

Environmental Science and Sustainability

Jagruti Patel

Unit 1: Understanding Environment, Natural Resources, Ecosystems and Sustainability

Fundamental environmental concepts, Concept of sustainability;

- Natural resources Non-renewable Resources, Renewable Resources (A) Forest resources, (B) Water resources, (C) Mineral resources, (D) Food resources, (E) Energy resources, (F) Land resources, Role of an individual in conservation of natural resources.
- Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. (A) The water cycle, (B) The Carbon cycle, (C) The Oxygen cycle,
- Food chains

Fundamental environmental concepts

Environmental Protection Act (1986) defined,
“Environment as the sum total of water, air and land, their inter-relationship among themselves and with the human beings, other living beings and property.

Fundamental Environmental Concepts and Their Relevance to Business Operations

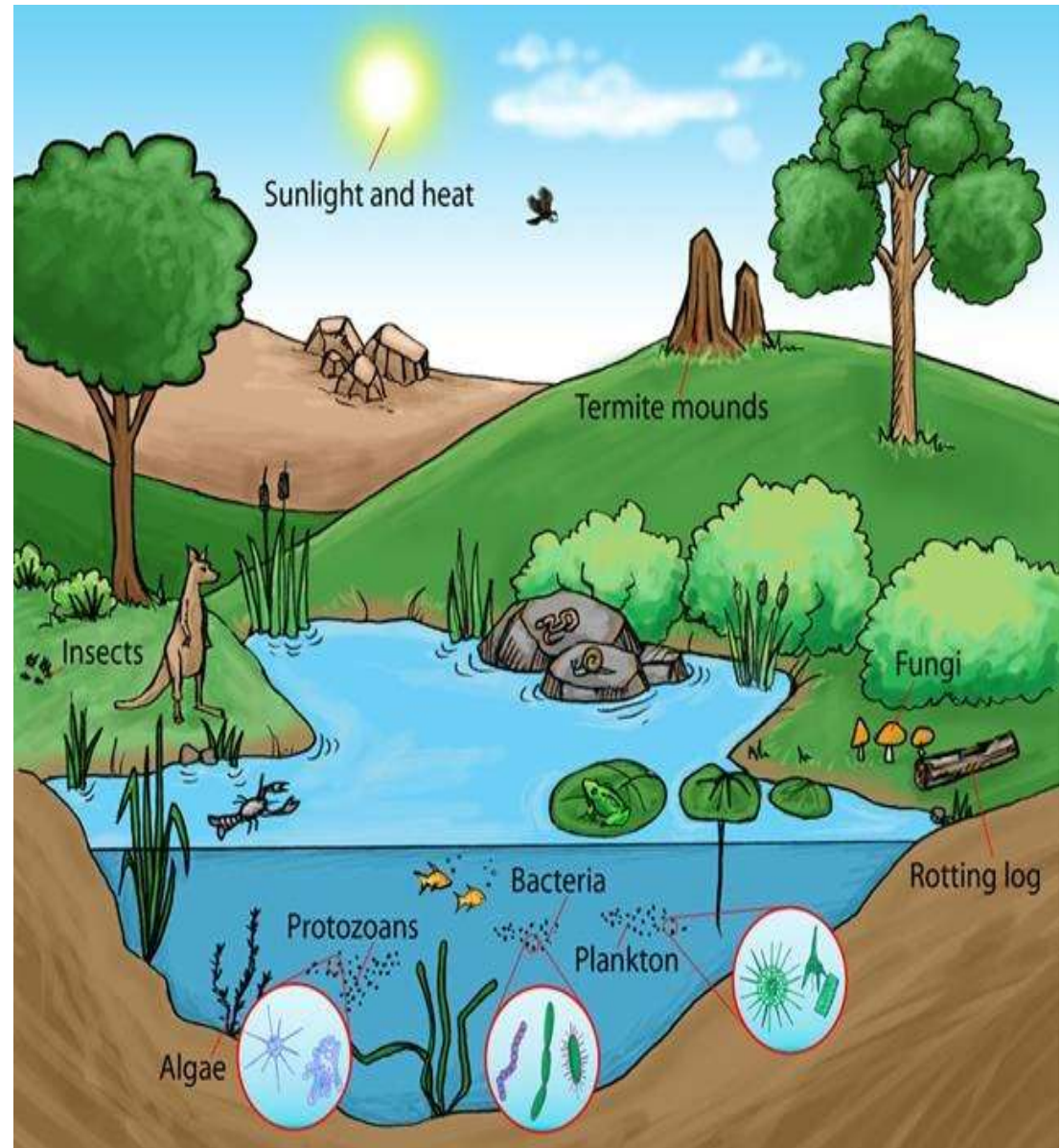
A. Fundamental Environmental Concepts

- Interdependence of Ecosystems**
- Sustainability**
- Biodiversity**
- Natural Resources and Conservation**
- Pollution and Waste Management**
- Climate Change and Global Warming**

Interdependence of Ecosystems

Ecosystem

An ecosystem is a community of living organisms (plants, animals, microbes) in conjunction with the non-living components (air, water, soil) of their environment.



Biodiversity

Refers to the variety of life on Earth.



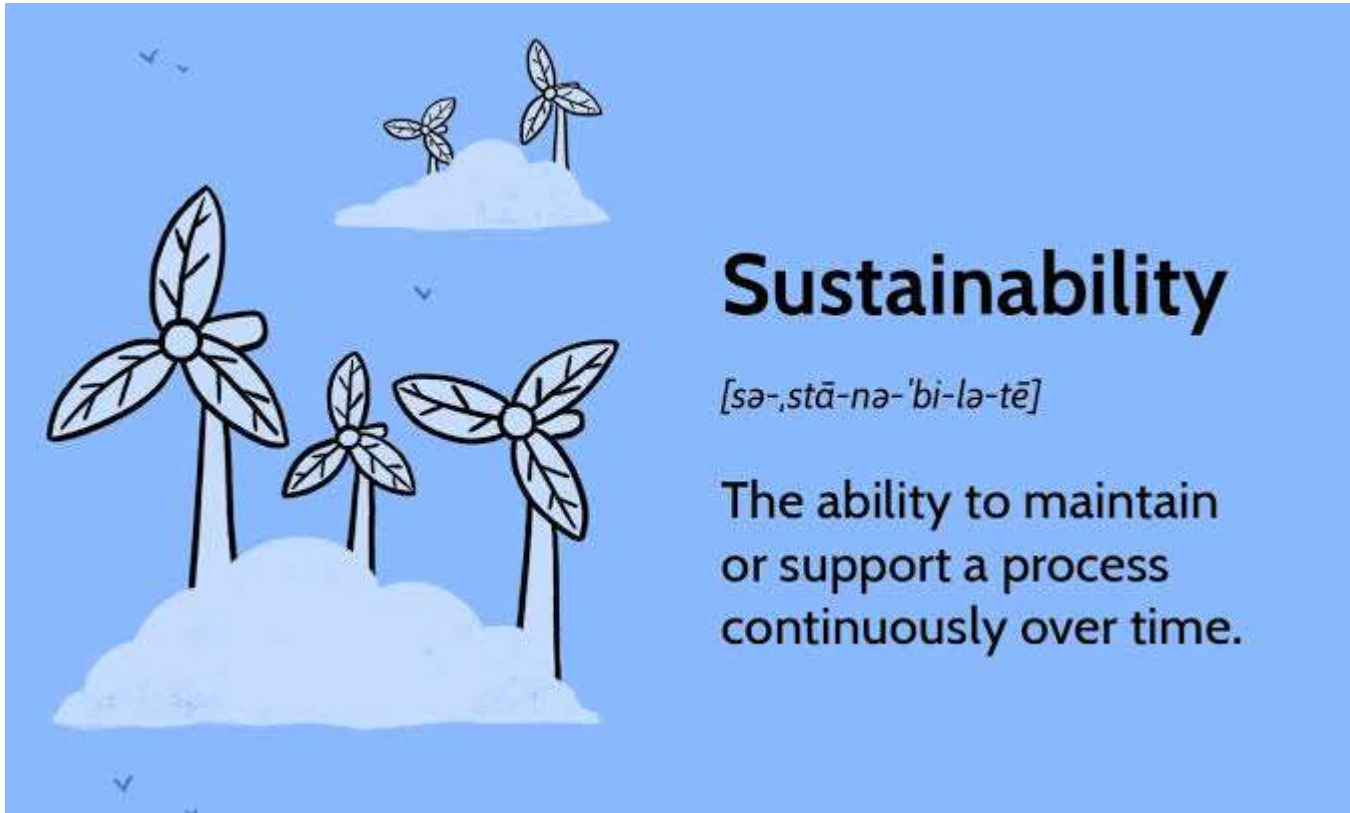
Carrying Capacity

This refers to the maximum population size of a species that an environment can sustain over time without degrading the environment.

Carrying Capacity



Sustainability



Sustainability

[sə-,stā-nə-'bi-lə-tē]

The ability to maintain
or support a process
continuously over time.

Sustainability

- Environmental Sustainability
 - Use of renewable energy
 - ☐ Waste recycling
 - ☐ Conservation of biodiversity
- ☐ Economic Sustainability
 - Green business practices
 - ☐ Responsible investment
 - ☐ Low-carbon economic models
- ☐ Social Sustainability
 - ☐ Fair wages
 - ☐ Gender equality

Why Businesses Should Care About the Environment

- a. Raw Materials & Resources
Every industry depends on nature
- b. Pollution & Legal Risks
- c. Reputation and Brand Value
- d. Cost Saving through Sustainability

Man-Environment Relationship

- Primitive Humans or Early Humans and Natural Equilibrium or Simple Lifestyle.
- Unique Abilities of Humans
- Impact of Humans on the Environment
- Industrialization & Consumption
- Overexploitation of Natural Resources
- Pollution and Health Hazards
- Impact of the Environment on Humans
 - Health Impact
 - Cultural and Aesthetic Loss
 - Economic Loss

WHAT ARE NATURAL RESOURCES?

- Natural resources are materials or substances that occur in nature and are used by humans for various purposes such as food, fuel, shelter, and economic development.

- Classification of Natural Resources:

- 1. Based on Origin:

- a. Biotic (Living organisms)

Example:

- Cow gives us milk – a biotic resource.
 - Forests give us wood and fruits.

