MODULE 1

Introduction to Environment

Definition—scope and importance of Environmental Studies—Renewable and Non-renewable Resources. Concept of an ecosystem: Structure and function of an ecosystem—Producers—consumers and decomposers—Energy flow in the ecosystem—Ecological succession—Food chains and ecological pyramids—and Biodiversity

INTRODUCTION TO ENVIRONMENT

ENVIRONMENT

Environmental science is the study of nature and the facts about environment. Environment can be defined as "all the social, economical, physical and chemical factors that surrounds man" or "all abiotic and biotic components around man-all living and non-living things surround man".

The word environment is derived from the French word *'Environ'* meaning *encircle.* Environment is a very broad concept and involves everything that affects an organism during its lifetime. Therefore, environment can simply be defined as one's surroundings. It includes everything around the organism, *i.e.*, abiotic (non-living) and biotic (living) environment. Abiotic environment consist of soil, water and air while the biotic environment includes all other organisms with which the organism comes into regular contact.

Environment can be defined in many ways, some of its commonly used definitions are :

1. It is in totality of all social, biological and physical or chemical individually as well as collectively that compose the nature and man-made surroundings.
2. It refers to sum total of conditions which surround man at a given point in space and time.
3. It is the representative of physical components of the earth wherein man is the important factor influencing his environment.

In general, the environment can be described as the physical surroundings and conditions affecting the lives of people and animals.

The global environment consists of four segments :

(*i*) Atmosphere (*ii*) Hydrosphere (*iii*) Lithosphere (*iv*) Biosphere.

CONCEPTS

According to ancient man the environment was the Panchaboodhas (i.e.) air, water, land, sky and energy. The human were disciples of nature. They were able to protect themselves from harmful one and protect the others. But according to modern man the environment is only air land and water. Exploitation of various earth resources to satisfy the increasing needs of human population has resulted in 1) depletion of various resources of earth 2) pollution. Principles of environmental education:

- Examine the major environmental issues.
- Discover the root cause.
- Develop problem solving skills.
- Promote co-operation in solving problems.
- Emphasis active participation in prevention and solution to problems

SCOPE OF ENVIRONMENTAL SCIENCE

- Studying the interrelationship between the components of environment.
- Carrying out impact analysis and Environmental Audit
- Preventing pollution from existing and new industries
- Stopping the use of biological and nuclear weapons

- Managing unpredictable disasters etc.

Public Awareness

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection.

- Public awareness of environmental issue is at infant stage.
- 30-40% of public of developing country are aware of environmental. Problems but they do not bother about it.
- Ignorance and incomplete knowledge haveled to misconceptions.
- Development and improvement in std. of living has led to serious environmental disasters.
- Debates on environmental Issues are treated as anti-developmental.

Application

- Environmental science is essentially the application of scientific methods and principles to the study of environmental issues, so it has probably been around in some forms as long as science itself.
- Environmental science is often confused with other fields of related interest, especially ecology, environmental studies, environmental education, and environmental engineering.
- Environmental science is not constrained with any one discipline, and it is a comprehensive field.

Risk And Hazards In The Environment

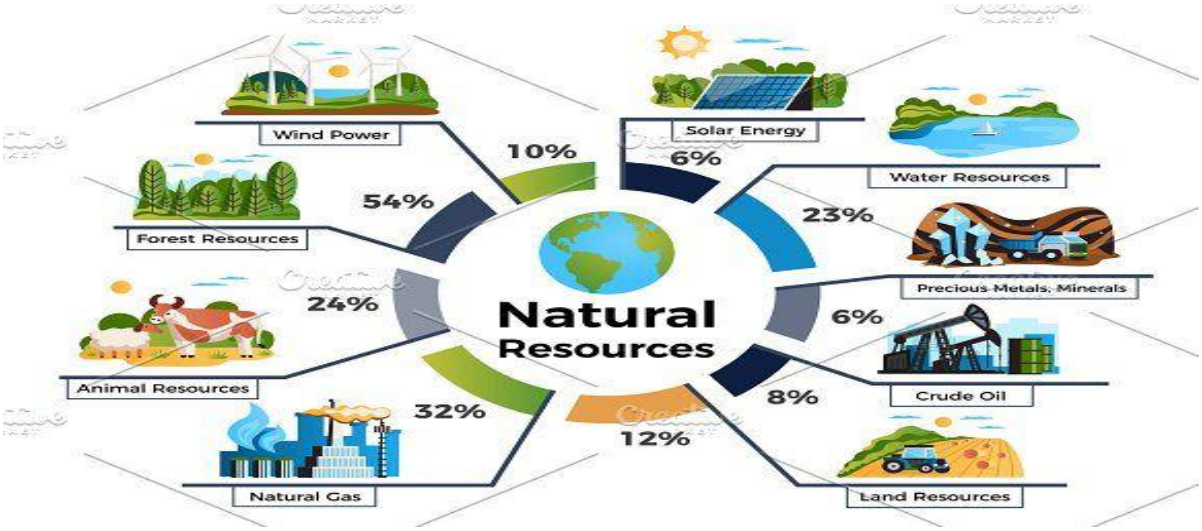
Environmental risk due to various environmental hazards is an important topic for environmental engineers to recognize and understand in order to protect human society and ecosystems from harms or damages at local, regional or global scales. For example, to deal with contaminated soil and ground water at a brown field, risk and exposure assessment help engineers choose an optimal solution to either treat the hazard (e.g., to remove the contaminants from the soil and water) or reduce the exposure (e.g., to cover up the land with a barrier). A hazard is a threat to life, health, property, or ecosystems, i.e., it involves something that could potentially be harmful. Therefore, when a dormant hazard comes to fruition, it will cause physical damage or destruction, loss of life, or drastic change to the

