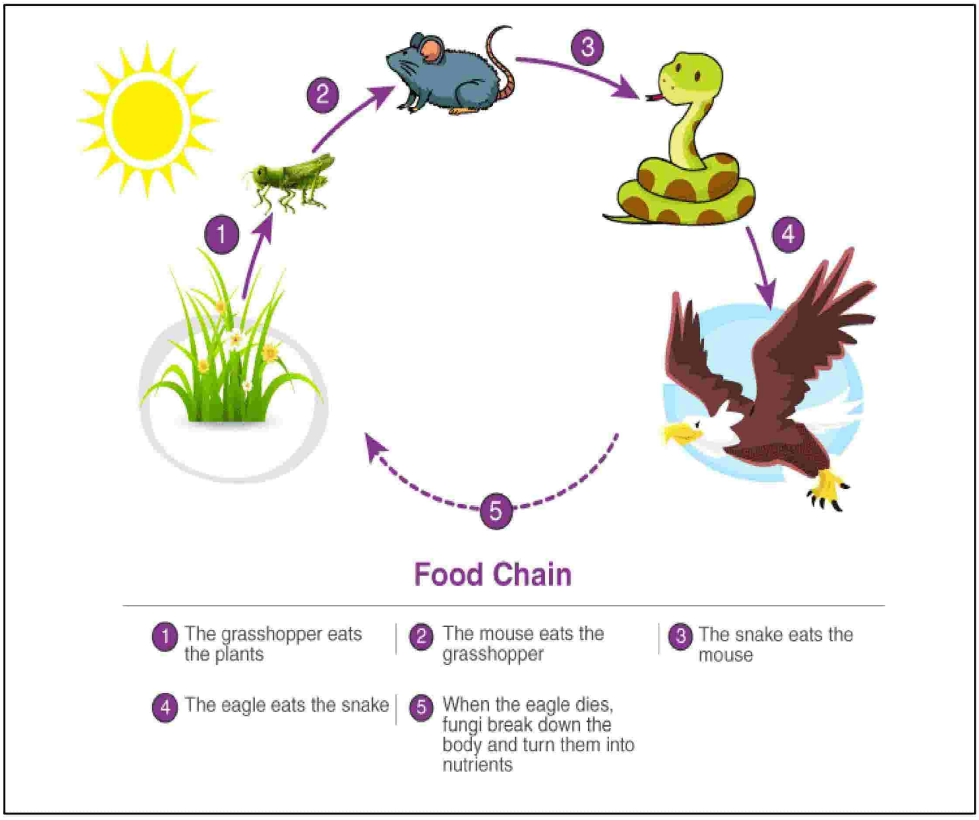
Producer 100 kcal → Herbivore 10 Kcal → Carnivores I 1.0 kcal → Carnivores II → 0.1 kcal or 100 cal.



Trophic Levels in Energy Flow

Energy moves through different trophic levels:

1. Producers (1st Trophic Level)
    - Example: Grass in a meadow.
2. Primary Consumers (2nd Trophic Level – Herbivores)
    - Example: A grasshopper eating grass.
3. Secondary Consumers (3rd Trophic Level – Carnivores)
    - Example: A frog eating a grasshopper.
4. Tertiary Consumers (4th Trophic Level – Top Predators)
    - Example: A snake eating a frog.
5. Decomposers (Final Level – Recyclers)
    - Example: Fungi decomposing dead organic matter.



Food Chains & Food Webs

- Food Chain: A linear sequence of energy transfer.
  - Example: Grass → Grasshopper → Frog → Snake → Hawk.
- Food Web: A complex network of food chains.
  - Example: In a pond ecosystem, multiple organisms feed on different species.

-Living organism of an ecosystem need food and for which they depend on one another. So the transfer of food or food energy from producer through a series of organism to decomposers with repeated eating and being eaten is known as "Food chain" OR

"A series of organisms arranged in linear manner with refereed eating and being eaten." OR

"The linear food predator relationship from producer to tertiary organisms is known as Food Chain."
-Each 'food' level in a food chain is known as "Trophic level"
-The amount of living material in different trophic levels is known as" Standing crop"

Food chain are two types

1. Simple food chain-If the food chain has only one trophic level besides the decomposers known as Simple Food Chain.
   e. g. *Eichhornia* in eutrophic pond
2. Complex food chain-If the food chain has Both producer and consumer trophic level known as Complex Food Chain."

e. g. Gross → Cattle → Man

Vegetation → Bees→ Bear

Vegetation → Insect → Frog / Toad → Snake→ Peacock

Types of Food Chain

Three types

1. Grazing food chain:- These food chain start from living green plants, goes to grazing herbivores & onto carnivores.

-Food chain directly depend upon solar radiation.

- Grasses → Rabbit → Fox

2. Parasitic food chain:- Also known as subsidiary or accessory food chain.

- In these food chain producer or consumer is parasitized.

-Food energy passes to smaller organism & terminated by parasite.

- Green plant → Sheep → Liver fluke

3. Detritus food chain:- Food chain goes from dead organic matter into microorganisms & then to organisms feeding on detritus & their predators.

- Fallen leaves → Detrivores → Small Fish → Large Fish → Shark

Food Web

Food does not always pass from one population to others in a linear sequence as in a food chain.

Definition: Interlocking of different food chains by developing interconnections at various trophic level so as to form a number of feeding interactions in a biotic community known as "Food web" OR Interlocking of several interlinked food chain

-Food web opens several alternate pathways for flow of food energy.

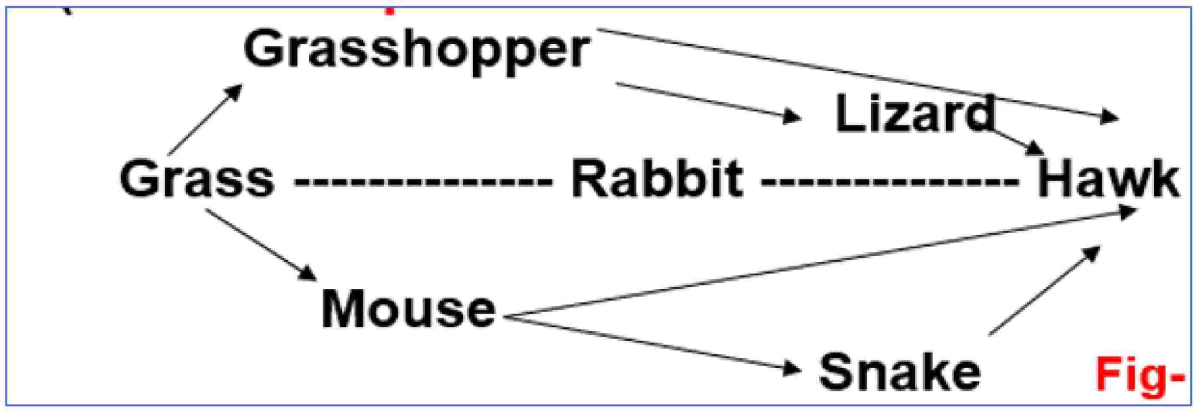
-Also allows an organism to obtain its food from two or more types of organism of the lower trophic level.

-Help in maintaining stability of ecosystem.

-Larger the No. of alternative pathways occurring in food web, more stable the ecosystem.

-Which keep diff. species under check & maintain a state of equilibrium called 'Homoeostasis'

(Below Five possible food chain interlocked together making food web)



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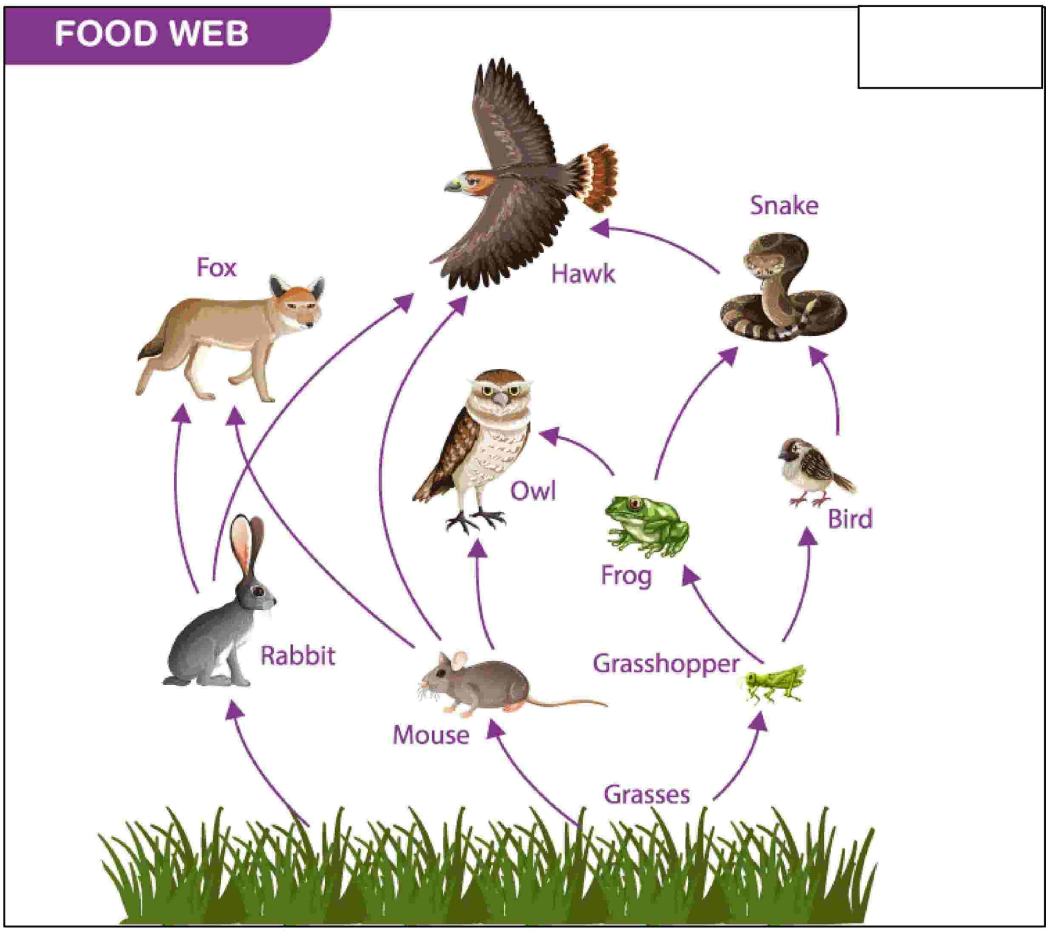


Ecological Pyramids

-Trophic structure & functions at successive trophic levels i. e.

Producers → Primary consumers → Secondary consumers

-May be shown graphically or by the pyramids.
-First or producer level constitute base of pyramid & the successive levels.
-The tiers making the apex.

Definition: The relationship between the various trophic levels of a food chain can be expressed in terms of number, biomass and energy by means of graphic diagrams called "Ecological pyramids" OR

It is a graphic representation of the trophic structure and function in successive trophic levels of an ecosystem.

-Ecological pyramids were first devised by a British ecologist Charles Elton(1927)
- Hence also called Eltonian pyramids.

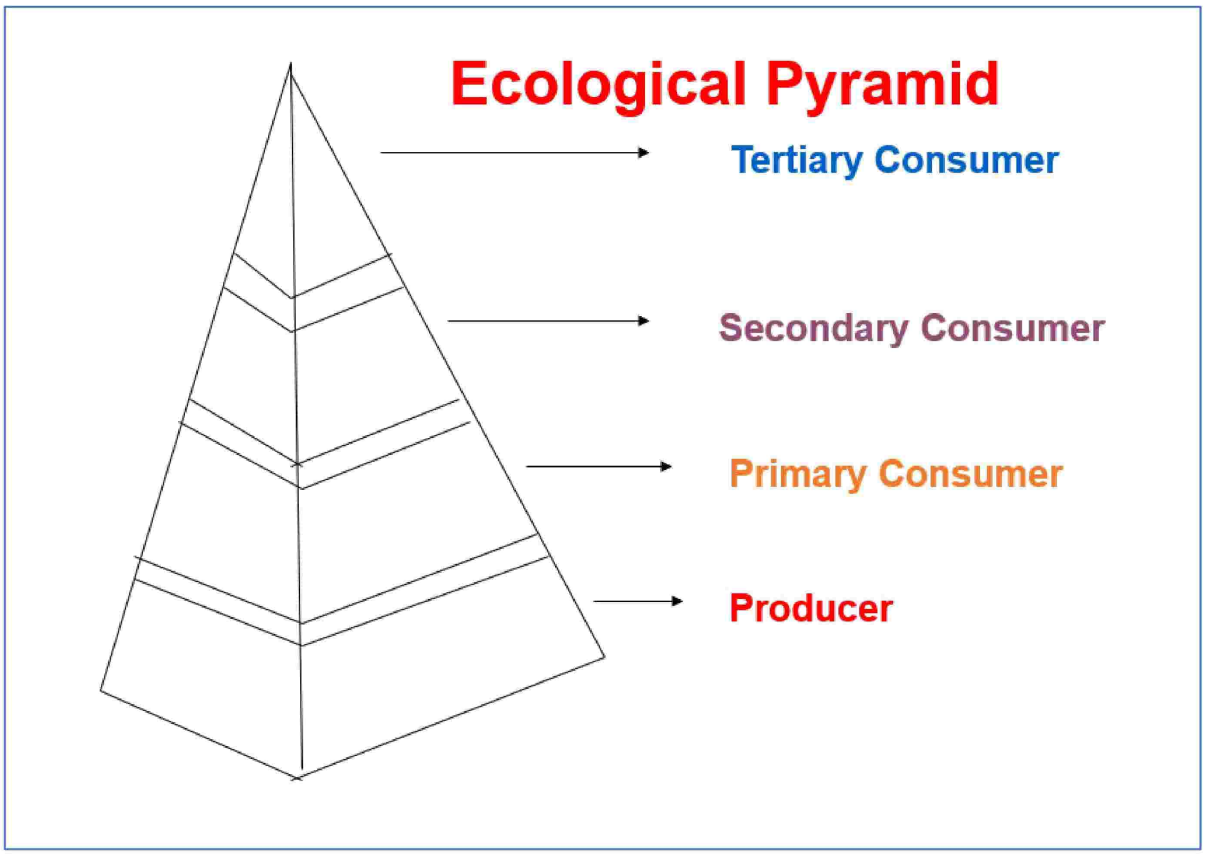
Types of Ecological Pyramids

Three main types

1. Pyramid of numbers:- Graphical representation of the No. of individuals at successive trophic levels of a food chain per unit area at anytime.
-In grassland the producers are maximum in No., thus pyramid become upright.
-Pond ecosystem upright.(▲)
-In a tree ecosystem pyramid of No. is always inverted because single plant may support the growth of many herbivores.(▼)

2. Pyramid of biomass:- The amount of living material present in an organism is called 'Biomass'.
-Measured both dry & fresh weight.
-Terrestrial ecosystem always have upright biomass(▲) pyramids, as crop plantsor grasses or trees posses maximum biomass.
- In an aquatic ecosystem pyramid of biomass is inverted.(▼)

3. Pyramid of energy:- Energy give best picture of overall nature of an ecosystem.
-Kind of pyramid is picture of rates of passage of food mass through food chain.
-It is always upright(▲) because there is always a gradual decrease in energy content at successive trophic levels from producer to various consumers.