- b. Abiotic (Non-living things)

Example:

- Iron used to make tools
 - Water used for drinking and farming

NATURAL RESOURCES

- Based on Availability

- a. Inexhaustible (Available in unlimited amount and naturally replenished)

- Examples: Sunlight, wind, rain, tides

- b. Exhaustible (Limited and take a long time to form again)

- Renewable resources: Can renew naturally but may still run out if overused

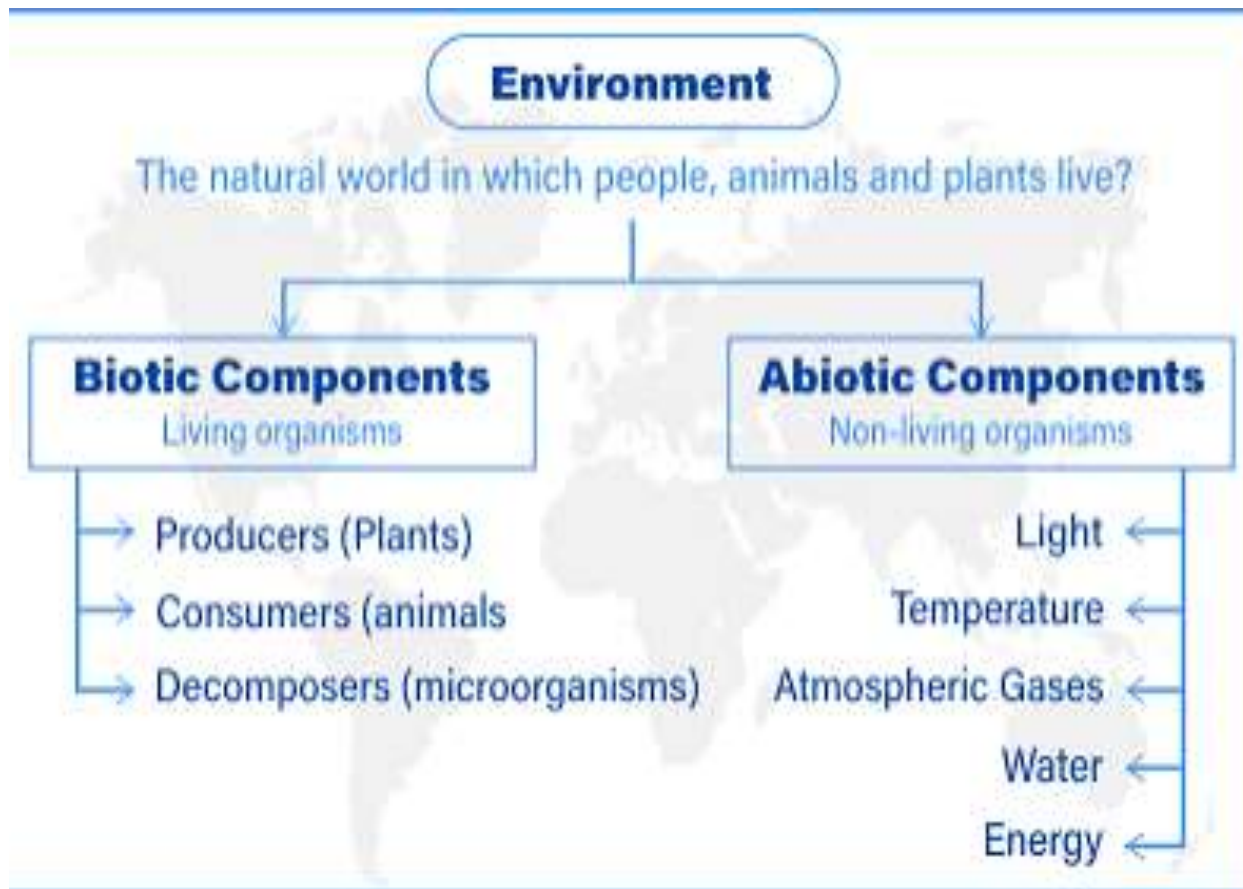
- (e.g. forests, fresh water, air)

- Non-renewable resources: Cannot be formed again easily (e.g. coal, petroleum, minerals)

Associated Problems with Natural Resources

- Overexploitation
- Pollution
- Habitat Destruction
- Climate Change
- Conflicts and Inequity

Components of Environment





TYPES OF RESOURCES

- A. Forest Resources
- B. Water Resources
- C. Mineral Resources
- D. Food Resources
- E. Energy Resources
- F. Land Resources

Forest



Functions of Forests

1. They manage the balance between carbon dioxide and oxygen in the atmosphere.
2. Forests shield the soil from erosion.
3. They act as an ecosystem for the wide variety of flora and fauna.
4. Help to reduce noise pollution.
5. Shield the surrounding areas from extreme weather conditions.
6. Forests also restrict the sudden movement of flood water
7. Forests are complex land ecosystems that support a wide variety of plants, trees and animals.
8. It provides a lot of resources like fruits, timber, firewood, honey, herbal medicines etc.
9. The forests also provide several raw materials for different manufacturing industries.
10. There are whole communities that depend entirely on forest resources for their survival.
11. Wind Erosion: In deserts, trees reduce wind erosion by checking wind velocity. Attract
12. Rainfall: By causing condensation of water vapour in clouds, forests attract rains.

Deforestation

- Forests are burned or cut for clearing land for agriculture, harvesting for wood and timber, and the development and expansion of cities.
- Shifting Cultivation or Human Cultivation:
- Commercial Logging
- Need for Fuelwood:
- Expansion for Agribusiness:
- Development Projects and Growing Need for Food:
- Raw Materials for Industrial Use:
- Overgrazing by animals:
- Insects and pests:
- Forest fires:
- Extreme weather

Why We Need to Conserve Forests (Needs)

- To maintain balance in nature
- To protect biodiversity

How to Conserve Forests (Measures)

1. Prevent forest fires
2. Use pesticides safely
3. Grow strong plants
4. Plant new trees (Afforestation)
5. Use eco-friendly fuel
6. Support social forestry
7. Use wasteland for forests
8. Plant trees with beauty and value
9. Grow ornamental trees
10. Renew old forests
11. Grow same-type trees in some areas (Monoculture)
12. Control tree cutting

WATER RESOURCES

The world depends on a limited quantity of fresh water. Water covers 70% of the earth's surface but only 3% of this is fresh water. Of this, 2% is in polar ice caps and only 1% is usable water in rivers, lakes and subsoil aquifers.

At a global level 70% of water is used for agriculture about 25% for industry and only 5% for domestic use.

The water cycle, through evaporation and precipitation, maintains hydrological systems which form rivers and lakes and support in a variety of aquatic ecosystems.

Water is Must for Life

Water plays an important role in many areas:

1. Water resources can be used in Agricultural and Industrial activities.

Example: Irrigating wheat and rice fields, cooling machines in factories.

2. Water is used for Drinking and Washing purposes.

Example: We drink water daily to survive; we use it to wash clothes, utensils, and ourselves.

3. Water is vital for the Fishing Industry.

Example: Fish farming (aquaculture) in rivers and ponds provides food and jobs.

4. Water is used for Marine transportation, boating purposes, and waterways.

Example: Ships and boats carry goods and people through rivers like Ganga and the Brahmaputra.

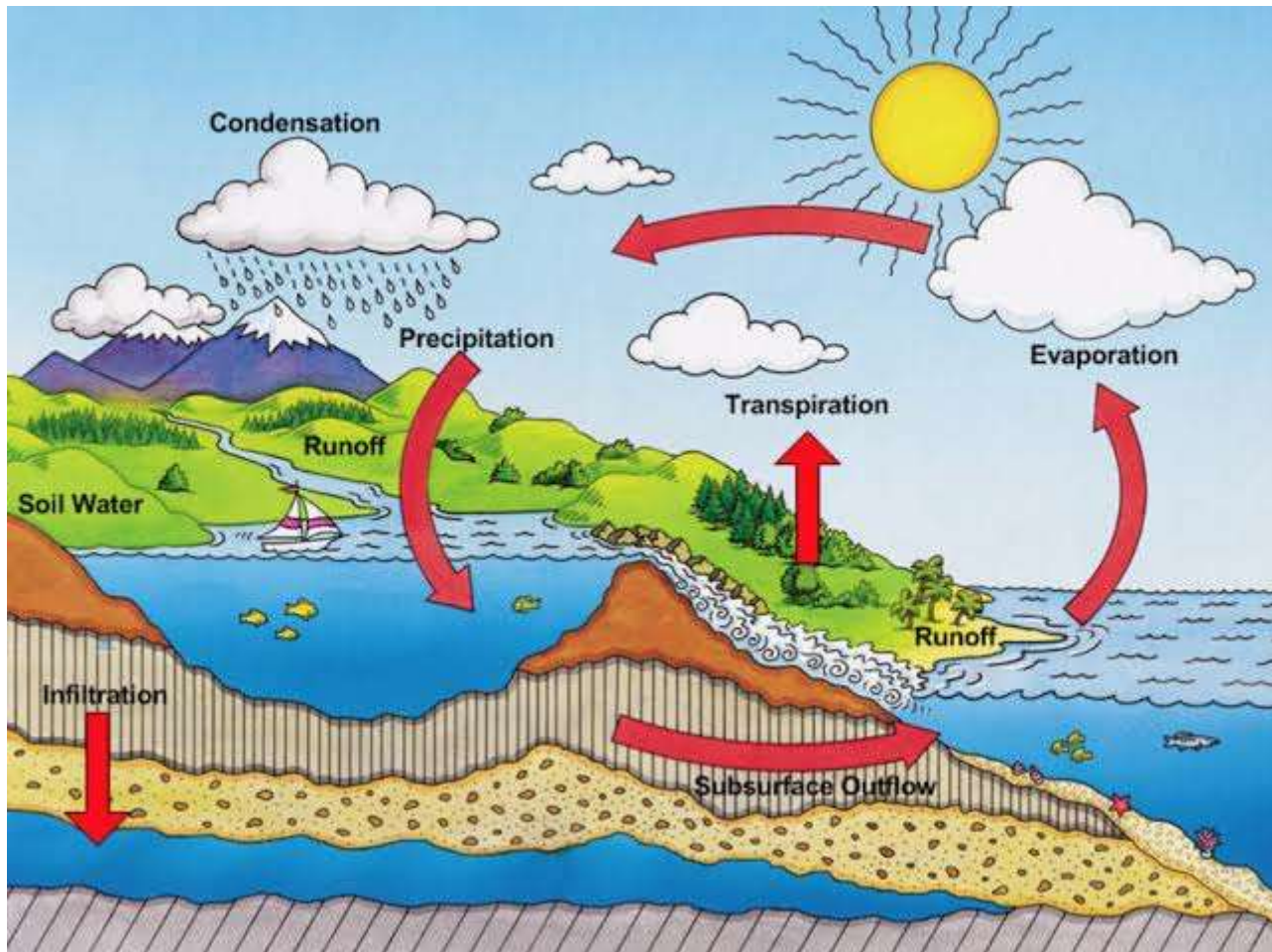
5. Electricity Generation.