environment, and result in an incident, accident, emergency event, or disaster. Hazards may be classified into:

- Chemical hazards – Combustion of Fossil fuels, industrial effluence, pesticides heavy metals.
- Physical hazards – Radioactive and UV radiations, Global warming, Chlorofluro carbons, Noise etc.
- Biological hazards – Bacteria, Viruses, Parasites.

NATURAL RESOURCES

Natural resources are important for living beings. There are many ways of classifying natural resources. The most general category is the amount of resources available for human consumption. There are two types of energy resources: renewable and non-renewable energy resources.



What is a Renewable Resource?

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

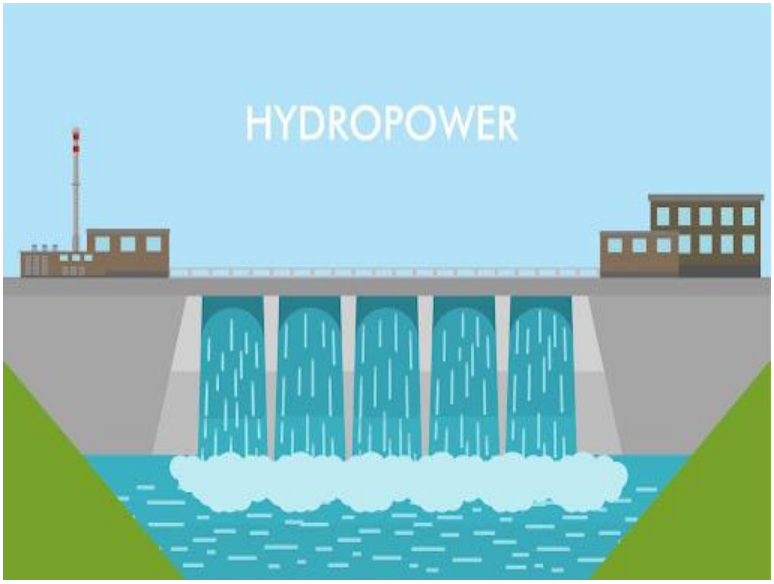
Renewable Resources: Examples

Sun - The energy obtained from sunlight is solar energy. The sun is the ultimate natural resource for all living beings on the earth. Plants utilize solar energy and make their own food through photosynthesis.

- Wind - It is an important renewable resource required for the survival of living organisms. Air is important to carry out photosynthesis (the process by which green plants turn carbon dioxide and water into food using energy from sunlight) and respiration (the inhaling of oxygen and the exhaling of carbon dioxide) in plants and animals, respectively. The energy that is obtained from wind is termed as wind energy.

Water - Water is required for survival. Humans use water for a variety of reasons, including drinking, washing, cooking, and cultivating crops. Hydro energy is generated by water flowing into a river or water held in a dam. Hydro energy is power that is generated from moving water such as rivers.

Converting hydro energy into electrical energy is a simple way to utilize it. Electrical energy is a specific form of energy that is the result of an electric charge. Electrical energy is a specific form of energy that is the result of an electric charge.



Soil- Soil is a valuable resource as it is the layer in which plants grow. Living beings require food to live. Plants produce most of the food that is required by living organisms.

Biogas- Biogas is a form of fuel that is a mixture of gases such as methane, carbon dioxide, hydrogen, and other gases produced by the breakdown of animal and plant wastes such as animal dung in the presence of water with the help of microorganisms. It is commonly used as a fuel for gas stoves, particularly in rural regions.

What is a Non-renewable Resource?