Biogeochemical cycles
-Number of minerals are required by living organisms for their metabolism & body building.

-These minerals elements are taken up by green plants from environments (Soil & atmosphere).
-Consumers obtain these minerals from producers.
-These minerals do not remain permanently locked up in organic matter.
-But returned to abiotic environment through decomposers.

Nutrient cycles:-The circulation of these minerals between biotic communities and abiotic environment is called as 'Nutrient cycles'
-To stress the biological, geological and chemical nature of the processes they are also called as biogeochemical cycling.
- Micronutrients Co, Fe& Cu having edaphic cycles.
-Macronutrients C, H & O have atmospheric cycles.

- Examples of Biogeochemical cycles are-
  1. Hydrological cycle
  2. Carbon cycle
  3. Nitrogen cycle
  4. Sulpher cycle
  5. Phosphorus cycle
  6. Iron cycle
  7. Oxygen cycle

-An important attributes (Qualities) of any Biogeochemical cycles is increasing conc. of mineral nutrient in higher trophic level. It is called Biological magnification.

Lecture No. 8 - 9

Topic: Types of Ecosystems

Sub-topics/ Key Points: Terrestrial, Aquatic, Agroecosystems, Forest ecosystems and Human-modified ecosystems

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Types of Ecosystem

Artificial & Natural

1. Artificial Ecosystem are created & maintained by human being.
   Examples-Gardens, Cropland, Aquarium, Dam, Village, City, Poultry

2. Natural Ecosystem is developed under natural conditions without any human interference.

Two Types:

a) Aquatic- e.g. Fresh water, lake, pond, river, stream & sea.

b) Terrestrial –e. g. Forest, desert & grassland.

Types of Ecosystems

An ecosystem is a functional unit of the environment where living organisms interact with non-living elements in a specific area. Ecosystems can be classified based on their location and characteristics.

Terrestrial Ecosystem

-Terrestrial ecosystem
-Occupies comparatively very little area on the earth (about 19%)
-Soil in grassland is moderately thick with rich organic contents & minerals.
-Rainfall is 25-75 cm in temperate& 40-100 cm in tropical grassland.

Components of Grassland Ecosystem
1. Abiotic components- Carbon, H, O, N, P, S

2. Biotic components-a) Producer- e. g. grasses
b) Consumers

↓

	↓ Primary (Herbivores)	↓ Secondary (Carnivores)	↓ Tertiary
e. g.	Cow, deer Mouse etc.	Fox, Snakes Frog, Birds etc.	Lion, Tiger

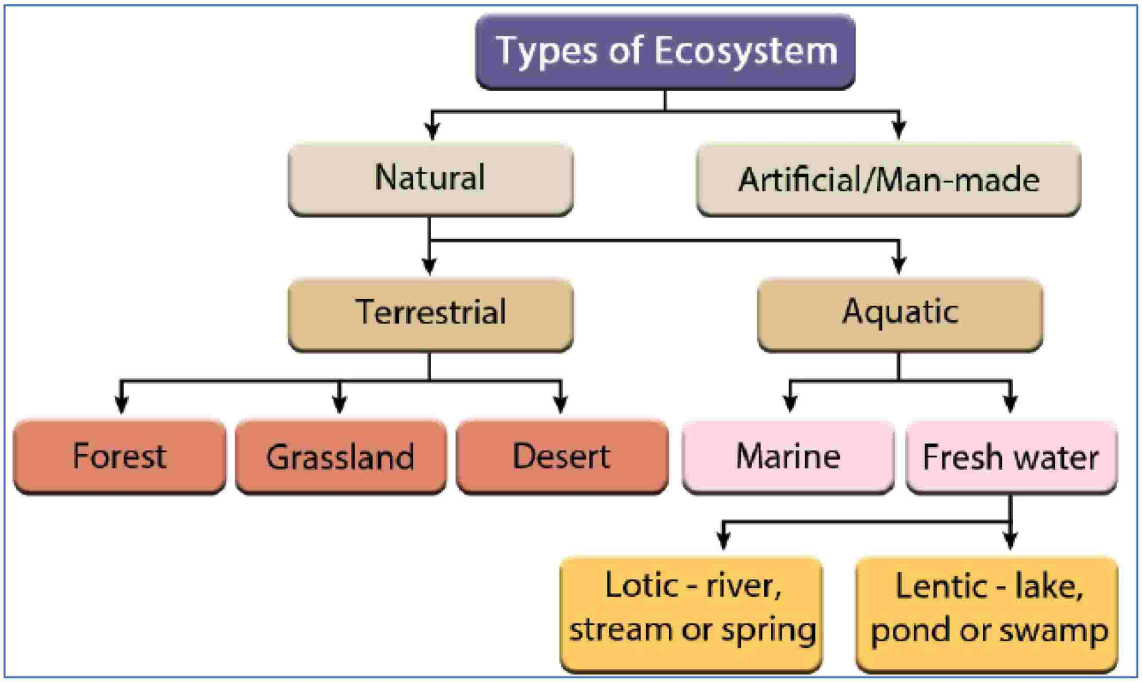
3. Decomposers- Organism which active in dead organic
matter. e. g. Higher fungi, Fusarium, Penicillium, Bacteria etc

A terrestrial ecosystem is a land-based ecosystem where living organisms interact with each other and the physical environment (air, soil, sunlight, water). These ecosystems are shaped by climate, temperature, altitude, and soil composition.

✓ Examples of Terrestrial Ecosystems: Forests, Deserts, Grasslands, Tundra, and Mountain Ecosystems.

✓ **Main Characteristics:**

- Found on land rather than water.
- Influenced by climatic factors like rainfall, temperature, and sunlight.
- Home to diverse flora and fauna adapted to the specific environment.
- Play a key role in carbon cycling, oxygen production, and habitat creation.



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2. Components of a Terrestrial Ecosystem

2.1 Biotic (Living) Components

✓ Producers (Autotrophs): Plants, trees, shrubs, grasses, mosses, and algae.

✓ Consumers (Heterotrophs): Animals depending on plants or other animals for food.

- Primary Consumers: Herbivores (Deer, Rabbits, Grasshoppers).
- Secondary Consumers: Carnivores (Foxes, Snakes, Birds).
- Tertiary Consumers: Top predators (Lions, Wolves, Eagles).

✓ Decomposers: Fungi, bacteria, earthworms—help in recycling nutrients.

2.2 Abiotic (Non-Living) Components

✓ Climate: Determines the type of terrestrial ecosystem (hot, cold, humid, dry).

✓ Soil: Provides nutrients essential for plant growth.

✓ Sunlight: Drives photosynthesis, supporting the entire food chain.

✓ Temperature: Affects metabolism and biodiversity.

✓ Water Availability: Controls vegetation and species survival.

Importance of a Terrestrial Ecosystem: These components interact to create a balanced ecosystem where energy and nutrients are cycled continuously.

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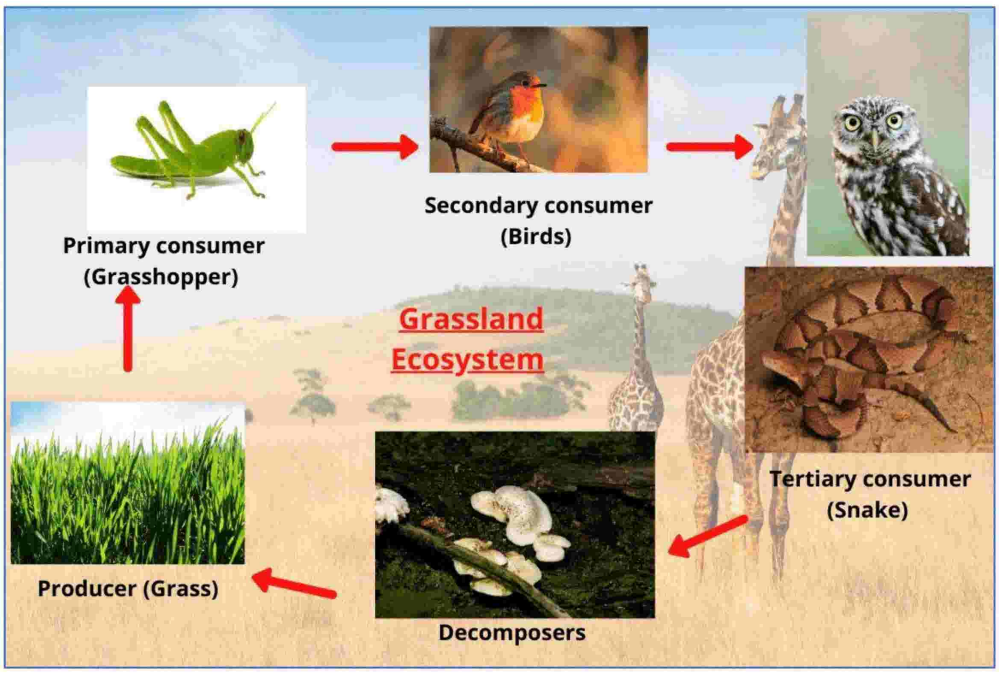
3. Types of Terrestrial Ecosystems

Terrestrial ecosystems are classified based on climate, vegetation, and biodiversity.

Ecosystem Type	Climate & Characteristics	Examples
Forest Ecosystem	High biodiversity, dense tree cover, humid or temperate climate.	Amazon Rainforest, Taiga Forest.
Grassland Ecosystem	Dominated by grasses, seasonal rainfall, supports large herbivores.	African Savannas, North American Prairies.
Desert Ecosystem	Extremely dry, sparse vegetation, extreme temperature variations.	Sahara Desert, Thar Desert.
Tundra Ecosystem	Cold temperatures, permafrost soil, minimal vegetation.	Arctic Tundra, Alpine Tundra.
Mountain Ecosystem	High altitudes, varied climate zones, diverse vegetation.	Himalayas, Andes, Rocky Mountains.



Detailed Study of Each Terrestrial Ecosystem

Forest Ecosystem

✓ Definition: A land ecosystem dominated by trees with rich biodiversity and a high rate of photosynthesis.

✓ Types of Forest Ecosystems:

1. Tropical Rainforests:

- Climate: High temperature, heavy rainfall (>200 cm/year).
- Vegetation: Evergreen trees, vines, ferns.
- Animals: Tigers, Jaguars, Monkeys, Parrots.
- Example: Amazon Rainforest (South America).

2. Temperate Forests:
   - Climate: Moderate temperature, seasonal rainfall.
   - Vegetation: Deciduous trees (Oak, Maple), conifers.
   - Animals: Bears, Deer, Foxes.
   - Example: Appalachian Forest (USA).
3. Boreal Forests (Taiga):
   - Climate: Cold, long winters, short summers.
   - Vegetation: Evergreen conifers (Pine, Spruce).
   - Animals: Moose, Lynx, Wolves.
   - Example: Siberian Taiga (Russia).

Importance of a Forest Ecosystem: Forests provide oxygen, habitat, carbon storage, and climate regulation.

Grassland Ecosystem

✓ Definition: A terrestrial ecosystem dominated by grasses with few scattered trees.

✓ Characteristics:

- Moderate rainfall (25-75 cm/year).
- Soil rich in nutrients, supporting large herbivores.

✓ Types of Grasslands:

1. Tropical Grasslands (Savannas) – Found in Africa, warm climate, seasonal droughts.
   - Example: Serengeti (Africa).
2. Temperate Grasslands (Prairies, Steppes) – Cooler climate, few trees, fertile soil.
   - Example: Great Plains (USA), Pampas (Argentina).

✓ Animals: Elephants, Zebras, Bison, Kangaroos.

Importance: Supports grazing animals, agriculture, and carbon sequestration.

Desert Ecosystem

-Desert are dry, sandy, rocky areas.