Example: Dams like Bhakra Nangal help in generating hydroelectric power

Sources of Water

- Underground Water
- Surface Water
- Evaporated Water

Water cycle



DAMs

1. Water supply in summer

Example: Dams store water to use during dry months.

2. Block water flowing into the sea

Example: Prevents wastage of freshwater.

3. Create artificial lakes for regular water supply

Example: Udaipur's Fatehsagar Lake.

4. Support irrigation and generate electricity

Example: Sardar Sarovar Dam.

5. Create ecosystems for birds and aquatic animals

Example: Migratory birds settle in dam reservoirs.

6. Help farmers grow multiple crops

Example: Irrigated farms can produce 2-3 harvests annually

DAMs

✗ Problems Caused by Dams:

1. Break natural river flow

Example: Blocks fish migration.

2. Damage to river ecosystems

Example: Disrupts life in the river basin.

3. Displacement of people

Example: Tribals losing their homes in dam projects.

4. Waterlogging and soil salinity

Example: Salt buildup ruins nearby farmland.

5. Affects wildlife habitats

Example: Tigers and elephants lose forest areas.

6. Disrupt fishing and water transport

7. Release greenhouse gases from rotting plants underwater

8. Harms tribal communities

9. High cost, low result

Example: Some dams don't deliver the promised benefits.

Effects of Overutilization and Pollution of Surface and Groundwater

- Global Climate Change
- Floods
- Drought
- Power Generation
- Sustainable Water Management
 - Building several small reservoirs instead of few mega projects
 - ☐ Develop small catchment dams and protect wetlands
 - ☐ Treating and recycling municipal wastewater for agricultural use
 - ☐ Preventing leakages from dams and canals
 - ☐ Preventing loss in municipal pipes
 - ☐ Effective rainwater harvesting in urban environments
 - ☐ Water conservation measures in agriculture such as using drip irrigation
 - ☐ Pricing water at its real value makes people use it more responsibly and efficiently and reduces water wasting

Recharging and Conservation of Water

1. Build small dams and artificial lakes

Example: Check dams in dry areas of Gujarat.

2. Construct ponds to store rainwater

3. Plant more trees to increase rainfall

4. Use water wisely – don't waste

Example: Turn off tap while brushing teeth.

5. Reuse water:

- Bath water for plants in the courtyard

- Spray used water on dusty roads to prevent pollution

6. Charge based on usage to prevent misuse

Example: Install water meters.

7. Treat dirty water and use it in farming and parks.

MINERALS RESOURCES

- A mineral is a naturally found substance that has a fixed composition and specific physical features.
- Examples: Coal, natural gas, and mineral oil are important energy minerals.
- Metals like iron, copper, silver, aluminum, manganese, and precious stones like diamonds are also minerals.

Characteristics of minerals

- 1) Exhaustibility
- 2) Localised occurrence
- 3) Unpredictable occurrence
- 4) Dependence on other factors
- 5) International character

There are over 3,000 different minerals. On the basis of composition, minerals

are classified mainly as metallic and non-metallic Minerals.

- **Metallic minerals** . Metallic minerals may be ferrous or nonferrous. Ferrous minerals like iron ore, manganese and chromites contain iron. A non ferrous mineral does not contain iron but may contain some other metal such as gold, silver, copper or lead.

- **Non metallic minerals**

do not contain metals. Limestone, Mica and gypsum are examples of such minerals.

Mining

The term "mining" refers to the process of taking out minerals or their ores from the Earth.

There are two methods of mining

1. Surface mining

This method of mining is utilized when the mineral deposits occur at or near the surface of the earth. It can be done by following three ways: open pit mining, dredging and strip mining.

2. Subsurface mining

This method is used when the mineral deposit lies deep beneath the Earth's surface. Big holes are dug in the earth surface to extract out ores from the horizontal ore bodies.

Mining



Environmental effect of mineral extraction and use

1. Land degradation
2. Surface and groundwater pollution due to the release of harmful trace elements such as Cobalt, cadmium, lead.
3. Adverse effect on the growth of vegetation.
4. Loss of fauna and flora, final resulting in deforestation
5. Air pollution due to emission of harmful gases.
6. Occupational health hazard

Uses of minerals

1. Development of industrial plants and machinery
2. Generation of energy. For example, coal, lignite, Uranium
3. Construction, housing, settlements
4. Defense equipment-weapons, armaments.
5. Transportation means
6. Communication-telephone wires, cables, electronic devices
7. Jewellery gold, silver, platinum, diamond

Conservation of Minerals

1. Recycling:

- Making old things useful again by processing them.
- Example: Recycling aluminum cans or metal scraps.

2. Reusing:

- Using the same items again and again without much change.
- Example: Reusing glass bottles or jars.

3. Decrease Consumption:

- Use minerals only when necessary, avoid waste.
- Example: Turning off machines or lights when not in use.

4. Substitution:

- Using other materials in place of scarce minerals.
- Example: Using plastic or bamboo instead of metal in some tools.

5. Use of Waste:

- Waste from one industry can be used as raw material in another.
- Example: Fly ash from thermal plants used in making bricks.

FOOD RESOURCE

Any substance or thing (solid or liquid) which can satisfy hunger, meet the body's needs for growth, and supply energy to maintain body temperature and perform daily activities is called food. Examples: Chapatti, rice, bread,

Functions of food

1. Physiological functions

- A. Providing energy
- B. Body building
- C. Regulatory function

2. Social functions

Food has always been the central part of our community, social, cultural and religious life.

It has been an expression of love, friendship, and happiness at religious, social and family get-togethers.

3. Psychological functions

☐ In addition to satisfying physical and social needs, foods also satisfy certain emotional needs of human beings. These include a sense of security, love, and acceptance

NUTRIENTS – sources, functions

NUTRIENT	BODY FUNCTION	FOOD SOURCES
Carbohydrate	Energy, protein sparing – 4kcal/g	Cereals, pulses, veg, fruits
Protein	Growth, repair, energy, enzymes, antibodies, hormones	Pulses, meat, fish, milk products, egg, cereals
Fat (lipid)	Energy, EFA, fat-sol vit, insulation.	Fats, oils, meat, fish, nuts dairy products
Minerals	Skeletal, growth, blood clotting, immunity	Dairy, GLV, fruits, whole grains
Vitamins	Vision, immunity, bone, teeth, metabolism	meat, veg, legumes, organ meat nuts

Ww

Vitamin Sheet

@dr.williamwallace



A	Healthy vision, skin, bones, teeth, & reproduction	Liver, eggs, fish, milk, carrots, sweet potato, pumpkin, spinach
B1 Thiamine	*Helps convert food into energy *critical for nerve function	Pork, soy, watermelon, tomato, spinach
B2 Riboflavin	*Helps convert food into energy *supports healthy hair, skin, blood & brain	Dairy, meat, green leafy veggies, enriched wheat, oysters
B3 Niacin	*Helps convert food into energy *essential for healthy nervous system	Beef, chicken, shrimp, avocados, tomato, spinach, peanuts
B6 Pyridoxine	*Helps make red blood cells *improves sleep, appetite, & mood	Chicken, tofu, watermelon, fish, legumes, banana
B7 Biotin	*Helps convert food into energy *helps breakdown glucose	Whole grains, eggs, almonds, soybeans, fish
B9 Folate	*new cell creation *DNA synthesis	Legumes, green leafy veggies, chickpeas, tomato, asparagus
B12 Cobalamin	*Helps break down amino acids, fatty acids * Helps make red blood cells	Dairy, beef, pork, poultry, fish, eggs
C	*Acts as an antioxidant *Helps make new cells *Supports immune system	Fruit, pepper, broccoli, tomato, spinach
D	Helps strengthen/form bones & teeth (with calcium and phosphorous)	Egg yolk, fatty fish, liver, sunlight
E	*Acts as antioxidant *Helps stabilize cell membranes	Nuts, avocado, whole grains, seeds
K	*Essential for blood clotting *Helps regulate blood calcium	Broccoli, Brussels sprouts, liver, leafy greens

Types of water soluble vitamin

Vitamin-B

Vitamin-C

Types of fat soluble vitamin

Vitamin-A

Vitamin-D

Vitamin-E

Vitamin-K

Balanced diet

- A balanced diet is one that fulfills all of a person's nutritional needs.
- Humans need a certain amount of calories and nutrients to stay healthy.
- A balanced diet provides all the nutrients a person requires, without going over the recommended daily calorie intake.
- A diet that contains all the vital nutrients required by a human body is called a **balanced diet**. Balanced diet comprises vital nutrients like carbohydrates, fats, vitamins, minerals, proteins, and fiber.

Important Elements of the Management of Food Resources

- 1. Planning for food production**
- 2. Safe storage of food grains**
- 3. Processing of food materials**
- 4. Preservation of perishable foods**
- 5. Packaging of food materials**
- 6. Transportation of food materials**
- 7. Distribution of food materials**
- 8. Conservation of food materials**

Management of Food Resources

A. Planning for Food Production

- 1.** Fixing of annual production targets for major agricultural crops.
- 2.** Arrangements for supplying good quality seeds to achieve the targets.
- 3.** Provision of additional resources of irrigation to achieve the targets.
- 4.** Provision of adequate power supply for irrigation, harvesting and threshing operations.
- 5.** Arrangements for procurement of food grains from farmers.
- 6.** Provision of additional storage space.
- 7.** Provision of adequate transport for the food produced.