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

Non-renewable Resources: Examples

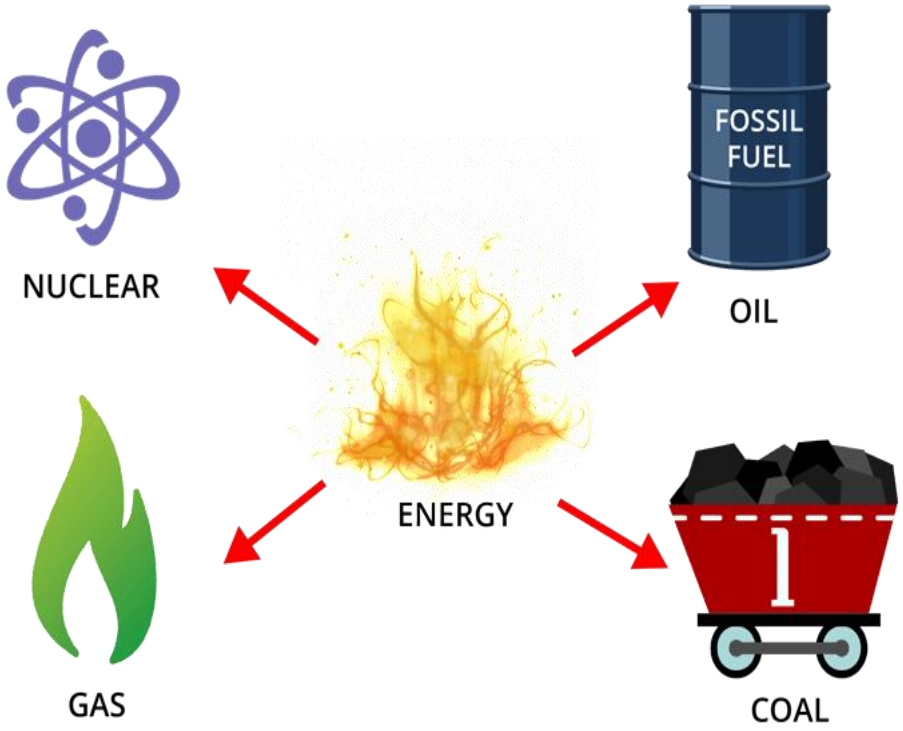
Fossil Fuels- Fossil fuels are non-renewable energy sources. This means that they will ultimately be finished, which is why energy prices are rising. Fossil fuels consist of coal, natural gas and petroleum.

Coal- Coal is used as a fuel, to generate electricity, and in factories and steam engines.

Natural gas- Natural gas, often known as compressed natural gas, is an excellent alternative to petrol and diesel. It burns quickly and generates a large amount of heat. It's an excellent source of hydrogen.

Petroleum- Mineral oil or crude oil are other names for petroleum. Petrol, diesel, cooking gas, and kerosene are all made from this liquid mineral. It can be found deep within the earth.

Nuclear energy- This energy source involves use of radioactive material that is found in nature. Uranium is primarily used to make nuclear reactor fuel rods. Heat is generated when neutrons(neutral particles present in the atom) hit with the fuel rods. This converts water to steam, which is used to move turbines. As a result, it generates electricity.

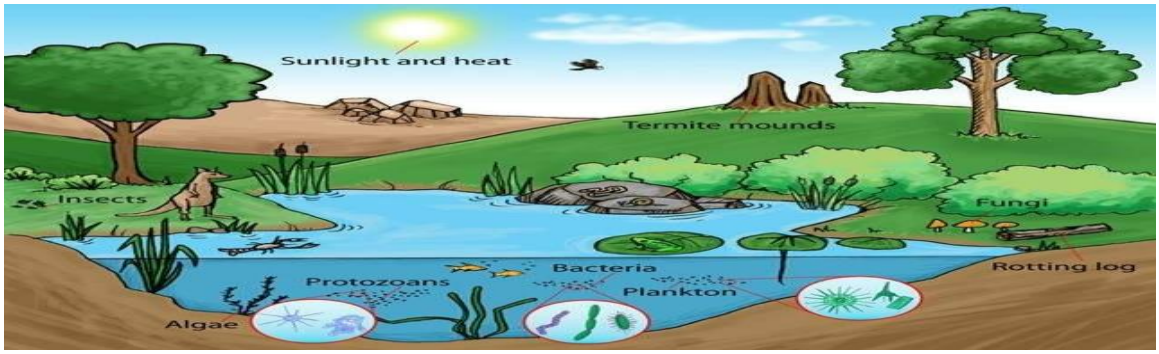


Difference between Renewable and Non-renewable Resources

Renewable Resources	Non-renewable Resources
1. Can be replaced by natural processes in a short duration of time or can be recycled.	1. These are natural resources that either cannot be replaced or may take millions of years to be replaced by natural processes like coal and oil.
2. It can be reused or recycled and used multiple times.	2. It cannot be reused or recycled.
3. Some of the examples are: wind energy, solar power, hydroelectricity, geothermal.	3. Some of the examples are: petrol, coal, Natural gas, nuclear energy, fossil fuels.
4. There is no harm to the environment by using renewable resources.	4. Huge harm done to the environment because of the harmful emissions.