-Rainfall less than 25 cm / year & temp. touches 50 °C in daytime & nights are very cool.

-Storms blow throughout year.

-About 17% area of land is occupied by desert.

-Major deserts in world are Death Valley (Great western Desert, U.S.A.),Gobi (Central Asia), Sahara (Africa), Thar Desert (India, Rajasthan), Patagonia (South America) & Kalahari (Africa).

-Thar Desert is present in Rajasthan & adjoining area of Pakistan.

-Sahara is largest desert in the world.

Desert commonly two types

1**. Hot Desert:** Tropical-subtropical desert with sandy, rocky, soil,

low rainfall, high day temp. & frequent sand storms.
-Oasis occurs at these places.

2. **Cold Desert:** Occurs in dry, barren & rocky temperate tract with sparse vegetation.
-Precipitation little, mostly as snow e. g. Laddakh, Lahaul.
- Laddakh, Drass-Second minimum temp. of world (- 75° C)

Desert Ecosystem

✓ Definition: A dry land ecosystem with extreme temperatures and low rainfall (<25 cm/year).

✓ Characteristics:

- Hot during the day, cold at night.
- Sandy or rocky soil with little organic matter.
- Adapted plants and animals to conserve water.

✓ Types of Deserts:

1. Hot Deserts – Sahara (Africa), Thar (India), Sonoran (USA).
2. Cold Deserts – Gobi Desert (China), Antarctica Desert.

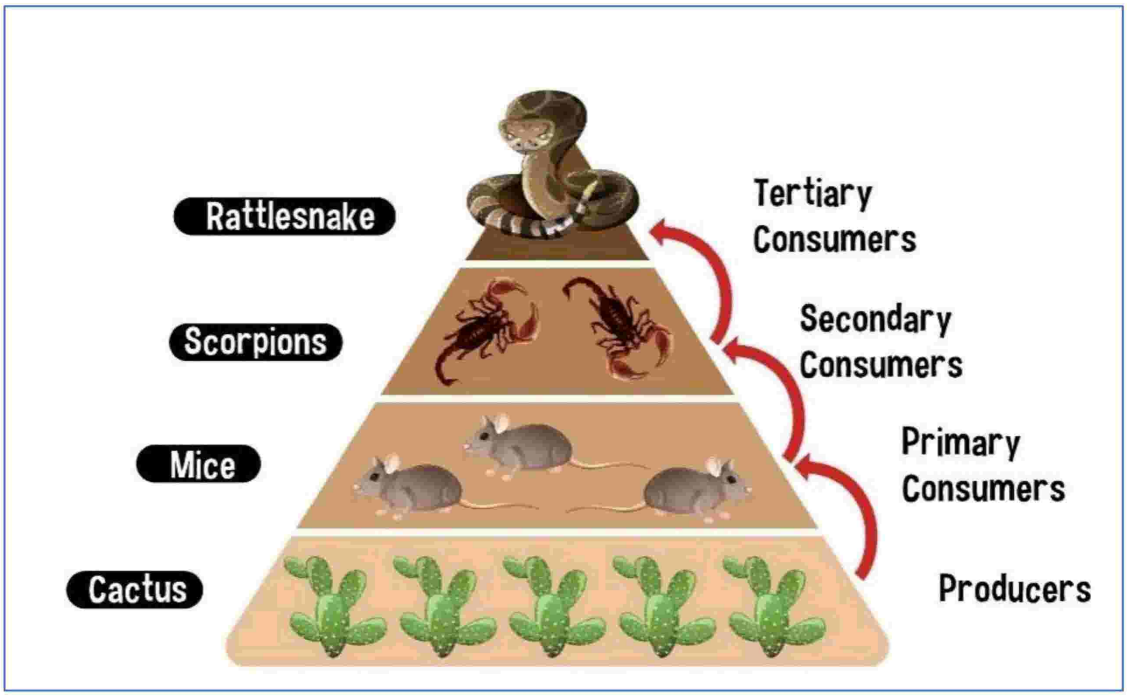
✓ Flora & Fauna:

- Plants: Cacti, Date Palms, Acacia trees.
- Animals: Camels, Scorpions, Desert Foxes.

Biotic communities of Desert Ecosystem

1. Producers:-e. g. Shrubs, some grasses & few trees, Xerophytic plants.
2. Consumers:-e. g. Reptiles & insects, some nocturnal rodents & birds.
3. Decomposers:- Very few are present due to poor vegetation & less dead organic matter. e. g. Some fungi, bacteria, thermophilic.

Importance of Desert Ecosystem: Regulates temperature extremes and stores minerals.



Forest Ecosystem

-Characterized by lush vegetation, comparatively high temp. &rainfall throughout year.
-Occupy about 40% of land but in India only about 1/10 of land.

Major Forest Types of world

1. North Coniferous or Taiga forests 2. Temperate deciduous forests
3. Temperate evergreen forests 4. Temperate rain forests
5. Chaparral 6. Thorn forests
7. Tropical deciduous forests 8. Tropical evergreen forests

Components

1. Abiotic:- Organic, inorganic substances & Dead organic matters present in soil.
2. Biotic:- a) Producers- Mainly trees
   b) Consumers

↓

↓ ↓ ↓

	Primary (Herbivores)	Secondary (Carnivores)	Tertiary
e. g.	Ants, Flies	Fox, Snakes	Lion, Tiger
	Leaf Hoppers	Lizards, Birds etc.	
	Elephants		
	Deer etc.		

3. Decomposers- e. g. Fungi (Aspergillus's, Fusarium, Alternaria) (Bacillus, and Bacteria Pseudomonas etc.)

4.4 Tundra Ecosystem ❄

✓ Definition: A cold, treeless biome with permafrost soil.

✓ Climate: Freezing temperatures, strong winds, little precipitation.

✓ Types of Tundra:

1. Arctic Tundra – Found in Greenland, Canada, Russia.
2. Alpine Tundra – Found in high mountains (Himalayas, Alps).

✓ Flora & Fauna:

- Plants: Mosses, Lichens, Dwarf Shrubs.
- Animals: Polar Bears, Arctic Foxes, Reindeer

Importance: Acts as a carbon sink, regulating global temperatures.

4.5 Mountain Ecosystem

✓ Definition: An ecosystem found in high-altitude regions with varied climate conditions.

✓ Climate:

- Temperature decreases with altitude.

- Heavy snowfall at higher elevations.

✓ Flora & Fauna:

- Plants: Conifers, Alpine flowers, Shrubs.
- Animals: Snow Leopards, Mountain Goats, Eagles.

✓ Examples:

- Himalayas (Asia)
- Andes (South America)
- Rocky Mountains (North America)

Importance: Provides water sources (glaciers), biodiversity, and climate regulation.

Importance of Terrestrial Ecosystems

Terrestrial ecosystems play a vital role in maintaining ecological balance, supporting biodiversity, and providing essential services for life on Earth. Their significance can be categorized into environmental, ecological, economic, and social benefits.

Aquatic Ecosystem

-Contain excess of water.

-Oxygen & light are deficient.

-Pressure increases with depth of water.

-Surface water develops waves.

Two types

1. Lentic:-Water occur on the land. e. g. Rivers, Streams

2. Lotic:- Standing water. e. g. Ponds, Lakes.

Pond Ecosystem

-Small water reservoir which may or may not dry up during dry periods.

-It may be natural or artificial.

-Seasonal variations appears in pond ecosystem due to change in temp. , PH, Rainfall.

Various components of pond ecosystem are-

1. Abiotic:- It includes quality & quantity of water, rainfall, temp. light penetration, PH, turbidity, O2 content, Co2 content, organic matter & inorganic salts.

2. Biotic:-

1. Producers:- Phytoplankton e. g. Diatoms, Spirogyra.
Macrophytes: Green plants may be submerged, free floating, amphibious. e. g. Ceratophyllum, Chara, Lemna, Najas, Hydrilla, Vallisneria, Wolffia, Azolla, Salvinia, Trapa, Typha, Eichhornia,Pistia, Sagittaria etc.

2. Consumers:-Primary consumers- Zooplankton, nektons & neuston.
Secondary consumers -Frog, Bugs, Small fishes, Insects.
Tertiary consumers- Large fishes feed on small fish, King fisher

Decomposers:- Fungi and bacteria.

Marine Ecosystem

Comprises about 70% of the earth's surface.

-Water is saltish with average mineral content of 3.5%.

-Hedgpeth (1957) divided environment of ocean into two parts- Benthic & Pelagic.

-Benthic or bottom varies at various levels i.e. supratidal, intertidal, sub tidal, bathyral, abyssal & hadal.

-Open sea envio. Above the benthic is called Pelagic environment.

-Area of open sea over continental shelf called neritic zone.

-Remaining part called oceanic zone.

-Pelagic area in neritic zone called neritic pelagic.

-While in oceanic zone it is known as oceanic pelagic.

-On the basis of depth of sea water oceanic zone divided into-epipelagic, mesopelagic, bathyropelagic,& abyss pelagic.

-Biotic components are-

1. Producers- Mainly phytoplankton's, such as diatoms, some microscopic algae, red & brown algae.

2. Consumers-a) Primary-Crustaceans, Moll uses, Fishes etc.

b) Secondary- Carnivorous fishes

c) Tertiary- Cad, Haddock, Halibut (Fish)

3.Decomposers-Chiefly bacteria & some algae.

Artificial Ecosystem:

1. Characteristic Features of an Artificial Ecosystem:

1. **Human-Made** – Created and maintained by humans for specific purposes.
2. **Low Biodiversity** – Limited species diversity, often focusing on a few selected organisms.
3. **Requires External Inputs** – Needs fertilizers, irrigation, and pesticides to sustain.
4. **Simplified Food Chains** – Fewer trophic levels, often lacking natural predators.
5. **Unstable Without Maintenance** – Cannot survive without human intervention.
6. **Monoculture Dominance** – Mostly consists of a single crop or species (e.g., wheat fields, fish farms).
7. **Less Resilient to Change** – More vulnerable to pests, diseases, and environmental changes.
8. **Limited Self-Purification** – Lacks natural processes for recycling nutrients and waste.
9. **Controlled Population Growth** – Organism numbers are managed artificially.
10. **Designed for Specific Goals** – Created for agriculture, aquaculture, urban landscaping, etc.

2. Structure of an Artificial Ecosystem:

An artificial ecosystem consists of three main components:

(i) Abiotic Components (Non-Living Factors):

- **Light** – Can be natural or artificial.
- **Water** – Usually supplied through irrigation or tanks.
- **Soil** – May be modified with fertilizers or chemicals.

- **Nutrients** – Often supplemented artificially.
- **Temperature & Climate Control** – Managed in greenhouses or indoor environments.

(ii) Biotic Components (Living Organisms):

- **Producers (Autotrophs):** Usually limited to a few species, such as crops or aquatic plants in fish farms.
- **Consumers (Heterotrophs):** Includes livestock, fish, or controlled insect populations.
- **Decomposers:** Often absent or inefficient due to chemical use, requiring artificial waste disposal.

(iii) Energy Flow & Nutrient Cycle:

- Energy is provided through artificial means, such as chemical fertilizers.
- Nutrient cycles are incomplete, requiring external support for balance.
- Lacks natural decomposers to recycle organic material efficiently.

Functions of an Artificial Ecosystem:

1. **Food Production** – Supports agriculture, aquaculture, and livestock farming.
2. **Aesthetic & Recreational Purposes** – Used in gardens, parks, and aquariums.
3. **Conservation Efforts** – Zoos and botanical gardens help protect endangered species.
4. **Industrial & Economic Benefits** – Provides raw materials for industries (e.g., timber, fisheries).
5. **Controlled Research Environments** – Used for scientific studies on plants, animals, and climate control.
6. **Urban Landscaping** – Greenhouses, rooftop gardens, and indoor plant systems for air purification.
7. **Pollution Management** – Some artificial ecosystems, like constructed wetlands, help in wastewater treatment.
8. **Monitored Growth & Yield** – Enables farmers and researchers to increase production efficiency.

Examples of Artificial Ecosystems

1. Agricultural Ecosystems

- **Crop Fields** – Wheat fields, rice paddies, cornfields, etc.
- **Plantations** – Tea, coffee, rubber, sugarcane, and orchards.
- **Greenhouses** – Controlled environments for growing vegetables and flowers.
- **Hydroponic Farms** – Soil-less farming using nutrient solutions.

2. Aquatic Ecosystems

- **Aquariums** – Artificially maintained water habitats for fish and aquatic plants.
- **Fish Farms (Aquaculture)** – Ponds or tanks for breeding fish, prawns, or shellfish.
- **Artificial Lakes & Reservoirs** – Man-made water bodies for water supply and recreation.

3. Urban & Recreational Ecosystems

- **Botanical Gardens** – Designed for plant conservation and research.
- **Zoos** – Artificial habitats for animals, managed for conservation and tourism.
- **Parks & Gardens** – Landscaped areas in cities for recreational purposes.
- **Golf Courses** – Green spaces maintained with irrigation and chemical treatments.

4. Industrial & Constructed Ecosystems

- **Man-Made Wetlands** – Used for wastewater treatment and flood control.
- **Terrariums** – Enclosed environments for small plants and animals.
- **Vertical Farms** – Multi-layered indoor farming systems.

Agroecosystem:

- An **agroecosystem** is a human-managed ecosystem designed for agricultural production, including crop cultivation and livestock farming.