Need for Safe Storage of Food Materials

- India loses around 10% of its total food grain production post-harvest and over 30% of its fruits and vegetables due to poor storage and handling.
- Annual post-harvest losses amount to nearly ₹1.5 lakh crore, highlighting the economic cost of inefficiencies.



Storage of Food Materials

- **Factors Which Damage Stored Food Materials**
- **A. Abiotic Factors** – Temperature, moisture, humidity, materials of the container, etc.
- **B. Biotic Factors** – Rodents, birds, animals, insects, worms, microorganisms, action of enzymes.
- **B. Need for Safe Storage of Food Materials**
 1. Most of the food crops are seasonal, so it is necessary to keep them in safe storage to make them available even when out of season.
 2. Safe storage of food crops as well as other food materials like fruits and vegetables is necessary to meet the dietary requirements of all types of people.
 3. Safe storage also facilitates the distribution of food materials to distant places in the country.
 4. Proper storage of food grains is essential to avoid their wastage and spoilage

Food Processing

- **Food Processing**
 - We get our food from crop plants and animals. Only some of the foods obtained from plants and animals are eaten in the raw form.
 - The process in which raw food materials are changed into a more readily usable form is called **food processing**.
 - **Examples of processed food** – sugar, vegetable ghee, edible oils, butter,
 - curd, desi ghee, biscuits, instant coffee, etc.
 - **Food Processing Techniques**
 - **Traditional techniques:** Heat treatment, fermentation, pickling, smoking, drying, curing
 - **Modern techniques:** Pasteurisation, canning, ultra-heat treatment, high-pressure processing, modified atmosphere packaging, quick freezing
- **Purpose or Advantages of Food Processing**
 - 1. Food processing prevents the food from spoilage.
 - 2. Food processing ensures the availability of food products throughout the year.
 - 3. Food processing ensures the availability of food even in far-flung areas.
 - 4. Food processing helps in retaining the nutritive value of foods.
 - 5. Processed foods are easy to store, transport and distribute.

Food Processing

Purpose or Advantages of Food Processing

1. Food processing prevents the food from spoilage.
2. Food processing ensures the availability of food products throughout the year.
3. Food processing ensures the availability of food even in far-flung areas.
4. Food processing helps in retaining the nutritive value of foods.
5. Processed foods are easy to store, transport and distribute.

Disadvantages of Food Processing

1. Food processing removes some of the nutrients, vitamins and fiber present in the food.
2. Processed foods are obtained from laboratories and not nature.
3. Frequent intake of processed foods can make people become angry and irritable.
4. Consumption of natural whole foods can help level out mood, sustain energy and promote relaxation.
5. Trans fats and sugar present in processed items can cause inflammation, which may lead to asthma.
6. Daily consumption of processed foods promotes aging and kidney damage as they contain phosphates and genetically engineered ingredients

Food Preservation

- Food preservation is the process in which perishable food materials are given suitable physical or chemical treatment to prevent spoilage and retain nutritive value for long periods.
- The basic aim is to **stop or slow down the decay of food.**
- **Two Basic Steps in Food Preservation**
 1. Destroy the microorganisms that cause food spoilage.
 2. Create conditions that prevent the growth and action of food-spoiling microorganisms

Food Preservation

- **Methods of Food Preservation**

A. Bactericidal Methods

Bacteria, yeast, molds, etc., are killed or eliminated by cooking, canning, and irradiation with gamma rays.

B. Bacteriostatic Methods

Growth of microorganisms is prevented or rendered inactive.

- Methods include sun drying, dehydration, salting, adding sugar, pickling (in vinegar), smoking, refrigeration

- **Advantages of Food Preservation**

1. Prevents the wastage of perishable food materials.
2. Increases the safe storage period of various perishable foods.
3. Makes seasonal fruits and vegetables available throughout the year.

Examples: peas, sweet corn, etc

ENERGY RESOURCES

- Energy is defined by physicists as **the capacity to do work**

Energy resources:

Energy resources can be divided mainly into two classes:

(1) Renewable energy resources:

(2) Non-renewable energy resources:

(1) Renewable Energy

Renewable energy is energy which is generated from natural sources i.e. sun, wind, rain, tides and can be generated again and again as and when required.

They are available in plenty and by far most the cleanest sources of energy available on this planet.

Renewable technologies are suited to Large-scale production and Small off grid applications

Main forms (sources) of renewable energy

Wind Energy

Hydro Energy

Solar Energy

Bio-fuel Energy

Geothermal Energy

Wind energy

Wind energy

Wind power or wind energy is a form of renewable energy that harnesses the power of the wind to generate electricity. It involves using wind turbines to convert the turning motion of blades, pushed by moving air (kinetic energy) into electrical energy (electricity).

Advantages of Wind Power

1. Wind power creates good-paying jobs.
2. Wind power is a clean and renewable energy source.
3. Wind power benefits local communities.
4. Wind power is cost-effective.

Challenges of Wind Power

1. Wind power must compete with other low-cost energy sources.
2. Ideal wind sites are often in remote locations.
3. Turbines produce noise and alter visual aesthetics.
4. Wind plants can impact local wildlife.

Solar energy

Solar energy is radiant light and heat from the Sun that is harnessed using a range of technologies such as solar power to generate electricity, solar thermal energy (including solar water heating), and solar architecture. It is an essential source of renewable energy, and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power, and solar water heating to harness the energy.

Applications of solar energy

1. Solar Water Heating
2. Solar-distillation
3. Solar-pumping
4. Solar Drying for Agriculture
5. Solar Cooking
6. Solar Electric Power Generation
7. Solar Green Houses
8. Solar Storage
9. Solar at Night
10. Portable Solar Power

Solar energy

- **Advantages**

1. Solar energy is clean & green energy
2. Not dependent on other sources of Energy
3. Non-maintenance
4. Safer than Other
5. Renewable Energy
6. Electricity Bill Reduction
7. Maximum Usage
8. Technology Development

- **Disadvantages**

1. High Cost of Solar Panels
2. Sunlight Dependent
3. Installation Can Be Difficult
4. Space Constraints
5. Solar Energy Storage Is Expensive
6. Difficulty With Relocation

Biogas

The Benefits of Biogas in India

- In rural India, where many families still rely on traditional cooking methods such as wood burning stoves, the air inside homes can be severely polluted, leading to serious health problems. Women and children spend the most time indoors and are particularly vulnerable. Biogas offers a clean and sustainable alternative that can improve the health and well-being of rural communities.
- Biogas can play a critical role in transforming the energy dependence of rural and agricultural communities, which majorly depends on burning wood, dung, charcoal, coal and other fossil fuels for their energy needs.
Only 26.53% of the total power generated in India is from renewable sources.
- The high dependence on non-renewable sources is the leading cause of the long-standing energy problems in the country

Biogas

Sources of Biogas

1. Sewage
2. Crop residue
3. Vegetable residue
4. Poultry dropping
5. Algae
6. Cattle waste

Merits of bioenergy

1. Reduces the demand for wood fuel
2. Decreases the use of fossil fuels
3. Supports sustainable agriculture
4. Reduces the risk of violence
5. Improves health
6. Increases access to education

Limitations of bio energy

1. Biomass plants require a lot of space.
2. Can lead to deforestation.
3. It is not entirely clean
4. Biomass energy is not as efficient as fossil fuels.

NUCLEAR ENERGY, COAL, PETROLEUM, AND GAS

NUCLEAR ENERGY, COAL, PETROLEUM, AND GAS

Nuclear fission uses uranium to create energy.

Nuclear energy is a nonrenewable resource because once the uranium is used, it is gone!

Coal, petroleum, and natural gas are considered nonrenewable because they cannot be replenished in a short period of time. These are called fossil fuels.

Advantages of Non-renewable Resources:

Available in highly concentrated form

Easy to store

Reliable supply

Lower cost per unit of energy produced as the technology is matured

Disadvantages of Non-renewable resources:

When coal is burnt it produces carbon dioxide that causes global warming.

Since coal contains impurities like S and N, it produces toxic gases during burning which causes acid rain and air pollution.

Traces of mercury and radioactive compounds are also released when coal is burned.

Severe human health threat.(lung disease)

Land Resources

Uses of Land:

1. For Residential and for Construction purpose.
2. For the construction of roads.
3. For Agricultural and for Gardening purpose.
4. For creating Forests.
5. For the construction of big Industrial Units.
6. For preparing canal and water resources

Land degradation and desertification

Land degradation is caused by multiple forces, including extreme weather conditions, particularly drought.

It is also caused by human activities that pollute or degrade the quality of soils and land utility.

It negatively affects food production, livelihoods, and the production and provision of other ecosystem goods and services.

Desertification is a form of land degradation by which fertile land becomes desert.

These social and environmental processes are stressing the world's arable lands and pastures essential for the provision of food and water and quality air.

Land degradation and desertification can affect human health through complex pathways.

Main causes of Land degradation are as follows

1. Deforestation
2. Excessive use of fertilizers and pesticides
3. Overgrazing
4. Water-logging
5. Desertification
6. Soil erosion
7. Wasteland
8. Landslides

Soil erosion

- It is a process in which the top fertile layer of soil is lost. Due to soil erosion, the soil becomes less fertile. The top layer of soil is very light which is easily carried away by wind and water. There movement of top soil by the natural or human activities source is known as soil erosion.
- Causes of Soil erosion
 1. Wind
 2. Water
 3. Overgrazing
 4. Deforestation
 5. Use of agrochemicals
 6. Logging and Mining
 7. Construction
 8. Rain

Effects of Soil Erosion

1. Loss of Arable Land
2. Clogging of Waterways
3. Air Pollution
4. Desertification
5. Destruction of Infrastructure
6. Soil Compaction
7. Reduced Organic and Fertile Matter
8. Soil acidity levels
9. Water pollution

Soil erosion

- Solutions (Prevention) to Soil erosion
 1. Crop Rotation
 2. Increased structure for plants
 3. Water control
 4. Soil conservation
 5. Increased knowledge

Desertification

Causes of desertification

1. Deforestation
2. Poor agricultural practices
3. Over exploitation of natural resources
4. Bad livestock practices

Consequences of desertification

1. Loss of biodiversity
2. Food insecurity
3. Loss of vegetation cover
4. Increased risk of zoonotic diseases
5. Loss of forest cover
6. Decrease in drinking water reserves

Control of land degradation

1. Afforestation
2. Proper management of grazing to control overgrazing.
3. Planting of shelter belts of plants.
4. Control of mining activities.
5. Proper discharge and disposal of industrial effluents and wastes after treatment.
6. Proper management of waste-lands.
7. Avoid over-irrigation, especially in dry areas.
8. Avoid over use of fertilizers and pesticides.