ECOSYSTEM

Living organisms cannot be isolated from their non-living environment because the later provides materials and energy for the survival of the farmer. An ecosystem is therefore defined as a natural functional ecological unit comprising of living organisms and their non-living environment that interact to form a stable self-supporting system.



Ecosystem

Characteristics of Ecosystem

- Ecosystem is an open system which receives input in the form of solar energy and matter and results in synthesis of organic food.
- At the same time each component of ecosystem gives out energy as well as waste matter, referred to as output. Therefore, a regular input of energy is necessary for maintenance of life upon earth.
- Ecosystem maintains a relatively stable state of equilibrium amongst its various components by homeostasis. It fluctuates within certain limits and can be controlled via number of controls as carrying capacity, recycling of wastes, self regulation and feedback system.

CONCEPTS OF ECOSYSTEM

Ecology is the study of the distribution and abundance of organisms, the flows of energy and materials between abiotic and biotic components of ecosystems.

STRUCTURE OF ECOSYSTEM

The structure of an ecosystem is the description of the organisms and physical features of environment including the amount and distribution of nutrients in the ecosystem. From the structure point of view, all ecosystems consist of the following basic components: Abiotic Components: Abiotic components of an ecosystem include basic inorganic elements and compounds, such as soil, water, oxygen, calcium carbonates, phosphates, and a variety of organic compounds. Biotic Components: The biotic components include all living organisms present in the environmental system which can be further classified into the following three types. 1. Producers (Autotrophic components) 2. Consumers 3. Decomposers

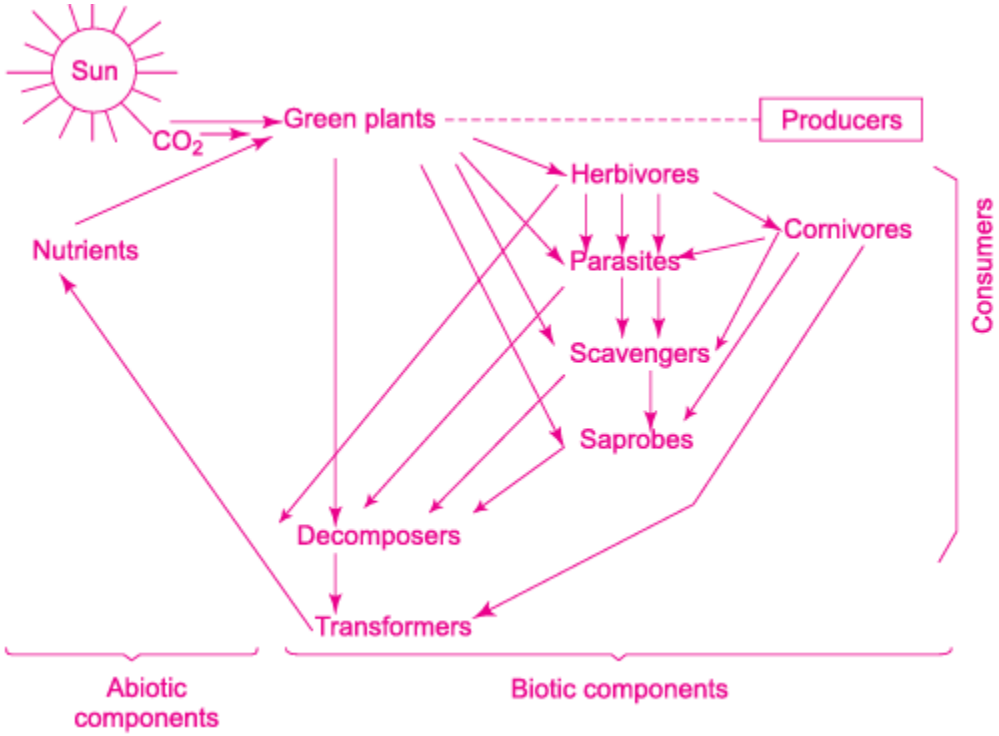
Functions of all ecosystems are based on the following operations.

1. Reception of radiant energy of sun and manufacture of organic materials from inorganic ones by producers.
2. Consumption of producers by consumers and further elaboration of consumed materials.
3. Conversion of dead bodies of producers and consumers by decomposers into nutrients which are suitable for reutilization by producers.

Function of organisms in an ecosystem

1. Producer (autotrophy): make food; plants, algae.

2. Consumer (heterotrophy): eat other organisms.
3. Decomposer: eat dead organic matter; bacteria and fungi



Structure and Functional Operations of an Ecosystem

Classes of Consumers

1. Herbivore – primary consumer – eats plants
2. Carnivores – secondary – meat eaters; eat herbivores.
3. Tertiary – feed on carnivores
4. Omnivores – eat plants/animals.