1. Characteristic Features of an Agroecosystem

1. **Human-Managed** – Created and maintained by humans for food and raw material production.
2. **Monoculture Dominance** – Typically focuses on a single crop or livestock species (e.g., wheat fields, dairy farms).
3. **Low Biodiversity** – Reduced variety of plants, animals, and microorganisms compared to natural ecosystems.
4. **External Inputs** – Requires chemical fertilizers, pesticides, and irrigation for sustainability.
5. **Simplified Food Chains** – Fewer trophic levels with limited interactions among organisms.
6. **High Productivity** – Designed for maximum yield in a limited time.
7. **External Energy Dependence** – Uses fuel-powered machinery, artificial lighting, and fertilizers to boost production.
8. **Less Resilient to Changes** – Highly vulnerable to pests, diseases, and climate fluctuations.
9. **Controlled Population Growth** – Farmers regulate crop density and livestock numbers.
10. **Soil Degradation Risk** – Continuous farming can lead to loss of nutrients and soil fertility.

2. Structure of an Agroecosystem

(i) Abiotic Components (Non-Living Factors):

- **Soil** – Managed with fertilizers to enhance fertility.
- **Water** – Often supplied through irrigation.
- **Nutrients** – Artificially supplemented with chemical or organic fertilizers.
- **Climate Control** – Greenhouses and weather-monitoring tools regulate temperature and moisture.
- **Machinery** – Tractors, harvesters, and irrigation systems for large-scale farming.

(ii) Biotic Components (Living Organisms):

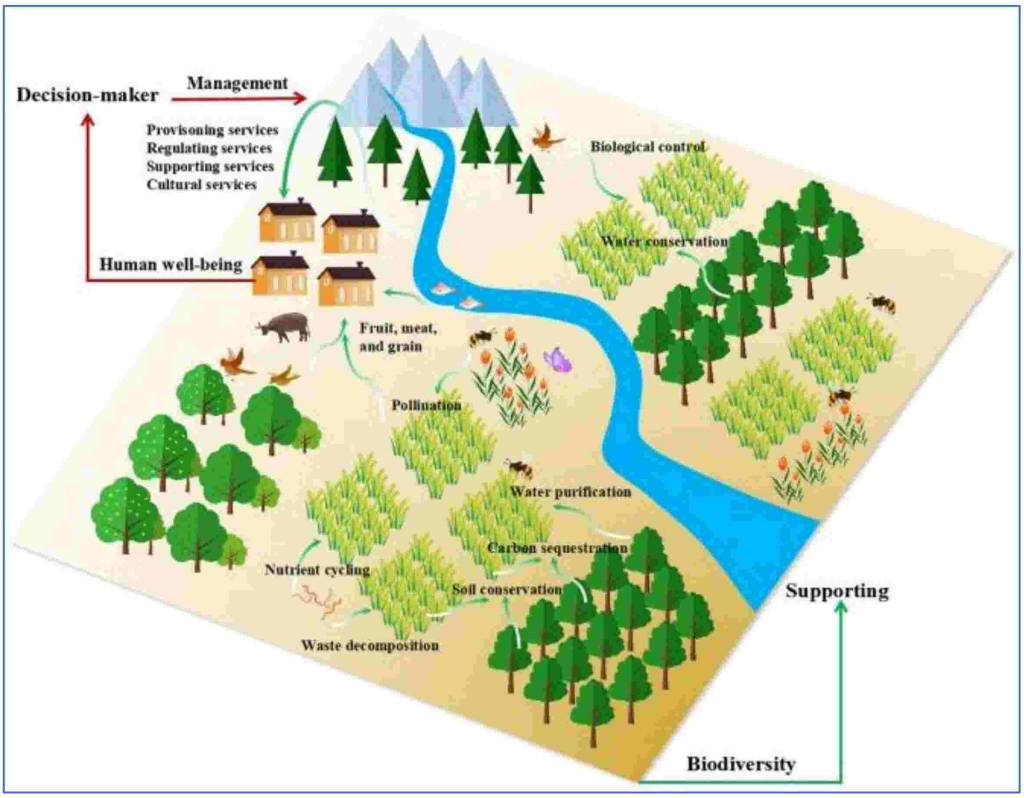
- **Producers (Autotrophs):** Crops such as wheat, rice, maize, vegetables, or fruit trees.
- **Consumers (Heterotrophs):** Domesticated animals like cows, chickens, sheep, and humans consuming the produce.
- **Decomposers:** Bacteria and fungi that break down organic matter, but their role is often reduced due to chemical usage.

(iii) Energy Flow & Nutrient Cycle:

- **Energy Source:** Mostly sunlight, but artificial lighting is sometimes used in controlled environments.
- **Nutrient Cycle:** Often disrupted, leading to soil degradation and dependency on fertilizers.
- **Waste Management:** Crop residues and animal waste are either reused (composting) orremoved.

3. Functions of an Agroecosystem

1. **Food Production** – Provides staple crops, vegetables, fruits, and livestock products.
2. **Economic Development** – Supports farmers, agribusiness, and industries.
3. **Raw Material Supply** – Provides cotton, sugarcane, timber, and biofuels.
4. **Employment Generation** – Creates jobs in farming, food processing, and agribusiness.
5. **Controlled Crop & Livestock Growth** – Farmers regulate planting cycles and breeding.
6. **Technological Advancements** – Uses GMOs, hydroponics, and precision farming for efficiency.
7. **Environmental Impact** – Can lead to deforestation, water pollution, and habitat loss if not managed sustainably.



Conservation Efforts for ecosystem

To protect terrestrial ecosystems, various conservation measures are being implemented globally.

1. Afforestation & Reforestation

✓ Afforestation – Planting trees in areas where there were no forests before.

✓ Reforestation – Restoring forests that were cleared or degraded.

✓ Benefits:

- Absorbs CO_2, helping to combat climate change.
- Restores biodiversity and animal habitats.
- Prevents soil erosion and desertification.
- Regulates rainfall and improves air quality.

Example: China's "Great Green Wall" Project aims to plant billions of trees to combat desertification in the Gobi Desert.

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2. Protected Areas & National Parks

✓ Definition: Areas designated to conserve biodiversity, wildlife, and ecosystems.

✓ Types:

- National Parks – Strictly protected areas for wildlife conservation.
- Wildlife Reserves – Areas where sustainable human activities are allowed.
- Biosphere Reserves – Large ecosystems with protected core areas and buffer zones.

✓ Importance:

- Provides safe habitats for endangered species.
- Prevents illegal poaching and logging.
- Supports ecotourism and sustainable development.

Example: Kaziranga National Park (India) protects the one-horned rhinoceros from poaching.

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3. Sustainable Land Use

✓ Definition: Using land responsibly to meet human needs without degrading natural ecosystems.

✓ Sustainable Practices:

- Agroforestry – Growing trees alongside crops to improve soil health.
- Crop Rotation & Organic Farming – Reduces chemical use and soil depletion.
- Eco-friendly Urban Planning – More green spaces, less deforestation.
- Wildlife Corridors – Connecting habitats to allow species migration.

✓ Benefits:

- Reduces land degradation & soil erosion.
- Maintains biodiversity while supporting agriculture.
- Improves water conservation & prevents desertification.

Example: The "Zero Deforestation" policy in Costa Rica promotes sustainable farming and forest conservation.

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4. Pollution Control & Waste Management

✓ Strategies to Reduce Pollution:

- Reducing plastic use and promoting biodegradable materials.
- Industrial regulations to minimize toxic waste.

- Waste recycling & composting to reduce landfill pollution.
- Strict air quality laws to control vehicle and factory emissions.

Example: Sweden recycles nearly 99% of its waste, reducing landfill impact.

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5. Climate Change Mitigation

✓ Actions to Reduce Global Warming:

- Transition to Renewable Energy – Solar, wind, hydroelectric power.
- Reducing Greenhouse Gas Emissions – Cutting down fossil fuel use.
- Carbon Sequestration Techniques – Capturing CO_2 through reforestation.
- International Agreements – Paris Agreement aims to limit global warming to below 2°C.

Example: Norway is aiming to be carbon-neutral by 2030 by investing in green energy and electric vehicles.

Difference between Natural Artificial Ecosystems

Feature	Natural Ecosystem	Artificial Ecosystem
1. Formation	Formed naturally over time.	Created and maintained by humans.
2. Sustainability	Self-sustaining and independent.	Needs continuous human intervention.
3. Biodiversity	High, with diverse species.	Low, often limited species.
4. Food Chain Complexity	Complex and balanced food chains.	Simplified food chains with fewer levels.
5. Energy Flow	Solar energy is efficiently utilized.	Requires external energy inputs.
6. Nutrient Recycling	Naturally recycles nutrients.	Often disrupted; needs fertilizers.
7. Population Control	Regulated by natural predators and prey.	Controlled by humans through breeding or pesticides.
8. Adaptability	Adapts to environmental changes.	Less adaptable; vulnerable to disruptions.
9. External Inputs	Does not need artificial fertilizers or irrigation.	Needs artificial irrigation, fertilizers, and pesticides.
10. Species Interaction	Complex interactions like symbiosis and competition.	Limited or artificially managed interactions.
11. Stability	More stable, able to recover from changes.	Less stable, needs human maintenance.
12. Self-Purification	Natural cleansing processes (e.g., water bodies purify themselves).	Pollution builds up faster, requiring cleanup.
13. Habitat Diversity	Includes forests, oceans, deserts, etc.	Exists mainly in controlled environments like farms, zoos, and aquariums.
14. Climate Influence	Regulates carbon cycles and global climate.	Minimal impact on global climate.
15. Longevity	Exists for millions of years, evolving naturally.	Short-term existence, dependent on human maintenance.

Lecture No. 10 - 12

Topic: Biodiversity and its Conservation

Sub-topics/ Key Points: Importance, Value, Types, Biogeographical classification, Hotspots, Threats, Conservation strategies

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Biodiversity:

Definition of Biodiversity

Biodiversity (or biological diversity) refers to the variety of life forms present in a particular region, including different species of plants, animals, microorganisms, and ecosystems. It encompasses genetic diversity, species diversity, and ecosystem diversity, which all contribute to the stability and resilience of life on Earth.

According to the Convention on Biological Diversity (CBD):

"Biodiversity means the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part."

Levels of Biodiversity

1. Genetic Diversity – Variation of genes within species (e.g., different breeds of dogs, varieties of rice).
2. Species Diversity – Variety of species in an ecosystem (e.g., tigers, elephants, and deer in a forest).
3. Ecosystem Diversity – Different ecosystems within a region (e.g., forests, deserts, wetlands).

Importance of Biodiversity

1. Ecological Importance

✓ Maintains Ecosystem Stability – Diverse ecosystems are more resilient to environmental changes.

✓ Nutrient Cycling & Soil Fertility – Microorganisms help decompose organic matter and enrich the soil.

✓ Pollination & Seed Dispersal – Insects, birds, and animals pollinate flowers and spread seeds for plant reproduction.

✓ Regulation of Climate & Water Cycle – Forests and wetlands absorb carbon dioxide and regulate rainfall.

Example: Coral reefs support marine biodiversity by providing habitats for thousands of fish species.

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2. Economic Importance

✓ Agriculture & Food Production – Crop diversity ensures food security and resistance to pests.

✓ Medicinal Resources – Many life-saving drugs are derived from plants and microbes (e.g., Penicillin from fungi).

✓ Raw Materials for Industries – Biodiversity provides timber, fibers, rubber, and dyes for manufacturing.

✓ Ecotourism & Recreation – National parks and wildlife attract tourists, generating revenue.

Example: The Amazon Rainforest provides medicinal plants used in 70% of modern pharmaceuticals.

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3. Social & Cultural Importance

✓ Sacred & Religious Value – Many cultures consider animals, plants, and rivers sacred (e.g., Ganges River in India).

✓ Livelihood for Indigenous Communities – Many tribes depend on biodiversity for food, medicine, and shelter.

✓ Aesthetic & Recreational Value – Natural landscapes provide peace, inspiration, and relaxation.

Example: The Himalayas hold spiritual significance in Hinduism and Buddhism.

4. Biodiversity & Human Survival

✓ Oxygen Production – Plants and trees provide oxygen through photosynthesis.

✓ Water Purification – Wetlands filter pollutants, keeping freshwater clean.

✓ Pest & Disease Control – Natural predators keep pest populations in check.

✓ Disaster Mitigation – Mangrove forests protect coastal areas from storms and tsunamis.

Example: The Sundarbans Mangrove Forest (India & Bangladesh) protects coastal communities from cyclones.

Values of Biodiversity

Biodiversity provides numerous benefits to humans and the environment. These benefits can be classified into direct and indirect values, along with ethical and aesthetic values.

1. Direct Use Values (Consumptive & Productive Values)

Direct use values refer to the tangible benefits that humans obtain from biodiversity, such as food, medicine, and raw materials.

✓ Food Resources

- Biodiversity provides crops, fruits, vegetables, fish, and livestock.
- Genetic diversity in crops improves resistance to pests, diseases, and climate change.

Example: Different varieties of rice and wheat help improve global food security.

✓ Medicinal Resources

- Over 70% of modern medicines come from plants, animals, and microorganisms.
- Many antibiotics, painkillers, and cancer drugs are derived from nature.

Example: Penicillin (from fungi) and quinine (from the Cinchona tree) treat infections and malaria.

✓ Industrial & Commercial Products

- Biodiversity provides timber, rubber, resins, fibers, and dyes for industries.
- Raw materials are used in the paper, textile, and cosmetics industries.
  Example: Natural rubber is obtained from the rubber tree (Hevea brasiliensis).