Wastelands

- A waste land is some place **that's empty and desolate, with no sign of life or growth.**

Causes of formation of waste lands

1. Over-Cultivation
2. Overgrazing
3. Deforestation
4. Dumping of wastes and mines
5. Misuse and unscientific land management

Waste Land Development

Wasteland development provides a source of income for the rural poor. It ensures a constant supply of fuel, fodder and timber for local use. Makes the soil fertile by preventing soil erosion and conserving moisture.

The major objectives of wasteland reclamation are:

- To improve the physical structure and quality of the marginal soils.
- To improve the availability of good quality water for irrigating these lands.
- To prevent soil erosion, flooding and landslides.
- To conserve the biological resources of the land for sustainable use.

Role of Individual in Conservation of Natural Resources

1. Water Conservation

1. Installing flow-restricting shower heads to save water during showers.
2. Taking bucket-baths instead of showers.
3. Turning off the tap while brushing teeth.
4. Immediately fixing any leaking taps and pipes in our homes.
5. Practicing rain water harvesting to reduce the wastage of rainwater.
6. Use of drip irrigation and sprinkling irrigation to improve irrigation efficiency
7. and reduce evaporation

2. Energy Conservation

1. Switch off lights and electrical appliances when not using them
2. Switch to energy-saving LED light globes
3. Shut doors and close curtains.
4. Understand and improve your home's energy use
5. Save energy in the kitchen
6. Get the best energy deal
7. Insulate your roof
8. Save money with solar energy

3. Soil Conservation

1. Practice no till farming. With no till farming, crops are allowed to remain rather than being ploughed under at the end of the season.
2. Use terrace farming,
3. Practice contour farming.
4. Use a rain barrel.
5. Restore wetlands

Ecosystems

- "The complex system in which interactions between the different components of the environment occur, is referred to as an ecosystem".

TYPES OF ECOSYSTEMS

- a) Natural ecosystem:
 - i. Terrestrial Ecosystem- For example forest, grassland, desert, etc.
 - ii. Aquatic Ecosystem- It can be distinguished as:
 - A. Fresh water ecosystem
 - B. Marine ecosystem-
- b) Man Engineered ecosystem: Artificial ecosystems are maintained by man himself through planned manipulations. For example, man tries to control the biotic community and physicochemical environment

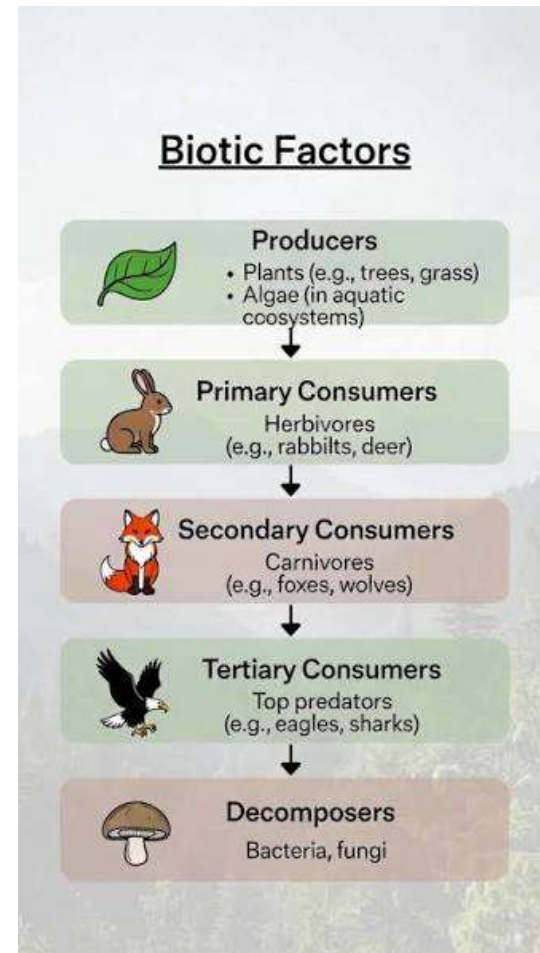
STRUCTURE (COMPONENTS) AND FUNCTIONS OF ECOSYSTEM

A. Biotic components

B. Abiotic components

A. Biotic components

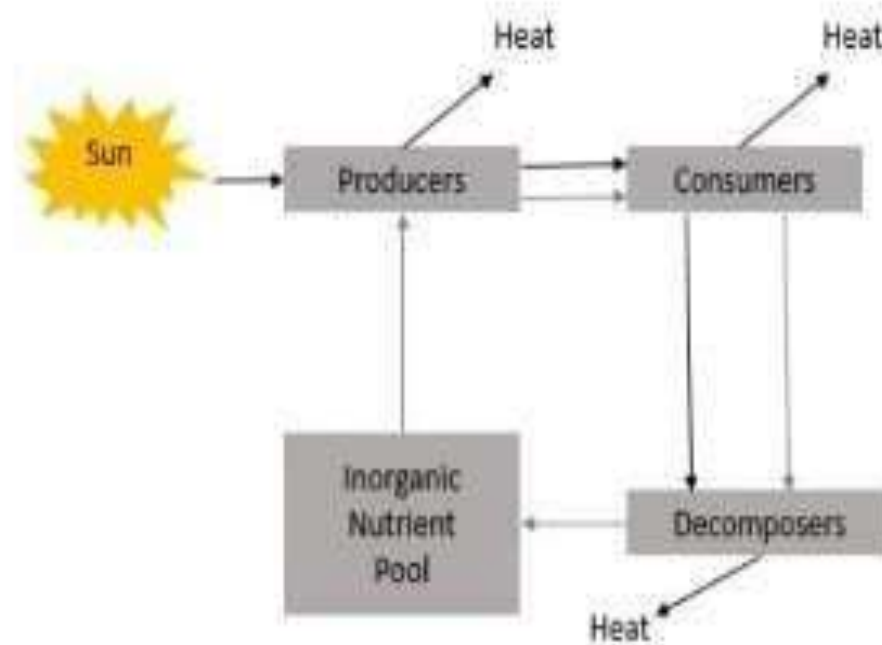
- Based on nutrition, biotic components can be categorized into **autotrophs, heterotrophs and saprotrophs (or decomposers)**



STRUCTURE (COMPONENTS) AND FUNCTIONS OF ECOSYSTEM

- Abiotic components are mainly of two types:
- **1. Climatic factors:** Which include rain, temperature, light, wind, humidity, etc.
- **2. Edaphic factors:** Which includes soil, PH, topography, minerals, etc

ENERGY FLOW THROUGH THE ECOSYSTEM

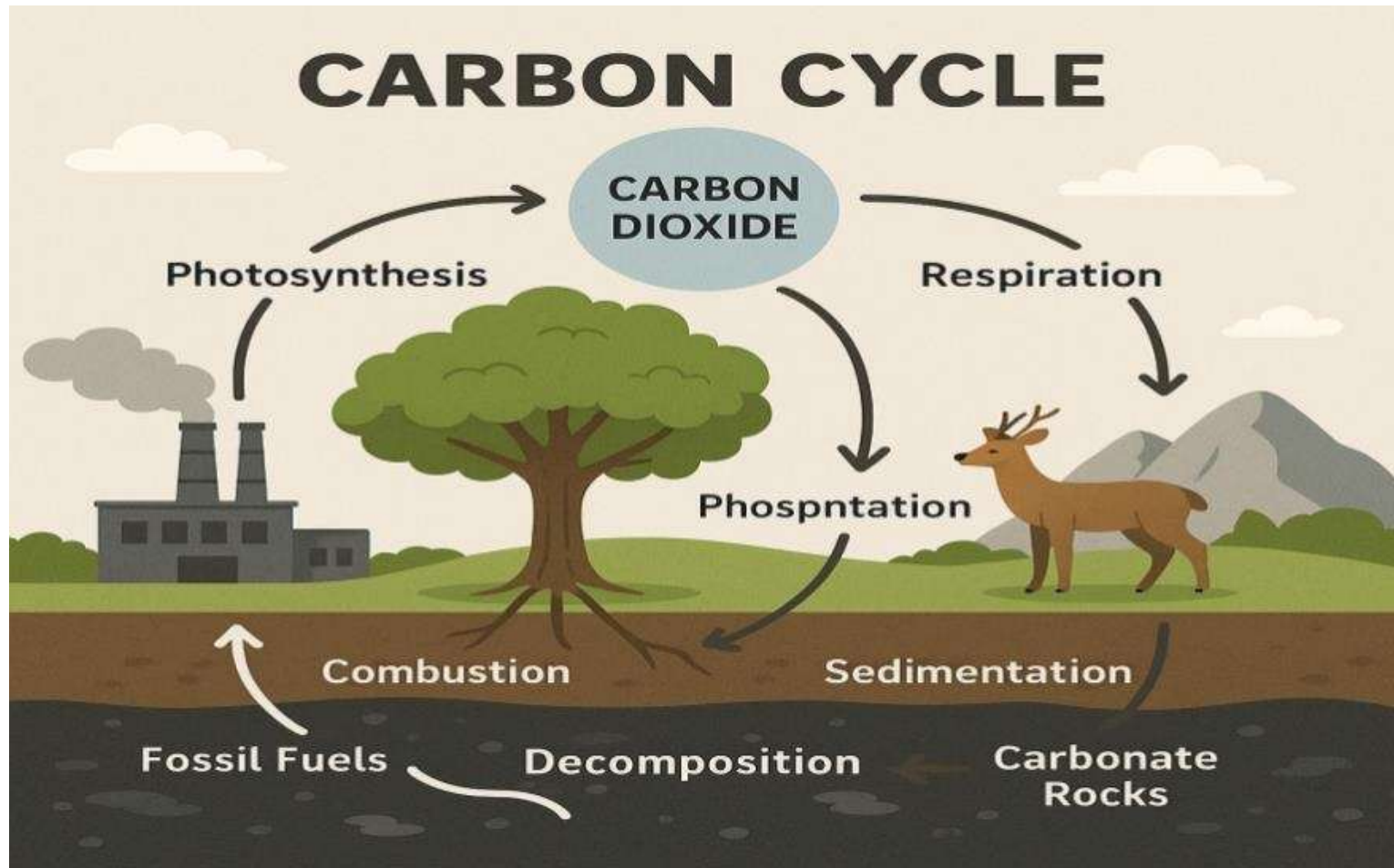


BIOGEOCHEMICAL CYCLES

- Following are some important biogeochemical cycles
Water Cycle ,Carbon Cycle, Oxygen Cycle, Nitrogen Cycle, Integration Cycle.
- **WATER CYCLE**
- **Done in Water Resources**