Functions of Ecosystem

Ecosystem representing the highest level of ecological integration is capable of energy transformation, accumulation, and circulation. Ecologically, it emphasizes on obligatory relationships, interdependence, and casual relations. The four important functional aspects of ecosystem can be discussed as: (i) productivity, (ii) decomposition (iii) energy flow and (iv) nutrient cycling.

PRODUCTIVITY

The productivity of an ecosystem refers to the rate of production, i.e., the amount of organic matter or biomass accumulated per unit area in any unit time. It is measured as weight (g/m2/yr) or energy (kcal/m2/yr). Productivity is of following types:

Primary Productivity

The amount of energy accumulated in green plants as biomass or organic matter per unit area over a time period through the process of photosynthesis is known as primary productivity. It is of two sub types: GPP and NPP

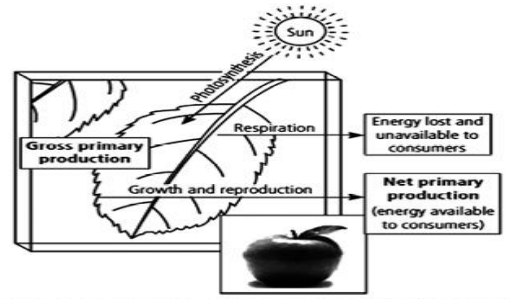


Fig.: Distinction between gross primary productivity (GPP) and net primary productivity (NPP). A plant uses some of its GPP to survive through respiration. The remaining energy is available to consumers.

Gross Primary Productivity (GPP)

- It is the amount of organic matter synthesized by producers per unit time and per unit area.
- It is equal to rate of increase in body weight of producers plus loss suffered through respiration, grazing and damages.
- It depends upon photosynthetic efficiency of producers, availability of solar energy as well as inorganic nutrients.

Net Primary Productivity (NPP)

- It is the amount of organic matter stored by producers per unit time and per unit area.
- It is equal to organic matter synthesized by photosynthesis minus utilization in respiration and other losses.
- It depends upon gross primary productivity as well as amount of consumption of photosynthates.
- NPP is equal to GPP – R, where R is energy used in respiration.

Secondary Productivity

- The rate of resynthesis of organic matter by the consumers is known as secondary productivity.
- It depends upon the loss while transferring energy containing organic matter from the previous trophic level plus the consumption due to respiration and predation.
- It is small and decreases with rise of trophic level.
- It is due to synthesis of organic matter from organic matter.

Decomposition

- It is physical and chemical breakdown of complex organic remains with the help of organisms called decomposers.
- In terrestrial ecosystem, upper layer of soil is the main site of decomposition. Organic remains (dead plant parts, animal remains and excretions) are also called detritus. It is of two types: above ground detritus (leaf litter, dried plant parts, remains of animals, their droppings, and excretions) and below ground detritus (mainly dead roots, also underground dead animals).
- Decomposition completely disposes off the whole detritus. It helps in recycling of biogeochemicals and creating space for newer generations of organisms.

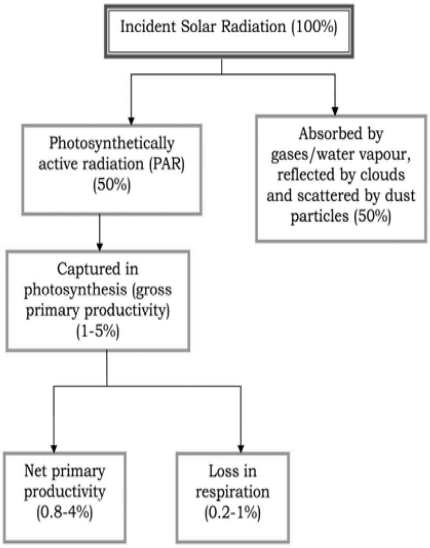
ENERGY FLOW

1. Ecosystems require a constant input of energy as every component of an ecosystem is regularly dissipating energy.
2. Flow of energy is governed by two laws of thermodynamics.

- First law, energy can be transferred as well as transformed but is neither created nor destroyed.
- Second law, every activity involving energy transformation is accompanied by dissipation of energy.