✓ Genetic Resources

- Wild species contribute genetic material for improving agriculture and medicine.
- Crossbreeding & genetic engineering use biodiversity to develop disease-resistant crops.
  Example: Wild rice varieties help scientists develop high-yielding rice strains.

2. Indirect Use Values (Ecosystem Services)

Indirect use values refer to the ecological services that biodiversity provides, which support life on Earth.

✓ Climate Regulation

- Forests and oceans act as carbon sinks, absorbing excess CO_2.
- Plants release oxygen through photosynthesis.
  Example: The Amazon Rainforest absorbs 2 billion tons of CO_2 annually.

✓ Water & Air Purification

- Wetlands and forests filter pollutants and improve water & air quality.
  Example: Mangroves prevent water contamination by absorbing pollutants.

✓ Pollination & Seed Dispersal

- Bees, butterflies, and birds help in pollinating crops and wild plants.
- Many plant species rely on animals to disperse seeds for reproduction.
  Example: Bees pollinate 75% of global food crops like apples, coffee, and almonds.

✓ Soil Fertility & Erosion Control

- Microorganisms decompose organic matter, enriching soil nutrients.
- Tree roots prevent soil erosion and landslides.
  Example: Earthworms improve soil fertility by breaking down organic matter.

✓ Natural Disaster Mitigation

- Mangrove forests protect coastal areas from tsunamis and cyclones.
- Coral reefs act as natural barriers against ocean waves.
  Example: The Sundarbans Mangrove Forest in India & Bangladesh reduces cyclone damage.

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3. Social, Cultural & Aesthetic Values

Biodiversity has deep cultural, spiritual, and aesthetic significance.

✓ Spiritual & Religious Significance

- Many plants and animals hold sacred importance in different religions.
  Example: The Peepal tree (Ficus religiosa) is considered sacred in Hinduism & Buddhism.

✓ Ecotourism & Recreation

- National parks and wildlife sanctuaries attract millions of tourists worldwide.
  Example: Safari tourism in African national parks supports conservation efforts.

✓ Aesthetic & Artistic Inspiration

- Many paintings, literature, and films are inspired by nature & wildlife.
  Example: The famous painting "Starry Night" by Vincent van Gogh was inspired by nature.

4. Ethical & Moral Values

Biodiversity holds intrinsic value, meaning all living beings have a right to exist, regardless of human use.

✓ Ethical Responsibility

- Every species has the right to live, and humans must protect biodiversity.

Example: The conservation of tigers under Project Tiger in India.

✓ Legacy for Future Generations

- Protecting biodiversity ensures sustainability for future generations.

Example: Reforestation projects aim to restore lost biodiversity

Types of Biodiversity

Biodiversity can be classified into three main types:

1 Genetic Diversity

2 Species Diversity

3 Ecosystem Diversity

Each type of biodiversity plays a critical role in maintaining ecosystem balance, sustainability, and resilience.

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1 Genetic Diversity

Definition:

Genetic diversity refers to the variation in genes and DNA within a species. It includes differences in traits, adaptations, and resistance to environmental changes.

Importance:

✓ Higher genetic diversity increases a species' ability to adapt to environmental changes.

✓ Provides resistance to diseases, pests, and climate fluctuations.

✓ Helps in the evolution of new species over time.

Examples:

- Different breeds of dogs (Labrador, German Shepherd, Pug) show genetic variation within the species *Canis lupus familiaris*.
- Rice varieties (Basmati, Japonica, Indica) have different flavors, growth conditions, and resistance to pests.
- Human blood groups (A, B, AB, O) are a result of genetic diversity.

Threats to Genetic Diversity:

Habitat destruction reduces population sizes, leading to inbreeding and loss of genetic diversity.

Overuse of genetically modified organisms (GMOs) reduces traditional crop diversity.
Climate change can eliminate genetically unique populations.

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2 Species Diversity

Definition:

Species diversity refers to the variety of different species within an ecosystem. It includes:

✓ Species Richness – Number of species in an ecosystem.

✓ Species Evenness – Distribution of individuals among species.

Importance:

✓ A diverse ecosystem is more stable and resilient against environmental changes.

✓ Prevents species extinction by maintaining food chains and ecological balance.

✓ Increases productivity in an ecosystem, ensuring sustainable resources.

Examples:

- A rainforest has high species diversity (birds, mammals, insects, plants).
- A desert has low species diversity but is adapted to extreme conditions.
- The Great Barrier Reef is rich in marine species like corals, fish, and sea turtles.

Threats to Species Diversity:

Habitat destruction (deforestation, urbanization) causes species extinction.

Overhunting & poaching reduce population sizes.

Pollution & climate change alter species' survival conditions.

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3 Ecosystem Diversity

Definition:

Ecosystem diversity refers to the variety of ecosystems within a geographical region. It includes different habitats, ecological processes, and interactions.

Types of Ecosystems:

✓ Terrestrial Ecosystems – Forests, deserts, grasslands, mountains.

✓ Aquatic Ecosystems – Oceans, rivers, lakes, wetlands.

✓ Artificial Ecosystems – Agricultural lands, urban areas.

Importance:

✓ A greater number of ecosystems provide diverse habitats for species survival.

✓ Supports natural cycles like the carbon and nitrogen cycles.

✓ Provides ecosystem services such as water purification, air filtration, and climate regulation.

Examples:

- The Amazon Rainforest supports a tropical ecosystem.
- The Sundarbans Mangrove Forest helps protect coastal areas.
- Coral reefs provide shelter to marine species and protect coastlines.

Threats to Ecosystem Diversity:

Deforestation destroys ecosystems, reducing biodiversity.

Urban expansion converts natural areas into human settlements.

Pollution affects the balance of ecosystems, leading to species decline.

Biogeographical Classification: Definition & Explanation

Definition:

Biogeographical classification refers to the scientific division of Earth's surface into different biogeographical regions based on their climate, flora (plants), fauna (animals), and geographical features. It helps in understanding the distribution of species and ecosystems across the world.

Biogeography is the study of how species and ecosystems are distributed across different regions of the planet.

Importance of Biogeographical Classification:

✓ Helps in biodiversity conservation by identifying regions rich in species.

✓ Aids in studying the evolution and migration of species.

✓ Assists in climate change research by analyzing species adaptation.

✓ Provides a scientific basis for wildlife protection and conservation laws.

Major Biogeographical Realms of the World (Wallace's Classification)

Based on species distribution and evolutionary history, the world is divided into 8 major biogeographical realms:

1 Palearctic – Covers Europe, North Africa, and most of Asia.

2 Nearctic – Includes North America and Greenland.

3 Neotropical – Encompasses South America and Central America.

4 Afrotropical (Ethiopian) – Covers Sub-Saharan Africa and Madagascar.

5 Indomalaya (Oriental) – Includes India, Southeast Asia, and southern China.

6 Australasian – Covers Australia, New Guinea, and nearby islands.

7 Antarctic – Includes Antarctica and surrounding islands.

8 Oceania – Encompasses Pacific islands, excluding Australia.

Example: The Indomalayan region includes diverse species like the Bengal tiger, Asian elephants, and Indian rhinoceros.

Biogeographical Classification of India

India has been divided into 10 biogeographical zones based on vegetation, climate, and wildlife:

1. Trans-Himalayan Region – Cold, dry, high-altitude region (Ladakh, Spiti Valley).
2. Himalayan Region – Includes forests, alpine meadows, and diverse wildlife.
3. Indian Desert – Covers Thar Desert with extreme climate conditions.
4. Semi-Arid Region – Grasslands and scrublands in western and central India.
5. Western Ghats – Biodiversity hotspot with evergreen forests and unique species.
6. Deccan Plateau – Dry deciduous forests, central India's major ecosystem.
7. Gangetic Plains – Fertile plains with rich agricultural biodiversity.
8. North-East India – Rainforests, high biodiversity, and endemic species.

9. Coastal Zones – Mangroves, lagoons, estuaries with rich marine life.
10. Islands (Andaman & Nicobar, Lakshadweep) – Coral reefs, unique flora and fauna.
Example: The Western Ghats are home to lion-tailed macaques, Malabar civets, and the Nilgiri tahr.

Biogeographical Classification of India

India is one of the 17 megadiverse countries in the world, possessing rich biodiversity due to its varied geography, climate, and ecosystems. To understand and conserve its biodiversity, India has been biogeographically classified into 10 distinct zones based on climate, vegetation, topography, and wildlife.

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10 Biogeographical Zones of India

1. Trans-Himalayan Region

✓ Located in Ladakh, Jammu & Kashmir, and parts of Himachal Pradesh.

✓ Characterized by cold deserts, high-altitude plateaus, and glaciers.

✓ Sparse vegetation with cold-resistant species like shrubs and alpine grasses.

✓ Wildlife: Snow leopard, Tibetan antelope, Himalayan wolf, ibex, bharal (blue sheep).

✓ Protected Areas: Hemis National Park, Pin Valley National Park.

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2. Himalayan Region

✓ Extends across Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh.

✓ Features temperate forests, alpine meadows, and glaciers.

✓ High species endemism and acts as a climate regulator.

✓ Wildlife: Red panda, Himalayan black bear, musk deer, monal pheasant (state bird of Uttarakhand).

✓ Protected Areas: Nanda Devi Biosphere Reserve, Valley of Flowers National Park.

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3. Indian Desert

✓ Covers Rajasthan, parts of Gujarat, and Haryana.

✓ Characterized by hot arid climate, sand dunes, and scarce vegetation.

✓ Thorny bushes and xerophytic plants (adapted to dry conditions) dominate.

✓ Wildlife: Great Indian Bustard (critically endangered), Indian gazelle (Chinkara), desert fox, monitor lizard.

✓ Protected Areas: Desert National Park, Tal Chhapar Sanctuary.

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4. Semi-Arid Region

✓ Spans across Madhya Pradesh, Gujarat, Punjab, Haryana, Rajasthan, Maharashtra, Karnataka, Andhra Pradesh.

✓ Transitional zone between the desert and more humid regions.

✓ Dry deciduous forests, grasslands, and scrub vegetation.
✓ Wildlife: Blackbuck, Indian wolf, striped hyena, Indian fox.
✓ Protected Areas: Gir National Park (home to Asiatic Lions), Velavadar Blackbuck Sanctuary.

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5. Western Ghats (Sahyadri Hills)
✓ Extends across Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu.
✓ One of the world's eight "hottest" biodiversity hotspots.
✓ Evergreen & semi-evergreen forests, rich in endemic species.
✓ Wildlife: Malabar civet, Nilgiri tahr, lion-tailed macaque, great Indian hornbill.
✓ Protected Areas: Periyar Tiger Reserve, Silent Valley National Park.

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6. Deccan Plateau
✓ Covers Maharashtra, Madhya Pradesh, Chhattisgarh, Odisha, Andhra Pradesh, Telangana, Karnataka, Tamil Nadu.
✓ Dominated by dry deciduous forests, scrublands, and grasslands.
✓ Important watershed for Indian rivers (Godavari, Krishna, Kaveri).
✓ Wildlife: Indian giant squirrel, sloth bear, Indian pangolin.
✓ Protected Areas: Tadoba-Andhari Tiger Reserve, Nagarhole National Park.

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7. Gangetic Plains
✓ Spreads across Uttar Pradesh, Bihar, West Bengal, parts of Haryana, Punjab, Assam.
✓ Fertile alluvial plains formed by the Ganga, Yamuna, and Brahmaputra rivers.
✓ Agriculturally important region, but high human impact.
✓ Wildlife: Ganges river dolphin, swamp deer, one-horned rhinoceros, fishing cat.
✓ Protected Areas: Kaziranga National Park, Dudhwa National Park.

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8. North-East India
✓ Covers Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Sikkim.
✓ A part of the Indo-Burma biodiversity hotspot with tropical and temperate forests.
✓ Rich in medicinal plants, orchids, and bamboos.
✓ Wildlife: Clouded leopard, hoolock gibbon, golden langur, hornbill.
✓ Protected Areas: Manas National Park, Nokrek Biosphere Reserve.

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9. Coastal Zones
✓ Extends along the 9,000 km coastline of India, including West Coast (Arabian Sea) and East Coast (Bay of Bengal).
✓ Features mangroves, estuaries, lagoons, sandy beaches, and coral reefs.

✓ Important for marine biodiversity and fishing communities.

✓ Wildlife: Olive Ridley turtles, dugongs (sea cows), mangrove crabs, corals.

✓ Protected Areas: Bhitarkanika Mangroves, Gulf of Mannar Biosphere Reserve.

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10. Islands (Andaman & Nicobar, Lakshadweep)

✓ Includes Andaman & Nicobar Islands in the Bay of Bengal and Lakshadweep Islands in the Arabian Sea.

✓ Tropical rainforests, coral reefs, and marine biodiversity.

✓ High endemism due to geographic isolation.

✓ Wildlife: Nicobar megapode, saltwater crocodile, dugong, coconut crab.

✓ Protected Areas: Great Nicobar Biosphere Reserve, Mahatma Gandhi Marine National Park.