Refer slide no. 25

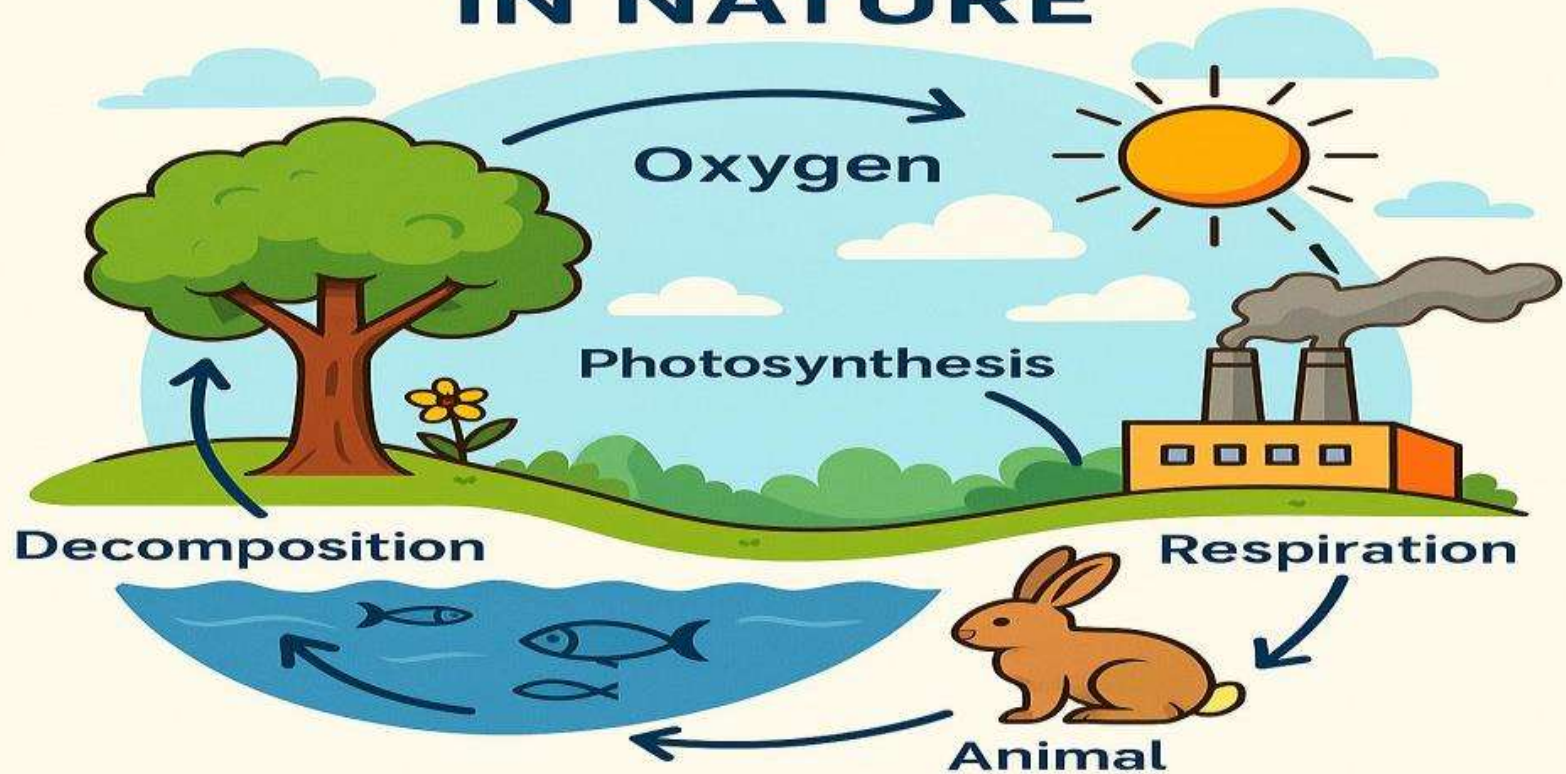
CARBON CYCLE



CARBON CYCLE

- Carbon cycle is the process where carbon compounds are interchanged among the biosphere, geosphere, pedosphere, hydrosphere, and atmosphere of the earth.
- Carbon present in the atmosphere is absorbed by plants via photosynthesis.
- During photosynthesis, plants take in carbon dioxide (CO_2) and water (H_2O) from the air and soil.
- These plants are then consumed by animals and carbon gets bio accumulated into their bodies.
- These animals and plants eventually die, and upon decomposing, carbon is released back into the atmosphere.
- Some of the carbon that is not released back into the atmosphere eventually become fossil fuels.
- These fossil fuels are then used for man-made activities, which pump more carbon back into the atmosphere.

OXYGEN CYCLE IN NATURE



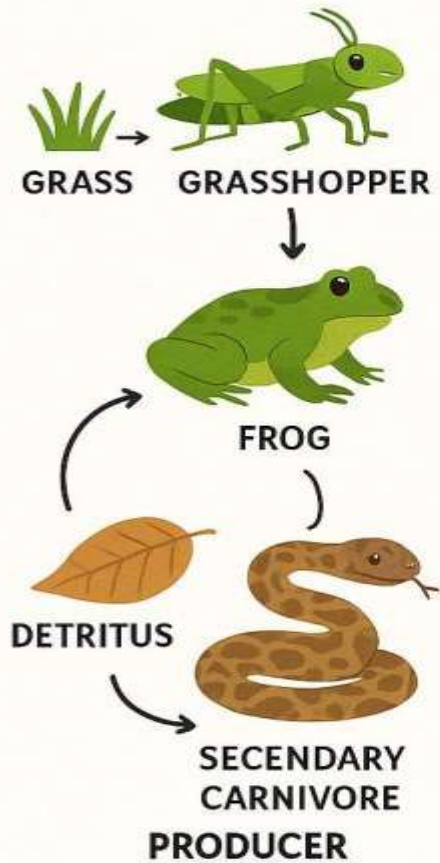
OXYGEN CYCLE

- **Stage - 1**
- All green plants during the process of photosynthesis, release oxygen back into the atmosphere as a by-product.
- **Stage - 2**
- All aerobic organisms use free oxygen for respiration.
- **Stage - 3**
- Animals exhale Carbon dioxide back into the atmosphere which is again used by the plants during photosynthesis. Now oxygen is balanced within the atmosphere.
- **Uses of Oxygen** - Breathing, Combustion, Supporting aquatic life, Decomposition of organic waste, rusting
- **Production of Oxygen : Plants, Sunlight:** Sunlight also produces oxygen. Some oxygen gas is produced when the sunlight reacts with water vapour in the atmosphere.

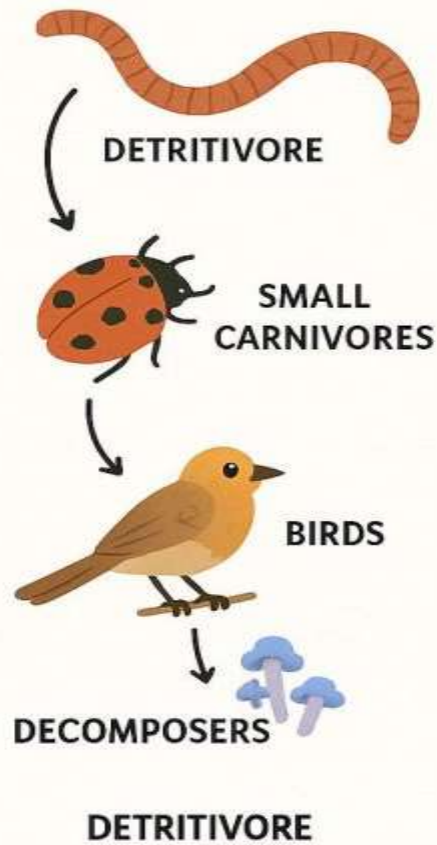
FOOD CHAINS

- A **food chain** is a linear pathway that shows **how energy and matter move** through an ecosystem from producers to top-level consumers and ultimately to decomposers.
- **Types of Food Chains**
 1. Grazing Food Chain
 2. Detritus Food Chain
 3. Parasitic Food Chain

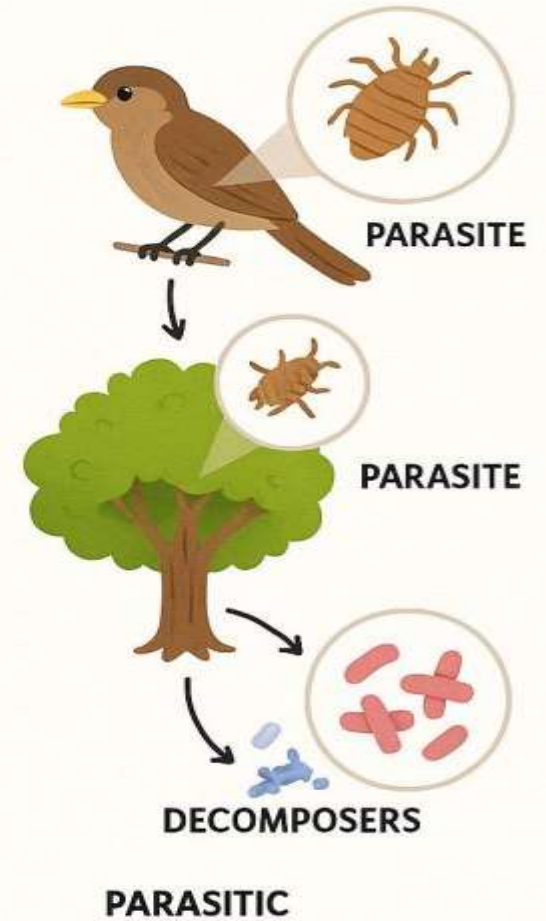
GRAZING FOOD CHAIN



DETRITUS FOOD CHAIN



PARASITIC FOOD CHAIN



Unit 2: Environmental Pollution, Waste Management, and Legislation

ESS

Environmental Pollution, Waste Management, and Legislation

- Definition, Causes, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards
- Solid waste Management: Causes, effects and control measures of urban and industrial wastes,
- Disaster management: floods, earthquake, cyclone and landslides.
- Overview of key environmental legislation and the judiciary's role in environmental protection.