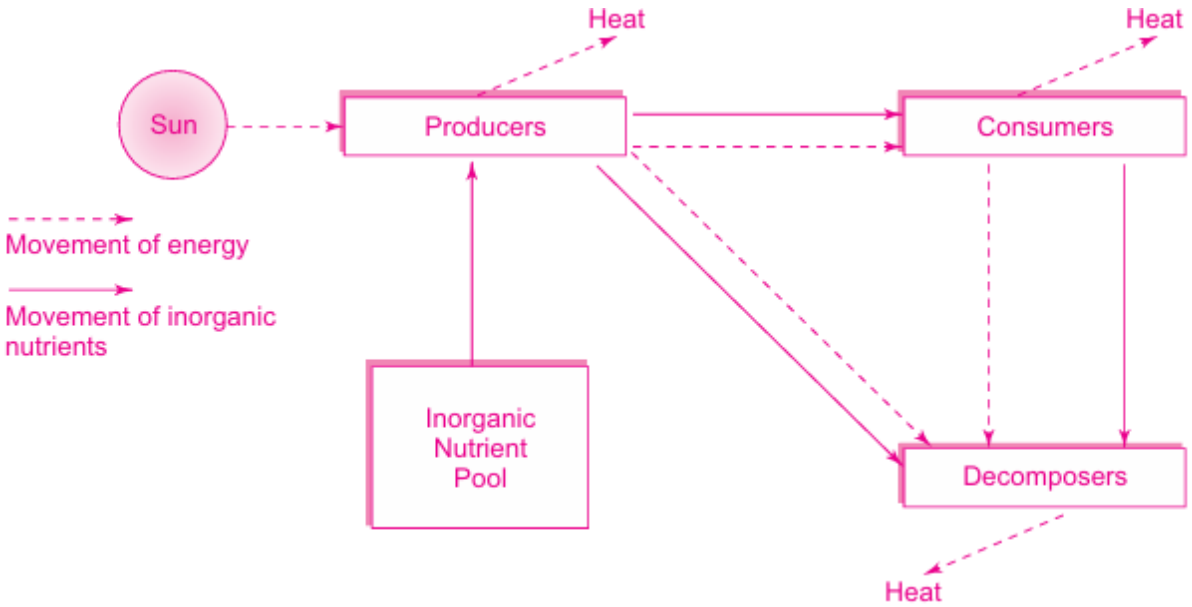
3. The source of energy in all ecosystems, except deep hydrothermal ecosystem is solar energy.
4. Energy does not remain trapped permanently in any organism. It is either passed on to the higher trophic level or becomes available.
5. The source of energy in all ecosystems, except deep hydrothermal ecosystem is solar energy.

6. Energy does not remain trapped permanently in any organism. It is either passed on to the higher trophic level or becomes available to detrivores and decomposers after the organism dies. Normally, herbivores feed on producers.
7. Part of the food energy is wasted in digestion and assimilation. Some of the assimilated food is broken down to release energy for performing body activities. A very small portion becomes part of the body of herbivore. Herbivores are eaten by primary carnivores, the latter by secondary carnivores and so on. At every step a lot of energy is wasted



Energy “flows” through the ecosystem in the form of carbon-carbon bonds. When respiration occurs, the carbon-carbon bonds are broken, and the carbon is combined with oxygen to form carbon dioxide. This process releases the energy, which is either used by the organism (to move its muscles, digest food, excrete wastes, think, etc.) or the energy may be lost as heat. The dotted arrows represent the movement of this energy. All energy comes from the sun, and the ultimate fate of all energy in ecosystems is to be lost as heat. Energy does not recycle. The other components shown in the diagram are the inorganic nutrients. They are inorganic because they do not contain carbon-carbon bonds. These inorganic nutrients include the phosphorous in our teeth, bones, and cellular membranes; the nitrogen in our amino acids (the building blocks of protein); and the iron in our blood. The movement of the inorganic nutrients is represented by the open arrows. Note that the autotrophs obtain these inorganic nutrients from the inorganic nutrient pool, which is usually the soil or water surrounding the plants or algae. These inorganic nutrients are passed from

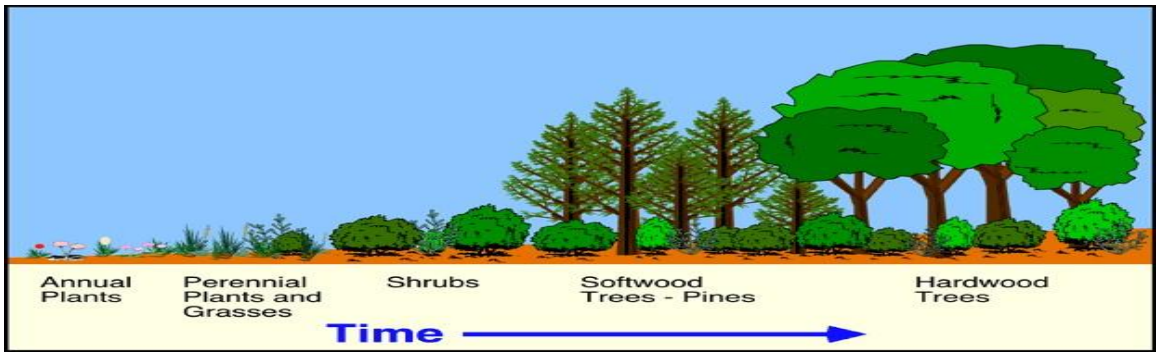
organism to organism as one organism is consumed by another. Ultimately, all organisms die and become detritus, food for the decomposers. At this stage, the rest of the energy is extracted (and lost as heat) and the inorganic nutrients are returned to the soil or water to be taken up again. The inorganic nutrients are recycled, but the energy is not recycled.