Summary Table of Biogeographical Zones of India

Zone	Characteristics	Major Wildlife	Protected Areas
Trans-Himalayan	Cold deserts, high-altitude plateaus	Snow leopard, ibex	Hemis NP
Himalayan	Alpine meadows, conifer forests	Red panda, musk deer	Nanda Devi NP
Indian Desert	Arid, sand dunes	Great Indian Bustard, Chinkara	Desert NP
Semi-Arid	Dry grasslands	Blackbuck, hyena	Gir NP
Western Ghats	Biodiversity hotspot	Lion-tailed macaque, Nilgiri tahr	Periyar NP
Deccan Plateau	Dry forests, scrublands	Sloth bear, pangolin	Tadoba NP
Gangetic Plains	Fertile alluvial plains	Ganges dolphin, one-horned rhino	Kaziranga NP
North-East India	Tropical forests	Hoolock gibbon, clouded leopard	Manas NP
Coastal Zones	Mangroves, estuaries	Olive Ridley turtle, dugong	Bhitarkanika NP
Islands	Coral reefs, rainforests	Nicobar megapode, saltwater crocodile	Great Nicobar BR

Importance of Biogeographical Classification in India

✓ Helps in conservation planning by identifying ecologically sensitive zones.

✓ Aids in wildlife protection and management through national parks and sanctuaries.

✓ Supports sustainable development by balancing ecological and economic needs.

✓ Assists in disaster management (coastal areas vulnerable to cyclones, floods).

✓ Enhances scientific research in biodiversity, climate change, and ecosystems.

Biodiversity Hotspots: Global & India

Biodiversity hotspots are regions with exceptionally high species richness and endemism but are also highly threatened by human activities. These areas are crucial for global conservation efforts due to their ecological importance.

Definition of Biodiversity Hotspots

A biodiversity hotspot is a region that:

✓ Has at least 1,500 species of vascular plants as endemics (species found nowhere else).

✓ Has lost at least 70% of its original vegetation due to human activities.

Concept introduced by: Norman Myers (1988).

Biodiversity Hotspots of the World

There are 36 biodiversity hotspots across the world, covering only 2.4% of Earth's land area but supporting more than 50% of the world's endemic plant species.

Major Biodiversity Hotspots of the World

Region	Location	Notable Species
Amazon Rainforest	South America	Jaguars, macaws, Amazon river dolphins
Congo Basin	Africa	Gorillas, okapi, African forest elephants
Indo-Burma	South & Southeast Asia	Asian elephants, Gibbons, Indian cobra
Sundaland	Indonesia, Malaysia	Orangutans, Sumatran tigers, Rafflesia flower
Coral Triangle	Pacific Ocean (Philippines, Indonesia)	Clownfish, sea turtles, coral reefs
Madagascar & Indian Ocean Islands	Madagascar, Seychelles	Lemurs, Baobab trees, chameleons
Mesoamerican Forests	Central America	Quetzals, howler monkeys, jaguars
Himalayas	South Asia	Snow leopards, red pandas, blue poppies

These regions are highly vulnerable due to deforestation, climate change, and human activities.

Biodiversity Hotspots in India

India is home to 4 out of the 36 global biodiversity hotspots. These hotspots are rich in endemic and rare species and are of great ecological importance.

1. The Himalayas

✓ Includes the entire Indian Himalayan region and neighboring countries.

✓ Unique Flora & Fauna: Snow leopard, red panda, Himalayan blue poppy, yak.

✓ Threats: Climate change, deforestation, poaching.

✓ Protected Areas: Great Himalayan National Park, Nanda Devi Biosphere Reserve.

2. Indo-Burma

✓ Covers northeastern India, Myanmar, Laos, Vietnam, and parts of China.

✓ One of the most threatened hotspots due to high human population pressure.

✓ Unique Flora & Fauna: Hoolock gibbon, Asian elephant, giant catfish.

✓ Threats: Habitat destruction, illegal wildlife trade, logging.

✓ Protected Areas: Kaziranga National Park, Manas Wildlife Sanctuary.

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3. Western Ghats (Sahyadri Hills)

✓ Spans Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu.

✓ One of the eight "hottest" hotspots in the world due to high endemism.

✓ Unique Flora & Fauna: Lion-tailed macaque, Nilgiri tahr, Malabar civet, neelakurinji flower.

✓ Threats: Deforestation, agriculture expansion, urbanization.

✓ Protected Areas: Silent Valley National Park, Periyar Wildlife Sanctuary.

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4. Sundaland (Including Nicobar Islands)

✓ Covers Andaman & Nicobar Islands and extends to Malaysia, Indonesia.

✓ Rich in marine and terrestrial biodiversity.

✓ Unique Flora & Fauna: Nicobar megapode, saltwater crocodile, dugong, pitcher plants.

✓ Threats: Rising sea levels, tourism, habitat destruction.

✓ Protected Areas: Great Nicobar Biosphere Reserve, Mahatma Gandhi Marine National Park.

Importance of Biodiversity Hotspots

✓ Conservation Priority – Supports high species richness & endemism.

✓ Climate Regulation – Maintains carbon balance and water cycle.

✓ Ecotourism & Economy – Provides sustainable livelihoods for locals.

✓ Medicinal Resources – Home to rare plants with medicinal properties.

✓ Cultural & Spiritual Value – Many indigenous communities depend on these ecosystems.

Threats to Biodiversity Hotspots

- Deforestation – Logging, agriculture, and urbanization.
- Poaching & Wildlife Trade – Illegal hunting of endangered species.
- Climate Change – Rising temperatures and habitat loss.
- Pollution – Industrial waste, plastic, and chemical runoff.
- Invasive Species – Non-native species threatening native biodiversity.

Conservation Efforts for Biodiversity Hotspots

✓ Biosphere Reserves & National Parks – Protecting critical habitats.

✓ Afforestation & Reforestation – Restoring lost forest cover.

✓ Eco-sensitive Zones (ESZs) – Limiting human activities in fragile areas.

✓ Community Participation – Involving local communities in conservation.

✓ Wildlife Protection Acts & International Treaties – Strengthening legal frameworks.

Examples:

- Project Tiger & Project Elephant – Conservation of key species.
- Ramsar Convention – Protection of wetlands.
- CBD (Convention on Biological Diversity) – Global biodiversity protection commitment.

Threats to Biodiversity

Biodiversity faces severe threats due to human activities and natural causes. These threats lead to species extinction, habitat destruction, and ecosystem imbalance. The main threats to biodiversity can be classified into natural threats and anthropogenic (human-induced) threats.

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1. Anthropogenic (Human-Induced) Threats

1. Habitat Destruction & Fragmentation

✓ Deforestation, urbanization, agriculture, and infrastructure projects destroy natural habitats.

✓ Example: Amazon rainforest deforestation for agriculture and cattle ranching.

✓ Effect: Leads to habitat fragmentation, isolating species and reducing genetic diversity.

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2. Overexploitation of Natural Resources

✓ Excessive hunting, fishing, and logging lead to species decline.

✓ Example: Overfishing of tuna and sharks in oceans, poaching of tigers and rhinos.

✓ Effect: Reduces population sizes, disrupts food chains, and causes species extinction.

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3 Climate Change & Global Warming

✓ Temperature rise, melting glaciers, sea-level rise, and changing weather patterns affect species survival.

✓ Example: Coral bleaching in the Great Barrier Reef due to rising ocean temperatures.

✓ Effect: Alters species distribution, food availability, and reproductive cycles.

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4. Pollution (Air, Water, Soil, Noise, and Light Pollution)

✓ Industrial waste, plastic pollution, chemical pesticides, and oil spills degrade ecosystems.

✓ Example: Oil spills in oceans harm marine biodiversity, plastic pollution kills sea turtles.

✓ Effect: Toxic substances accumulate in food chains, affecting health and survival.

5. Introduction of Invasive Species

✓ Non-native species introduced into an ecosystem outcompete or prey on native species.

✓ Example:

- Water hyacinth in Indian rivers chokes water bodies and depletes oxygen.
- African catfish in Indian lakes disrupts native fish populations.

✓ Effect: Reduces native biodiversity, alters ecosystems, and disrupts food chains.

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6. Poaching & Illegal Wildlife Trade

✓ Hunting, trading of rare and endangered species for profit (fur, ivory, medicinal use).

✓ Example: Poaching of Bengal tigers for skin and bones, illegal trade of pangolins.

✓ Effect: Leads to population decline and extinction of rare species.

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7. Agricultural Expansion & Monoculture Farming

✓ Large-scale agriculture, pesticide use, and monoculture crops reduce biodiversity.

✓ Example: Expansion of oil palm plantations in Indonesia destroying orangutan habitats.

✓ Effect: Loss of diverse plant species, soil degradation, and reduced pollinator populations.

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8. Mining & Industrial Activities

✓ Extraction of minerals, coal, and fossil fuels leads to deforestation and soil erosion.

✓ Example: Amazon forest destruction due to gold mining.

✓ Effect: Pollution, habitat destruction, and displacement of local species.

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9. Urbanization & Infrastructure Development

✓ Road construction, dams, and housing projects destroy natural habitats.

✓ Example: Construction of highways through forests causes habitat fragmentation.

✓ Effect: Isolates wildlife populations, disrupts migration patterns, and increases roadkill incidents.

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10. Genetic Pollution & Hybridization

✓ Crossbreeding of wild species with genetically modified organisms (GMOs) affects genetic purity.

✓ Example: Hybridization of wild and domesticated plant species reduces natural resilience.

✓ Effect: Loss of unique genetic traits, making species vulnerable to diseases.

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2. Natural Threats to Biodiversity

1. Natural Disasters

✓ Earthquakes, floods, volcanic eruptions, cyclones, and droughts destroy habitats.

✓ Example: Tsunami in 2004 destroyed coastal mangroves and coral reefs.

✓ Effect: Sudden loss of species, habitat destruction, and food shortages.

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2. Epidemics & Diseases

✓ Viral, bacterial, and fungal infections can wipe out entire populations.

✓ Example: White-nose syndrome in bats, chytrid fungus killing amphibians.

✓ Effect: Decline in species population, affecting ecosystem stability.

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3. Natural Climate Variations

✓ Long-term climate fluctuations can change biodiversity patterns.

✓ Example: Ice age events causing species migrations and extinctions.

✓ Effect: Forces species to adapt, migrate, or face extinction.

Consequences of Biodiversity Loss

✓ Ecosystem Imbalance – Disrupts food chains and ecological functions.

✓ Reduced Genetic Diversity – Makes species vulnerable to diseases.

✓ Economic Loss – Affects agriculture, fisheries, and ecotourism.

✓ Decline in Ecosystem Services – Reduces natural benefits like air purification, water filtration, and climate regulation.

✓ Increased Human-Wildlife Conflict – Habitat loss forces animals into human settlements.

Conservation Strategies for Biodiversity

Biodiversity conservation aims to protect, restore, and sustainably manage ecosystems and species to ensure the long-term survival of plant and animal life on Earth. Conservation strategies can be categorized into in-situ conservation (protecting species in their natural habitat) and ex-situ conservation (protecting species outside their natural habitat).

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1. In-Situ Conservation (On-Site Conservation)

This strategy protects species in their natural habitat by preserving entire ecosystems. It is the most effective method for maintaining biodiversity.

1. Protected Areas & Wildlife Reserves

✓ National Parks, Wildlife Sanctuaries, and Biosphere Reserves protect endangered species and their ecosystems.

✓ **Examples in India:**

- National Parks: Kaziranga (Rhinos), Jim Corbett (Tigers), Gir (Lions).
- Wildlife Sanctuaries: Manas, Periyar, Keoladeo Ghana.
- Biosphere Reserves: Sundarbans, Nilgiri, Nanda Devi.

✓ Impact: Reduces habitat destruction and promotes sustainable conservation.

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2. Sacred Groves & Community Reserves

✓ Sacred groves are forests protected by local communities due to religious and cultural beliefs.

✓ Examples in India: Khasi and Jaintia Hills (Meghalaya), Aravalli Hills (Rajasthan).

✓ Impact: Preserves traditional biodiversity-rich forests and prevents deforestation.

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3. Biodiversity Hotspot Protection

✓ India has 4 biodiversity hotspots (Western Ghats, Himalayas, Indo-Burma, Sundaland).

✓ Conservation efforts include afforestation, poaching bans, and reducing human encroachment.

✓ Impact: Helps conserve species endemic to these regions.

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4. Sustainable Forest & Land Use Management

✓ Agroforestry, sustainable agriculture, and afforestation programs maintain ecological balance.

✓ Impact: Reduces habitat destruction due to farming, mining, and urbanization.

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5. Wildlife Corridors & Habitat Connectivity

✓ Establishing green corridors to link fragmented forests helps in animal migration and genetic diversity.

✓ Example: Wildlife corridors for tigers in the Western Ghats and elephants in Assam.

✓ Impact: Prevents species isolation and promotes breeding.

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6. Ecotourism & Community Involvement

✓ Ecotourism programs encourage local communities to participate in conservation efforts.

✓ Example: Kerala's eco-tourism in Periyar National Park supports wildlife protection and local employment.

✓ Impact: Provides economic benefits to local communities while preserving nature.

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2. Ex-Situ Conservation (Off-Site Conservation)

This method conserves species outside their natural habitats through artificial environments like zoos, botanical gardens, and gene banks.

1. Zoos, Aquariums, and Wildlife Breeding Programs

✓ Protects endangered species and promotes captive breeding programs.

✓ Examples:

- Nandankanan Zoo (Odisha) – Captive breeding of white tigers.
- Delhi Zoo – Conservation of endangered species like one-horned rhinos.

✓ Impact: Prevents extinction and supports reintroduction into the wild.

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2. Botanical Gardens & Seed Banks

✓ Botanical gardens preserve rare and endangered plant species.

✓ Seed banks store genetic material for future cultivation.

✓ Examples:

- Indian Botanical Garden (Kolkata) – Preserves over 12,000 plant species.
- National Gene Bank (India) – Stores over 4 lakh seed samples.

✓ Impact: Prevents plant species loss and supports agriculture.