Environmental Pollution

- Environmental pollution is unwarranted disposal of mass or energy into earth's natural resource pool such as **water, land, or air** that results in long or short term detriment to the atmosphere and its ecological health to **negatively impact the living beings** and their life both **quantitatively and qualitatively**
- “A pollutant is a chemical or biological substance which harms water, air, or land quality.”
- **Types of pollutants**
- **On the basis of existence in nature**
 - Quantitative Pollutants
 - Qualitative Pollutant

Types of pollutants

- **On the basis of the form in which they persist**

- a. Primary Pollutants**

The substances which are directly emitted from the source and remain in that form are termed as primary pollutants eg, smoke, fumes, ash, dust, nitric oxide and sulphurdioxide.

- b. Secondary Pollutants**

The substances which are formed by chemical reaction between the primary pollutants and constituents of the environment (i.e. those which are already present in the environment) .eg smog, ozone, sulphur-trioxide, nitrogen dioxide.

- **On the Basis of Disposal**

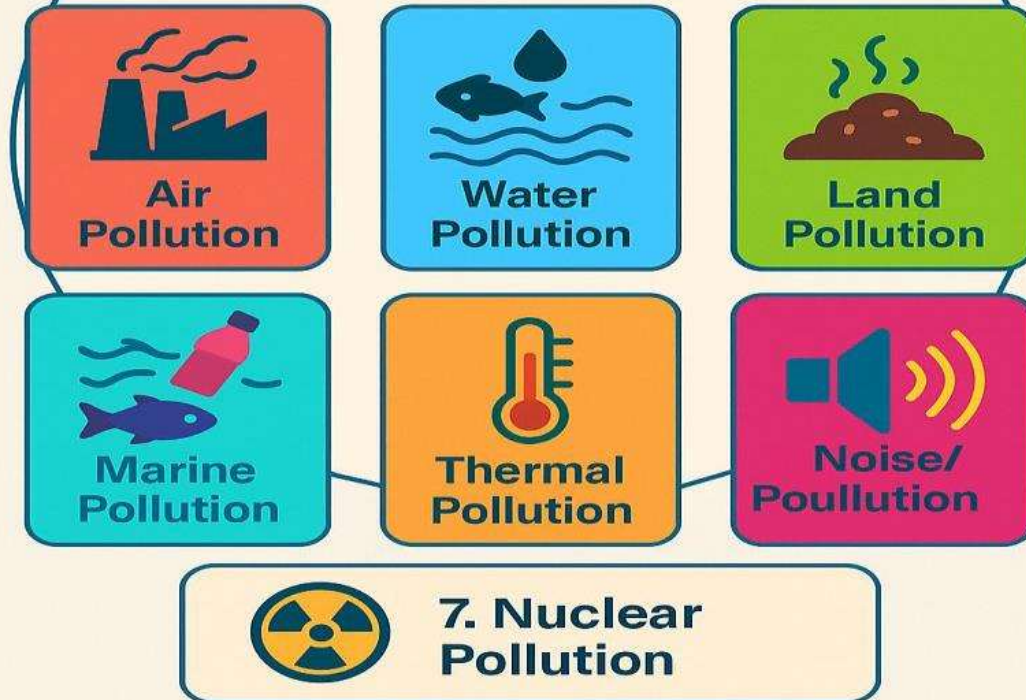
- a. Bio Degradable Pollutants**

The pollutants which are decomposed by natural processes eg. domestic (municipal) sewage.

- b. Non-Bio-degradable Pollutants**

The pollutants which don't decompose naturally or decompose slowly eg. DDT, Aluminium cans

Types of Pollution



AIR POLLUTION

- “Air pollution is defined as the introduction of pollutants, organic molecules, or other unsafe materials into Earth’s atmosphere.

- **Causes of air pollution**

Natural causes

1. Ash
2. Sulphur-dioxide
3. Ground level ozone
4. Salt spray
5. Volcanic gases
6. Radon.

Manmade Causes

1. Burning of traditional biomass such as wood, crop waste and dung.
2. Oil and gas sites that have methane leaks.
3. Construction sites.
4. High emission factors present in industries.
5. Gaseous emission from transportation.
6. Crackers bursting
7. Deforestation

Effects of Air pollution

1. Harmful to **human health** by causing coughing, difficulty in breathing, irritation to eyes, nose and throat, headache, dizziness, fatigue, respiratory diseases, cardiovascular damage, cancer, birth defects, damage of nervous system and even death.
2. Animals also get affected by air pollution **reproduction may get damaged**.
3. Harmful to **vegetation** as large exposure damages the stomata, growth and their survival.
4. Burning fossil fuels releases sulfur and nitrogen oxides into the atmosphere. **Acid rain** forms when sulfur dioxide and nitrogen dioxide mix with water droplets in the atmosphere to make sulfuric acid and nitric acid.
5. The hole in the ozone layer is caused by air pollutants. Chemicals used as refrigerants, such as chlorofluorocarbons (CFCs), contain chlorine atoms. Releasing chlorine atoms into the atmosphere **destroys ozone**.
6. Gaseous ammonia (NH₃) from agriculture and nitrogen dioxide (NO₂) from car, truck, and air plane emissions increase the amount of nitrogen in soils. Plants need nitrogen to grow, but too much nitrogen can limit the growth of some plants and increase the growth of others, **disrupting the balance of species within an ecosystem**.
7. Ecosystems can become **imbalanced** from air pollution.
8. Pollution particulates eventually fall back to earth, contaminating the soil
9. Air pollution creates acid rain, which can damage plants. Acid rain also changes soil chemistry, which can alter plant growth.
10. Air pollution is also one of the major causes of **global warming**. Global warming can also lead to more destruct have natural calamities such as storms and cyclones

Measures to prevent air pollution

1. Implement afforestation by planting more trees.
2. Use of public transportation.
3. Buy energy efficient vehicles like electric.
4. Consider “Going Green”.
5. Avoid Plastic Bags
6. Always use recyclable and reusable products.
7. Educate your companions and spread awareness in regards.
8. Use filters for chimneys.
9. Avoid usage of crackers.
10. Avoid using of products with chemicals.

WATER POLLUTION

- “Water pollution occurs when harmful substances—often chemicals or microorganisms— contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment.
- **Causes/Sources of water pollution**
 1. **Urbanization**
 2. **Deforestation**
 3. **Industrial Effluents**
 4. **Detergents, Pesticides, and Fertilizers**
 5. **Waterborne Diseases**
 6. **Agricultural Run-off**
 7. **Sewage and Wastewater**
 8. **Oil Pollution**
 9. **Radioactive Substance**
 10. **Organic Wastes**
 11. **Pathogens (Infectious Organisms)**
 12. **Chemical Pollutants (Heavy Metals)**

Water pollution

- **Effects of water pollution**

- Destruction of biodiversity
- Contamination of the food chain
- Lack of potable water
- Diseases
- Soil chemical contamination:
- Oil spills
- Mercury contamination:
- Thermal pollution

- **Measures to Prevent Water Pollution**

- Proper disposal of household chemicals:
- Proper chemical waste disposal:
- Wastewater treatment
- Sustainable agriculture:
- Preventing air pollution
- Plastic waste reduction:
- Water conservation
- Use of water-purifying plants:
- Avoid dumping untreated waste
- Industrial waste treatment:
- Use natural fertilizers and pesticides:
- Use of chemical purification methods:

LAND POLLUTION

- The degradation of the earth's land surfaces, both above and below ground level, is referred to as **land pollution**

- **Causes of Land Pollution**

- Agricultural Activities
- Mining Activities
- Urbanization
- Nuclear Waste
- Litter and Waste

- **Effects of Land Pollution**

- Climate Change
- Acid Rain
- Soil Degradation
- Water Contamination
- Harm to Wildlife
- Human Health Issues
- Loss of Ecosystems
- Soil Erosion
- Impact on Food Safety

- **Measures to Prevent Land Pollution**

- Sustainable Agricultural Practices
- Reforestation
- Solid Waste Treatments
- Reduce, Reuse, Recycle
- Composting

MARINE POLLUTION

- Marine pollution is the contamination of oceans by chemicals and trash, primarily from land based sources.

- **Causes of Marine Pollution**

- Direct Discharge
- Land Run-off
- Ship Pollution
- Atmospheric Pollution
- Climate Change
- Deep Sea Mining
- Marine Accidents

- **Effects of Marine Pollution**

- Eutrophication
- Plastic Debris
- Toxins
- Bioaccumulation
- Ocean Acidification
- Underwater Noise Pollution

- **Measures to Control Marine Pollution**

- Reduce Plastic Production & Waste
- Improve Wastewater Systems
- Use Eco-friendly Products
- Reduce Chemical Pollution
- Manage Oil Spills
- Beach & River Clean-ups
- Monitoring & Accountability

THERMAL POLLUTION

- Thermal pollution is the addition of excess and undesirable heat to natural water bodies, making it harmful to humans, animals, and aquatic life.

- **Causes/Sources of Thermal Pollution**

1. Nuclear Power Plants
2. Coal-Fired Power Plants
3. Industrial Effluents
4. Hydroelectric Power Generation
5. Domestic Sewage

- **Effects of Thermal Pollution**

- 1.Reduction in Dissolved Oxygen
2. Increase in Toxicity
3. Disruption of Biological Activity
4. Interference in Reproduction
5. Direct Mortality
6. Food Shortages for Fish

- **Control Measures for Thermal Pollution**

1. Cooling Towers
2. Cooling Ponds
3. Spray Ponds
4. Artificial Lakes

NOISE POLLUTION

- **Definition**

- Noise pollution refers to unwanted or excessive sound that can have harmful effects on human health, wildlife, and the overall environmental quality.