Energy and Nutrient Flow through Ecosystem

ECOLOGICAL SUCCESSION

Ecological succession is the gradual process by which ecosystems change and develop over a period of time. Each species is adapted to thrive and compete best against other species under a very specific set of environmental conditions. If these conditions change, then the existing species will be replaced by a new set of species which are better adapted to the new conditions. Ecological succession may also occur when the conditions of an environment suddenly and drastically change. A forest fire, windstorm, and human activities like agriculture etc. greatly alter the conditions of an environment. The following are the three proposed hypotheses pertaining to the mechanism of replacement.



Ecological succession

Facilitation Hypothesis

This hypothesis states that the invasion of later species depends on the conditions created by earlier colonists. Earlier species modify the environment so as to increase the competitive ability of species which are then able to displace them. Succession thus proceeds because of the effects of species on their environment.

Tolerance Hypothesis

This suggests that later successional species tolerate lower levels of resources than earlier occupants and can invade and replace them by reducing resource levels below those tolerated by earlier occupants. Succession proceeds despite the resistance of earlier colonists.

Inhibition Hypothesis

This hypothesis states that all species resist invasion of competitors and are displaced only by death or by damage from factors other than competition. Succession proceeds towards dominance by longer-lived species.

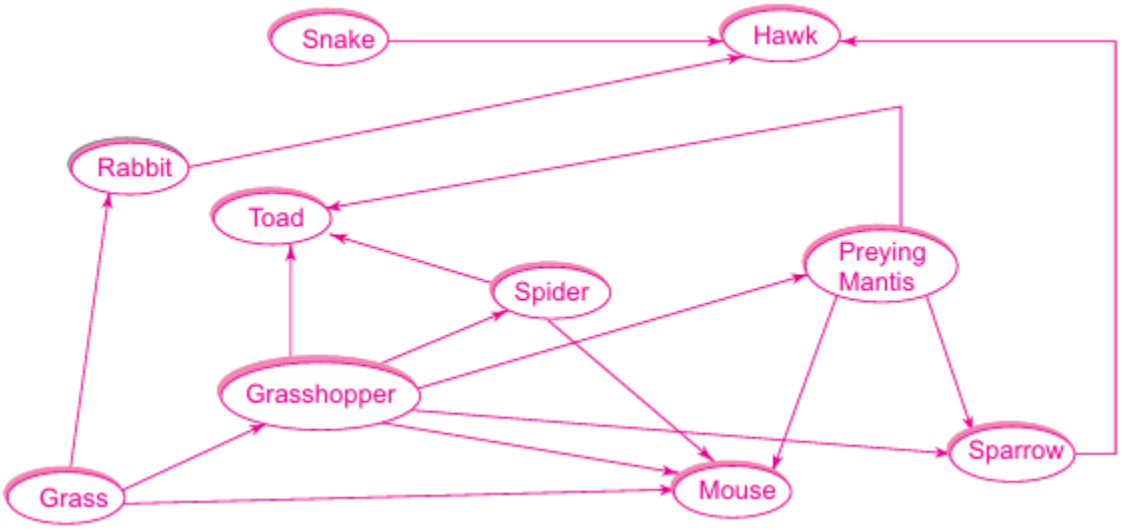
FOOD CHAIN

- A food chain is the path of food from a given final consumer back to a producer.
- The transfer of food energy from the producers, through a series of organisms (herbivores to carnivores to decomposers) with repeated eating and being eaten, is known as a Food chain. Producers utilise the radiant energy of sun which is transformed to chemical form, ATP during photosynthesis.

Characters of Food Chain

- A food chain is generally straight. The number of trophic levels is 3-6.
- There is progressive reduction in available biomass, energy and number of individuals with the rise in trophic level.

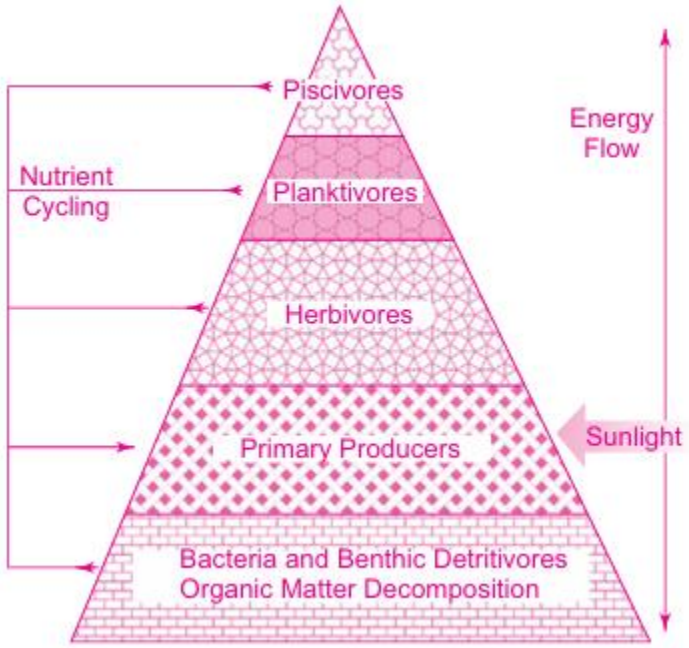
- A food chain consists of series of populations which are related by eating and being eaten.
- A major part of energy made available at each trophic level is lost as heat. In each trophic level a lot of biomass is consumed in liberating energy.
- Food chains are sustained by producers and decomposers. Some organisms like humans operate at more than one trophic level.