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3. Cryopreservation & Genetic Conservation

✓ Cryopreservation (freezing cells, tissues, and DNA) stores genetic material for future breeding.

✓ Example: Genome banks for preserving tiger and elephant DNA.

✓ Impact: Protects species' genetic diversity for future research.

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4. Captive Breeding & Reintroduction Programs

✓ Captive breeding in zoos and conservation centers helps endangered species recover.

✓ Example:

- Project Hangul – Conservation of Kashmiri red deer.
- Reintroduction of Indian Gharials in rivers.

✓ Impact: Helps revive populations of near-extinct species.

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3. Legal & Policy Measures for Biodiversity Conservation

1. National & International Wildlife Protection Laws

✓ The Wildlife Protection Act, 1972 (India) – Protects endangered species and bans hunting.

✓ Convention on Biological Diversity (CBD) – Global treaty to promote biodiversity conservation.

✓ CITES (Convention on International Trade in Endangered Species) – Regulates wildlife trade.

✓ Impact: Strict enforcement helps control poaching, habitat destruction, and illegal trade.

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2. Government Conservation Initiatives

✓ Project Tiger (1973) – Protects Bengal tigers in India.

✓ Project Elephant (1992) – Conservation of elephants.

✓ National Biodiversity Action Plan (NBAP) – Strategies to protect India's biodiversity.

✓ Impact: Protects keystone species and their ecosystems**.**

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3. Pollution Control & Sustainable Development Policies

✓ Ban on single-use plastics to protect marine biodiversity.

✓ Eco-sensitive zones to regulate industrial activities.

✓ Impact: Reduces pollution and environmental degradation.

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4. Community-Based & Global Conservation Efforts

4.1. Indigenous & Local Community Participation

✓ Tribal and rural communities protect forests, rivers, and wildlife.

✓ Example: Bishnoi community (Rajasthan) protects blackbucks.

✓ Impact: Strengthens conservation through traditional knowledge.

4.2NGOs & Conservation Organizations

✓ WWF (World Wildlife Fund) – Global conservation efforts.

✓ IUCN (International Union for Conservation of Nature) – Red List for endangered species.

✓ BNHS (Bombay Natural History Society, India) – Research & awareness programs.

✓ Impact: Strengthens biodiversity protection efforts worldwide.

4.3 Education & Public Awareness

✓ Environmental education in schools & colleges.

✓ Mass awareness programs on deforestation, pollution, and conservation.

✓ Impact: Encourages public participation in conservation efforts.

Lecture No. 13 - 16

Topic: Environmental Pollution

Sub-topics/ Key Points: Definition, Causes, Effects, Control measures: Air, Water, Soil, Marine, Noise, Thermal and Light pollution

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POLLUTION

Pollution is derived from Latin word ***"polluere"*** which means "to contaminate" any feature of environment. Pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings.

Environmental pollution is defined as an undesirable change in the physical, chemical and biological characteristics of any component of the environment (water, soil, air) that can cause harmful effect on various forms of life and property. Pollution can be primary (effects immediately on release to the environment) or secondary (product of interaction after release with moisture, sunlight, other pollutants etc.) pollution may be local, regional, trans boundary or global. The agent which causes pollution is called pollutant.

Pollutants can be classified as:

1. Degradable or non persistent pollutants: These can be rapidly broken by natural processes. *Eg.* Domestic sewage, discarded vegetables *etc.*
2. Slowly degradable or persistent pollutants: These remain in the environment for many years in an unchanged condition and take decades or longer to degrade. *Eg*: DDT
3. Non degradable pollutants: These cannot be degraded by natural processes. *Eg:* Toxic elements like lead or mercury and nuclear wastes

Various types of pollutions namely air, water, soil, marine, thermal and noise pollution are presented here under

AIR POLLUTION

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and environment. It can be defined as presence of foreign matter either gaseous or particulate or combination of both in the air which is detrimental to the health and welfare of human beings.

Pollutants that are emitted directly from identifiable sources are produced by natural events can be in the form of particulate matter or gaseous form. These are called primary pollutants *Ex*: Dust storms and volcanic eruptions and through human activities like emission from vehicles, industries *etc.* There are five primary pollutants that contribute to 90% of

global air pollution. These are carbon oxides (CO & CO2), N oxides, sulphur oxides, volatile organic compounds and suspended particulate matter.

The pollutants that are produced in the atmosphere, when certain chemical reactions take place among the primary pollutants and with others in the atmosphere are called secondary air pollutants. Eg: Sulphuric acid nitric acid, carbonic acid and acid rain.

Particulates are small pieces of solid material. Particulate matter can be 1) Natural such as dust, seeds, spores, pollen grains, algae fungi, bacteria and viruses 2) Anthropogenic such as mineral dust, cement, asbestos dust, fibers, metal dust, fly ash smoke particles form fires etc.

Causes of Air pollution:

Air pollution may originate form one or more variety of sources. The natural pollution include sources such as oceanic aerosol, volcanic emissions, biogenic sources, wind blown terrestrial dust and lightening. The artificial pollution generates from human activities and includes sources such as fuel burning, refuge burning, transportation, construction of buildings, chemical factories, metallurgical factories and, vehicles.

The third category includes solvent usage and sources include spray painting and solvent extraction. Automobiles are the first rate of polluters. Industries occupy second position.

1. **Industrial chimney wastes**: There are a number of industries which are source of air pollution. Petroleum refineries are the major source of gaseous pollutants. The chief gases are SO_2 and NO. Cement factories emit plenty of dust, which is potential health hazard. Stone crushers and hot mix plants also create a menace. Food and fertilizers industries which emit gaseous pollutants. Chemical manufacturing industries which emit acid vapours in air.
2. **Thermal power stations:** There are a number of thermal power stations and super thermal power stations in the country. The National thermal power corporation (NTPC) is setting up four mammoth coal-powered power stations to augment the energy generation. These are at Singrauli in U.P., Korba in M.P., Ramagundam in Andhra Pradesh and Farakka in W. Bengal.

The coal consumption of thermal plants is several million tones. The chief pollutants are fly ash, SO_2 and other gases and hydrocarbons.

3. **Automobiles**: The toxic vehicular exhausts are a source of considerable air pollution, next only to thermal power plants. The ever-increasing vehicular traffic density posed continued threat to the ambient air quality. Chief sources of emission in automobiles are (i) exhaust system, (ii) fuel tank and carburetor and (iii) crankcase. The exhaust produces many air pollutants including unburnt hydrocarbons, CO, NO and lead oxides. There are also traces

of aldehydes, esters, ethers, peroxides and ketones which are chemically active and combine to form smog in presence of light. Evaporation from fuel tank goes on constantly due to volatile nature of petrol, causing emission of hydrocarbons. The evaporation through carburettor occurs when engine is stopped and heat builds up, and as much as 12 to 40 ml of fuel is lost during each long stop causing emission of hydrocarbons.

Effects of Air Pollution:

i. **Effects on human health:** Particulates cause carcinogenic effects, accumulate in lungs and interfere with ability of lungs to exchange gases. Prolongeal exposure causes lung cancer and asthma. Cigarette smoking is responsible for greatest exposure to carbon monoxide (CO). Exposure to air containing even 0.001% of CO for several hours can cause collapse, coma and even death. As CO remains attached to heamoglobin in the blood for a long time, it accumulates and reduces the oxygen carrying capacity of blood. This impairs thinking, causes headaches, drowsiness and nausea. SO2 irritates the respiratory tissues. NO2 can irritate lungs, aggravate asthma and susceptibility to influenza and common colds. Many volatile organic compounds (benzene and formaldehyde) and toxic particulates can cause mutations and cancer.

ii. **Effects on plants** : Gaseous pollutants enter the leaf pores and damage the leaves of crop plants, interfere with photosynthesis and plants growth and reduces nutrient uptake and causes the leaves to turn yellow, brown or drop off altogether.

iii. **On materials**: Air pollutants break down the exterior paint on cars and houses.

iv. **Effect on stratosphere**: The upper stratosphere consists of considerable amounts of ozone, which works as an effective screen for UV light. This region is called ozone layer, which extends up to 60km above the surface of the earth. Ozone is a form of oxygen with 3 atoms instead of 2. It is produced naturally in the atmosphere. Presence of certain pollutants can accelerate the break down of ozone. Depletion of ozone effects human health, food productivity and climate as given below.

a. Effects on human health: - Sun burn, cataract, aging of skin and skin cancer are caused by increased UV radiation. It weakens the immune system by supporting the body‘s resistance to certain infections like measles, chickenpox & other viral diseases.

b. Effect on Food Production: UV radiation affects the ability of plants to capture light energy during the process of photosynthesis. This reduces the nutrient content and growth of plants mostly in legumes and cabbage. Plants and animals are damaged by UV radiations.

c. Effects on climate: Contribute to global warming, a phenomenon which is caused due to the increase in concentration of certain gases like CO_2, NO_2 methane and chloro floro

carbons (CFCs).

Control measures: Two approaches

1. Preventive technique
2. Effective control

Effective means of controlling air pollution is to have proper equipments in place. This includes devices for removal of pollutants form fuel gases through scrubbers, closed fuel collection recovery systems. The use of dry and wet collectors, filters, electrostatic precipitators etc.

Using unleaded petrol for vehicles is another way of control. The substitution of raw materials that cause more pollution with those that cause less pollution. Building higher smoke – stacks facilitate the discharge of pollutants as far away from the ground as possible. Industries should be carefully located so as to minimize the effect of pollution after considering topography and wind directions.

SOIL POLLUTION

Soil is a natural resource for which there is no substitute. Environmental historian Donald Worster reminds us that fertilizers are not a substitute for fertile soil. Soil can not be manufactured with a tank of chemicals. Soil is formed from the parent material by physical and chemical weathering of rocks. Climate and time are also important in the development of soils. Extremely dry or cold climates develop soils very slowly while humid and warm climates develop them more rapidly. It is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark uppermost ―top soil‖. The inorganic portion, which is made up of rock fragments, is formed over thousands of years by physical and chemical weathering of bedrock.

Soil pollution is the introduction of substances, biological organisms, or energy into the soil, resulting in a change of the soil quality, which is likely to affect the normal use of the soil or endangering public health and the living environment.

Causes of Soil Pollution

a. Erosion**:** Soil erosion can be defined as the movement of surface litter and topsoil from one place to another. It is a natural process often caused by wind and flowing water, accelerated by human activities such as farming, construction, overgrazing by livestock, burning of grass cover and deforestation.
b. Soil contaminants are spilled on the surface though many different activities. Most of

these are the result of accidents involving the vehicles that are transporting waste material from the site at which it originated to the site at which it is to be deposited. Others involve accidents involving vehicles (automobiles, trucks and airplanes) not transporting wastes, but carrying materials, including fuel, that when spilled contaminate the soil. When any liquid pollutant is on or just below the ground the surface for any period of time, one of these could happen to it, if it is not cleaned up first.

c. Pollutant might be washed away by precipitation, causing little or no harm to the ground on which it is found (however, pollutants will simply accumulate somewhere else).The pollutant, if volatile, could evaporate, again causing little harm to the soil (however, not a solution to the bigger pollution problem, as it might become a source of air pollution)

d. Excess use of fertilizers and pesticides: Pollutant could infiltrate through the unsaturated soil, same way has ground water. Agricultural practices including the use of agriculture chemicals are primary sources of pollution on or near the ground surface. Most agricultural chemicals are water soluble, nitrates and phosphates that are applied to fields, lawn and gardens to stimulate the growth of crops, gross and flowers. Farmers are generally use fertilizers to correct soil deficiency. Mixed fertilizers often contain ammonium nitrate, phosphorus and potassium.

e. Excess use of irrigation water

Effects of Soil Pollution

a) Food shortage: The foremost effect of loosing top soil is causing water pollution and reduced food production leading to food shortage. With population growth, it becomes more critical.

b) Desertification: Continuous exposure of eroded soil to sun for longer periods may transform the land into sandy and rocky in nature. These are symptoms of desertification rendering the soil unsuitable for cultivation.

c) Decrease in the extent of agricultural land

d) Top soil which is washed away also contributes water pollution by clogging of lakes, and increasing turbidity of water, ultimately leading to loss of aquatic life.

e) Excess use of irrigation leads to water logging and soil salinization.

f) Fertilizer run off leads to the eutrophication of waterways.

Control measures

a) Proper soil conservation measures to minimize the loss of top soil

b) INM, IPM, using bio pesticides and integrated environment friendly agriculture to reduce pesticides or fertilizers.

c) Appropriate water management practices in agriculture

d) Keeping the soil surface covered with crop residues or crop cover

e) Planting trees as a part of afforestation/ shelter belts/wind breakers

f) Cleaning up of polluted soil

WATER POLLUTION

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

Two types of pollutions:

Point source of pollution: This source of pollution can be readily identified because it has a definite source and place, where it enters the water. Eg: Municipal industrial discharges pipes.

Non point source of pollution: when a source of pollution cannot be readily identified such as agricultural run off, acid rain etc, it is called as non point source of pollution.

Causes of water pollution: (surface water)

- **Disease causing agents** parasitic worms, bacteria, viruses, protozoa that enter water from domestic sewage and untreated human and animal wastes.
- **Oxygen depleting wastes**: These are organic wastes that can be decomposed by aerobic bacteria. The amount of oxygen required to break down a certain amount of organic matter is called BOD. It is an indicator of level of pollution.
- **Inorganic plant nutrients** : There are water soluble nitrates and phosphates.
- **Excess pesticides:** For control of pest pesticides are used in discriminately. These fall on ground and leach with rain water to canals and rivers.
- **Water soluble organic chemicals**: These are acids, salts and compounds of toxic metals such as mercury & lead**.**
- **Variety of organic chemicals** : includes oil, gasoline, plastics, pesticides, detergents & many other chemicals.
- **The sediments of suspended matter**: Occur when soil is eroded.
- **Water soluble radio active isotopes**: Enter the water courses along with rain water.
- **Hot water** released by power plants & industries that use large volume of water to cool the plant results in a rise in temp of local water bodies.
- Acid drainage into rivers.