- **Causes of noise pollution**

1. Industrialisation
2. Vehicles
3. Events
4. Construction Sites
5. Aircraft Noise
6. Internal Building Noise
7. Household Equipment
8. Festivals and Firecrackers

- **Effects of Noise Pollution**

1. Hypertension
2. Hearing Loss:
3. Sleeping Disorders:
4. Cardiovascular Issues:
5. Interference in Communication:
6. Effect on Performance:
7. Stress:
8. Effect on Unborn Babies and Children:

- **Control Measures of Noise Pollution**

- Plant more trees:
- Ban honking in sensitive zones:
- Install soundproof system:
- Control musical instrument volume:
- Maintain dense tree cover:
- Avoid use of explosives in sensitive zones
- Turn off unused appliances:
- Minimize noise exposure at home:

NUCLEAR POLLUTION (RADIOACTIVE POLLUTION)

- Nuclear pollution, also known as **radioactive contamination**, refers to the presence or deposition of radioactive materials in solids, liquids, gases, or on surfaces where their presence is unintended or undesirable.

- **Causes of Nuclear Pollution**

- Nuclear Waste Disposal

- Nuclear Accidents

- Nuclear Weapons

- Medical Facilities

- Industrial and Research Facilities

- Mining and Extraction Activities

- Use of Radioisotopes in Manufacturing

- Radioactive Spills

- **Effects of Nuclear Pollution**

- Human Health Hazards
 - Infertility of Soil
 - Cell Damage and Mutation
 - Skin Burns and Lesions
 - Impact on Plant Life
 - Impact on Marine Life

- **Control Measures of Nuclear Pollution**

1. Separate Waste Streams
2. Limit Material Use
3. Minimize Waste Generation
4. Use Neutralizing Reagents
5. Proper Waste Storage
6. Labeling and Record-Keeping
7. Occupational Safety
8. Medical Safety Measures
9. Warning Signage
10. Use Alternative Energy
11. Nuclear Disarmament
12. Safe Site Planning

SOLID WASTE MANAGEMENT

- Solid Waste Management refers to the collection, transportation, processing, and disposal of solid waste in an environmentally and economically sustainable manner
- Types of solid waste
- Category Examples
 - Urban Waste Household garbage, commercial waste, street litter, construction debris Industrial Waste Metal scraps, chemical residues, ash, plastic, rubber,
 - Biomedical Waste Hospital waste, syringes, bandages, expired medicines
 - E-Waste Discarded electronic devices like mobiles, computers, and batteries
 - Hazardous Waste Flammable, toxic, corrosive, or reactive industrial waste
 - Agricultural Waste Crop residue, pesticide containers, and animal waste
- **Urban wastes**
 - Definition Urban waste is generated by households, commercial establishments, public areas, and municipal services. It includes biodegradable and non-biodegradable components.
 - Causes of Urban Waste
 1. Overpopulation and Urban Migration
 2. Changing Lifestyle & Consumerism
 3. Inefficient Municipal
 4. Construction and Demolition Activities
 5. Public Events & Markets

SOLID WASTE MANAGEMENT

- Effects of Urban Waste

1. Environmental pollution (air, soil, water contamination)
2. Blocked drains and urban flooding due to clogged waste
3. Unhygienic living conditions and vector-borne diseases.
4. Overburdened landfills and municipal budgets

- Control measures for urban waste

1. Source Segregation Separate dry and wet waste at the household and institutional levels.
2. Composting and Biogas Production Use organic waste to produce manure and energy.
3. Recycling and Reuse Encourage collection centers for paper, plastic, glass, and metals.
4. Waste-to-Energy Plants Convert non-recyclable dry waste into electricity or fuel.
5. Awareness Campaigns Educate citizens on waste reduction and proper disposal.
6. Strengthen Municipal Infrastructure Invest in better collection vehicles, bins, and landfill sites.
7. Public-Private Partnerships (PPP)

DISASTER MANAGEMENT

- Disaster management refers to the organization, planning, and application of measures preparing for, responding to, and recovering from natural or man-made disasters.

1. Floods Definition

- A flood is an overflow of water that submerges land which is usually dry. It is one of the most common and widespread natural disasters worldwide.
- Causes
 - ❑ Heavy rainfall beyond drainage capacity
 - ❑ Sudden melting of snow and glaciers
 - ❑ Dam failure or overflow
 - ❑ Deforestation and poor land use
 - ❑ Urbanization and poor drainage systems
 - ❑ Cyclones and tsunamis

Effects

- ❑ Loss of human lives and livestock
- ❑ Destruction of property and infrastructure
- ❑ Waterborne diseases such as cholera, dysentery
- ❑ Disruption of transportation and communication
- ❑ Soil erosion and destruction of crops
- ❑ Economic losses and displacement

Measures

- ❑ Construction of dams, levees, and embankments
- ❑ Flood forecasting and early warning systems
- ❑ Improved drainage systems in urban areas
- ❑ Afforestation and watershed management
- ❑ Proper zoning and land use planning

Floods

- Remedial Measures

- ☐ Immediate evacuation of affected people
- ☐ Emergency relief (food, water, shelter, healthcare)
- ☐ Rescue operations using boats and helicopters
- ☐ Disinfection of water sources to prevent diseases
- ☐ Reconstruction and rehabilitation efforts
- ☐ Financial compensation and insurance support

- Earthquakes

- An earthquake is the sudden shaking of the ground caused by the movement of tectonic plates beneath the Earth's surface.

- Causes

- ☐ Movement of tectonic plates along fault lines
- ☐ Volcanic eruptions
- ☐ Collapse of underground caves
- ☐ Nuclear explosions (man-made cause)

Earthquakes

Effects

- ☐ Massive loss of life and injuries
- ☐ Destruction of buildings, roads, and bridges
- ☐ Fire outbreaks due to gas line ruptures
- ☐ Landslides and tsunamis (secondary disasters)
- ☐ Disruption of essential services (electricity, water)
- ☐ Emotional trauma and economic setback

Preventive Measures

- ☐ Earthquake-resistant construction techniques ☐ Strict building codes and regulations in seismic zones
- ☐ Public awareness and mock drills
- ☐ Seismic hazard mapping and land use planning

Remedial Measures

- ☐ Deployment of search and rescue teams
- ☐ Emergency medical assistance and trauma counseling
- ☐ Restoration of communication and transport
- ☐ Rebuilding of homes and infrastructure
- ☐ Government aid and international support

Cyclones

Definition

A cyclone is a large scale air mass that rotates around a strong center of low atmospheric pressure, bringing high winds and heavy rainfall.

Causes

- ❑ Warm ocean waters and moisture-laden air
- ❑ Coriolis force (due to Earth's rotation)
- ❑ Atmospheric disturbances and pressure differences

Effects

- ❑ Strong winds damaging homes and infrastructure
- ❑ Heavy rainfall causing floods and waterlogging.
- ❑ Storm surges inundating coastal areas.
 - ❑ Destruction of crops and loss of livestock.
 - ❑ Disruption of electricity and transport.

Economic loss and displacement of communities.

Preventive Measures

- ❑ Early warning systems using satellite technology
- ❑ Construction of cyclone shelters and embankments
- ❑ Public education and emergency preparedness

- ❑ Proper drainage and storm water management
- ## Remedial Measures

- ❑ Evacuation of coastal populations before landfall
- ❑ Provision of emergency supplies and shelters
- ❑ Restoration of power and communication lines
- ❑ Medical care and mental health support
- ❑ Long-term rebuilding and livelihood assistance

Landslides

- Definition A landslide is the sudden downward movement of rock, earth, or debris on a slope due to gravity, often triggered by rain, earthquakes, or human activity.

Causes

- ☐ Intense rainfall or snowmelt
- ☐ Earthquakes and volcanic activity
- ☐ Deforestation and mining activities
- ☐ Poor construction and land use
- ☐ Overloading of slopes

- Effects

- ☐ Burial of people and property under debris
- ☐ Disruption of roads, railways, and pipelines
- ☐ River blockage and creation of artificial lakes
- ☐ Loss of agricultural land
- ☐ Environmental degradation
- ☐ Preventive Measures
- ☐ Retaining walls and proper drainage on slopes
- ☐ Reforestation and vegetation cover on hills
- ☐ Hazard zoning and controlled land use
- ☐ Monitoring of slope movement

Remedial Measures

- ☐ Immediate search and rescue operations
- ☐ Rehabilitation of displaced persons
- ☐ Slope stabilization and reengineering
- ☐ Awareness programs in hilly regions
- ☐ Restoration of services and infrastructure.

Overview of key environmental legislation and the judiciary's role in environmental protection.

India is one of the few countries where environmental protection is embedded in the Constitution and backed by an evolving legal framework. Over the decades, environmental challenges such as water pollution, air pollution, deforestation, hazardous waste, and industrial disasters have forced governments to enact specific laws to protect and preserve the environment.

The main environmental laws in India include

- The Water (Prevention and Control of Pollution) Act, 1974
- The Air (Prevention and Control of Pollution) Act, 1981
- The Environment (Protection) Act, 1986

These laws aim to monitor, regulate, prevent, and penalize activities that harm the environment, while promoting sustainable development.

- Key Objectives of Environmental Legislation

- To prevent and control pollution (air, water, soil, etc.)
- To protect biodiversity, forests, and wildlife
- To ensure the proper use of natural resources
- To hold polluters accountable
- To promote sustainable and eco-friendly development

Role of Judiciary in Environmental Protection

The Indian Judiciary, especially the Supreme Court and High Courts, has played a proactive role in environmental protection, often stepping in when the executive or legislature has failed.

- Citizens can file Public Interest Litigation (PIL) for environmental issues.
- These allow courts to take suo motu (on their own) actions.
- Example: M.C. Mehta v. Union of India – landmark case on pollution and Ganga river cleaning.

Constitutional Provisions Related to Environment

- ❑ Article 48-A (Directive Principles): “The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country.”
- ❑ Article 51-A(g) (Fundamental Duties): “It shall be the duty of every citizen to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures.”

Landmark Contributions

- ❑ Interpreted Article 21 (Right to Life) to include Right to a Healthy Environment.
- ❑ Issued strict guidelines for polluting industries, vehicle emissions, noise pollution, etc.
- ❑ Introduced “Polluter Pays” and “Precautionary Principles” in Indian environmental jurisprudence. Environmental Courts
- ❑ Encouraged creation of National Green Tribunal (NGT) in 2010 to deal with environmental disputes.