Ground water pollution: A greater threat to human life comes from ground water which is used for drinking and irrigation being polluted.

Causes of ground water pollution:

1. Urban runoff of untreated or poorly treated waste water storage and garbage
2. Industrial waste storage located above or near aquifer
3. Agricultural practices such as application of large amounts of fertilizers and pesticides, animal feeding operations etc in rural sector
4. Leaks from under ground storage tanks containing gasoline and other hazardous substances
5. Leachate from land fills
6. Poorly designed and inadequately maintained septic tanks
7. Mining waters

Effects of Water pollution:

1. Large amount of human waste in water increase the number of bacteria such as *Escherichia coli* and *streptococcus* sps which cause gastro intestinal diseases. Water borne diseases diarrhea, typhoid *etc.*
2. If more organic matter is added to water the O2 is used up. This causes fish and other forms of O2 dependent aquatic life dies.
3. Eutrophication due to inorganic pollutants.
4. Excess pesticides cause Biomagnification.
5. High levels of organic chemicals (acids, salts& toxic metals) can make the water unfit to drink, harm fish and other aquatic life, reduce crop yields
6. Variety of organic chemicals / oil gasoline, plastics detergents) are harmful to aquatic life and human life
7. Sediments (erosion) fish, clog the lakes and artificial reservoirs
8. Radioisotopes cause birth defects, cancer and genetic damage. Hot water cause thermal pollution not only decrease the solubility of O2 but also changes the breeding cycles of various aquatic organisms
9. Hot water because of thermal pollution not only decrease the solubility of O2 but also changes the breeding cycles of various aquatic organisms.
10. Accidental oil spills cause environmental damage.
11. Minamata disease is caused due to mercury poisoning of water.
12. Fluorine contamination in drinking water causes Fluorosis, NO3 contamination causes Blue baby disease (Methaemoglobinaceae) and PO4 contamination causes bone marrow

disease.

13. Arsenic poisioning is the major effect mostly in West Bengal. Arsenicosis or arsenic toxicity develops after 2-5 years exposure to arsenic contaminated drinking water.

Control measures of water pollution:

- Setting up of effluent treatment plants to treat waste water can reduce the pollution load in the recipient water. The treated effluent can be reused either for gardening or cooling purposes or wherever possible.
- Root zone process has been developed by Thermax by running contaminated water through the root zone of specially designed reed beds. These have the capacity to absorb from the surrounding air through their stomata openings. It creates O2 rich conditions where bacteria and fungi oxidize the wastes.
- Providing sanitation and waste water treatment facility.
- Integrated nutrient management (INM) and integrated pest management (IPM) practices will reduce the effects caused due to excess pesticides.

Thermal Pollution?

Thermal pollution is the rise or fall in the temperature of natural water bodies caused by human activities. It's most commonly due to industries and power plants releasing heated water into rivers, lakes, or oceans. This disrupts aquatic ecosystems and harms biodiversity.

Causes of Thermal Pollution

1. Industrial Effluents
   - Power plants (coal, nuclear, gas) use water as a coolant. After absorbing heat, this water is often discharged directly into nearby water bodies.
   - Manufacturing industries (e.g., steel mills, chemical plants) also use water for cooling machinery and processes.
   - Impact: Heated water increases the temperature of the receiving water body, affecting aquatic life.
2. Nuclear Power Plants
   - Release extremely hot water and sometimes radioactive waste.
   - This has a more severe impact compared to conventional plants due to the higher heat content.
3. Hydroelectric Projects
   - Water released from dam reservoirs is often much colder (from deep levels), which can reduce the temperature of the downstream river abruptly.

4. Deforestation
   - Trees and vegetation provide shade, helping regulate the temperature of water bodies.
   - When forests are cleared near rivers or lakes, direct sunlight heats the water.
5. Soil Erosion
   - Erosion increases the turbidity (cloudiness) of water, and sediment particles absorb more sunlight.
   - This causes the water to warm up more rapidly.
6. Urban Runoff
   - During rains, water flows over hot urban surfaces (roads, pavements, rooftops), absorbing heat.
   - This warm runoff enters storm drains and empties into natural water bodies.

Effects of Thermal Pollution

1. Decreased Dissolved Oxygen (DO) Levels
   - Warmer water holds less oxygen.
   - Aquatic life struggles to survive with low oxygen levels.
   - Fish may suffocate, and sensitive species may die off.
2. Disturbance in Aquatic Ecosystems
   - Some species thrive in cooler water and cannot tolerate high temperatures.
   - Thermal stress can alter reproductive cycles, behavior, and migration patterns.
3. Increased Metabolic Rates
   - Warmer temperatures cause fish and other organisms to use more energy (higher metabolism).
   - They need more food, produce more waste, and may suffer from malnutrition or organ failure.
4. Thermal Shock
   - Sudden changes in temperature (from dam releases or industrial discharges) can shock aquatic organisms.
   - This may result in mass deaths of fish and other wildlife.
5. Harmful Algal Blooms (HABs)
   - Warm water supports rapid growth of algae.
   - Algal blooms reduce oxygen further and can release toxins harmful to both aquatic life and humans.
6. Migration or Extinction of Species

- Temperature-sensitive species either migrate to cooler areas or die.
- Invasive species that tolerate heat may take over, disrupting the food chain.

Protection and Control Measures

1. Cooling Ponds or Cooling Towers
   - Cooling ponds: Man-made ponds where hot water is held and allowed to cool naturally before release.
   - Cooling towers: Structures that transfer heat from the water to the atmosphere, cooling it before it's returned to the water body.
2. Artificial Lakes or Reservoirs
   - Collect warm industrial water temporarily.
   - These lakes gradually cool the water and reduce the temperature before it reaches rivers.
3. Recycling Heated Water
   - Use the same water multiple times in industrial processes.
   - Instead of releasing, industries can recycle heated water for:
     - Heating buildings
     - Pre-heating for other operations
     - Agricultural use (if safe)
4. Use of Renewable Energy Sources
   - Solar, wind, hydro, and geothermal energy generation produce no heat waste.
   - Transitioning to renewables reduces dependency on thermal plants.
5. Afforestation and Riverbank Vegetation
   - Plant trees along rivers, lakes, and streams.
   - Provides shade, stabilizes soil, and prevents erosion.
6. Legislation and Regulations
   - Governments should enforce strict temperature discharge limits for industries.
   - Regular monitoring and inspection of industries to ensure compliance.
   - Environmental Impact Assessments (EIAs) before establishing new industrial plants.
7. Public Awareness and Research
   - Educate communities, industries, and farmers about the impacts of thermal pollution.
   - Promote innovation in cooling technologies and eco-friendly waste disposal.

MARINE POLLUTION

Marine pollution refers to the contamination of oceans, seas, and coastal areas due to human activities. It disrupts marine ecosystems, harms aquatic life, and affects human livelihoods.

Causes of Marine Pollution

1. **Industrial & Chemical Waste**

✓ Factories discharge toxic chemicals, heavy metals (mercury, lead), and untreated wastewater into oceans.

✓ Example: Oil refineries, textile industries, and pharmaceutical industries.

2. **Oil Spills & Petroleum Pollution**

✓ Accidental leaks from oil tankers, offshore drilling, and pipelines release oil into the ocean.

✓ Example: The Deepwater Horizon oil spill (2010) in the Gulf of Mexico.

3. **Plastic & Microplastic Pollution**

✓ Dumping of plastic waste, fishing nets, and microplastics from cosmetics pollutes oceans.

✓ Example: The Great Pacific Garbage Patch, a massive floating plastic island.

4. **Agricultural Runoff (Pesticides & Fertilizers)**

✓ Excessive use of pesticides and fertilizers washes into rivers and oceans, causing **eutrophication**.

✓ Example: Dead zones in the Gulf of Mexico due to fertilizer runoff.

5. **Sewage & Wastewater Discharge**

✓ Untreated human sewage and industrial wastewater release harmful bacteria and toxins.

✓ Example: Coastal areas in developing nations lack sewage treatment facilities.

6. **Ship & Maritime Pollution**

✓ Dumping of garbage, oil leaks, and ballast water from cargo ships introduce invasive species.

✓ Example: Cruise ships dispose of untreated sewage in oceans.

Effects of Marine Pollution

✓ Loss of Marine Biodiversity – Oil spills and toxic chemicals kill marine animals like fish, whales, and seabirds.

✓ Coral Reef Destruction – Pollution leads to coral bleaching and disrupts marine

ecosystems.

✓ Toxic Contamination in Food Chains – Microplastics and heavy metals accumulate in seafood, affecting human health.

✓ Eutrophication & Dead Zones – Excess nutrients cause algal blooms, depleting oxygen and killing marine life.

✓ Economic Losses – Fishing industries suffer due to declining fish populations, affecting livelihoods.

Control Measures for Marine Pollution

✓ Strict Laws & Regulations – Implementing MARPOL Convention (Marine Pollution Law) and banning illegal dumping.

✓ Oil Spill Response Techniques – Using booms, skimmers, and bioremediation to clean oil spills.

✓ Reducing Plastic Use – Promoting biodegradable alternatives and banning single-use plastics.

✓ Wastewater Treatment – Installing sewage treatment plants to prevent direct discharge into oceans.

✓ Eco-Friendly Shipping Practices – Regulating ballast water discharge and clean energy ships.

✓ Mangrove & Coral Reef Conservation – Protecting coastal ecosystems to filter pollutants naturally.

NOISE POLLUTION

Noise pollution refers to excessive, unwanted sound that disrupts normal life. It affects human health, wildlife, and the environment.

Causes of Noise Pollution

1. Industrial Noise

✓ Factories, power plants, and construction sites generate loud machinery noise.

2. Transportation Noise

✓ Vehicles, airplanes, trains, and ships contribute to constant background noise pollution.

3. Urbanization & Human Activities

✓ Loudspeakers, music festivals, construction work, and traffic congestion increase noise levels.

4. Military & Defense Activities

✓ Explosions, aircraft testing, and gunfire create high-decibel noise, affecting local communities.

5. Marine Noise Pollution

✓ Underwater noise from submarines, shipping vessels, and sonar systems affects marine life.

Effects of Noise Pollution

✓ Hearing Loss & Ear Damage – Prolonged exposure leads to permanent hearing impairment.

✓ Sleep Disorders & Mental Stress – Noise affects sleep patterns, causing anxiety, depression, and high blood pressure.

✓ Wildlife Disruptions – Loud noises disturb bird migration, animal reproduction, and marine life communication.

✓ Cognitive & Learning Problems – Students exposed to noise pollution struggle with focus and memory retention.

✓ Heart Diseases & Hypertension – Long-term exposure increases blood pressure and cardiovascular diseases.

Control Measures for Noise Pollution

✓ Strict Noise Regulations – Enforcing noise limits in industries, roads, and residential areas.

✓ Silent Zones – Declaring areas near hospitals, schools, and wildlife reserves as silent zones.

✓ Soundproofing & Green Barriers – Using acoustic insulation, tree plantations, and noise-absorbing walls.

✓ Vehicle & Industrial Noise Reduction – Using low-noise tires, better engine designs, and electric vehicles.

✓ Public Awareness & Behavior Change – Encouraging low-volume music, restricted honking, and quieter festivals.

LIGHT POLLUTION

Light pollution refers to excessive, artificial outdoor lighting that disrupts natural darkness. It affects **humans, wildlife, and ecosystems**.

Causes of Light Pollution

1. Urbanization & Over-Illumination

✓ Excessive use of streetlights, billboards, and neon signs.

2. Industrial & Commercial Lighting

✓ Factories, malls, stadiums, and skyscrapers use high-intensity lighting at night.

3. Uncontrolled Use of LED & Floodlights

✓ High-intensity LED lights and unregulated street lighting create skyglow.

4. Vehicular & Advertising Light Glare

✓ High-beam headlights and electronic billboard displays contribute to light pollution.

5. Space & Aviation Lighting

✓ Satellite launches and airport lighting systems add to light pollution.

Effects of Light Pollution

✓ Disrupts Circadian Rhythm & Sleep Patterns – Artificial light interferes with melatonin production, affecting human health.

✓ Affects Nocturnal Wildlife – Bats, owls, and sea turtles rely on natural darkness for survival.

✓ Wastes Energy & Resources – Unnecessary lighting increases electricity consumption.

✓ Skyglow & Astronomical Interference – Excess light obscures visibility of stars and hampers astronomical research.

Control Measures for Light Pollution

✓ Smart & Energy-Efficient Lighting – Using low-intensity LED lights with motion sensors.

✓ Downward-Facing Streetlights – Reducing light spillover into the sky.

✓ Light Curfews & Regulations – Enforcing limited lighting hours in urban and industrial areas.

✓ Public Awareness & Responsible Lighting – Encouraging low-energy home lighting and

avoiding excessive illumination.

✓ Astronomical Dark Sky Reserves – Designating areas for stargazing with minimal artificial light interference.

Pollution is a major global challenge affecting ecosystems, human health, and biodiversity. Strict enforcement of environmental laws, technological advancements, and community participation is necessary to control marine, noise, and light pollution effectively.