Food Web

ECOLOGICAL PYRAMIDS (ELTONIAN PYRAMIDS)

- An ecological pyramid is a graphic representation of an ecological parameter, like biomass, energy or number of individuals present in various trophic levels of a food chain with producers forming the base and top carnivores the tip. Each trophic level represents a functional level. Therefore, it includes all the members of all the species operating at that level.



The Ecological Pyramid in a lake

Types of Pyramids

Based on the shape of pyramid

- Inverted: Narrow base, gradually becoming broader towards the tip.
- Spindle shaped: Narrow both at base and tip, with broader part in the middle.
- Upright: With larger base and gradually tapering towards tip

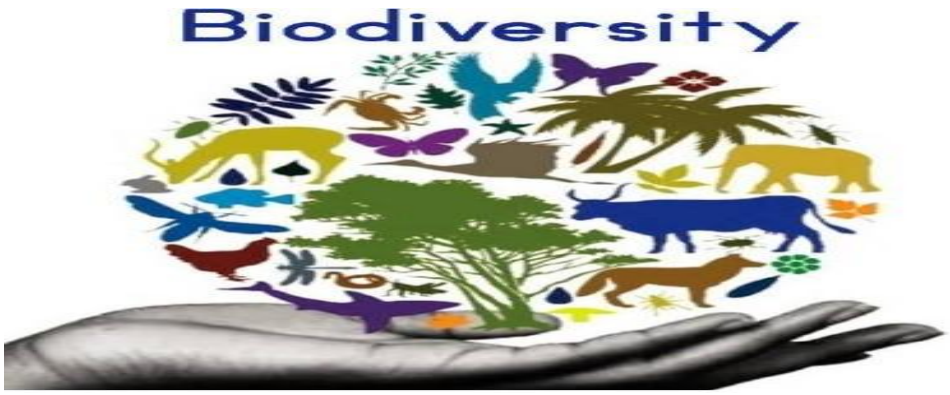
Based on ecological parameters

- Pyramid of Numbers: Shows number of individual organisms at each level.
- Pyramid of Biomass: Shows the total dry weight and other suitable measure of total amount of living matter.
- Pyramid of Energy: Shows rate of energy flow and productivity at successive trophic level.

BIODIVERSITY

The word biodiversity refers to the variety of living organisms (flora and fauna). Biodiversity or Biological diversity is defined as the variability among all living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part. Wilson, 1988 defined ‘Biological diversity’ or ‘biodiversity’ as that part of nature which includes the differences in genes among the individuals of a

species, the variety and richness of all the plant and animal species at different scales in space i.e. local, regional, country wise and global, and various types of ecosystems- both terrestrial and aquatic-within a defined area.



Types of Biodiversity:

Biological diversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels i.e., genetic, species and ecosystem.

Genetic diversity: Genetic diversity refers to the variation at the level of individual genes. Tremendous amount of genetic diversity exists within individual species. This genetic variability is responsible for the different characters in species. Genetic diversity is the raw material from which new species arise through evolution. Today, the genetic diversity is made use to breed new crop varieties, disease resistant crops.

Species diversity: The number of species of plants and animals that are present in a region constitutes its species diversity. This diversity is seen both in natural ecosystem and in agricultural ecosystem. Some areas are richer in species than others. For example, natural undisturbed tropical forests have much greater species richness than monoculture plantations developed by the forest department for timber products. A natural forest ecosystem provides large number of non-timber forest products that local people depend on such as fruits, fuel, wood, fodder, fiber, gum, resin and medicines. Timber plantations do not provide the large variety of goods that are essential for local consumption. Modern intensive agro ecosystem have a relatively lower density of crops than traditional agro pastoral farming systems, where multiple crops were planted.

Areas that are rich in species diversity are called 'hotspots' of diversity and the countries with highest species richness or have a relatively large proportion of these hot spots of

diversity are referred to as ‘megadiversity nations. India is among the world’s 15 nations that are exceptionally rich in species diversity. The earth’s biodiversity is distributed in specific ecological regions. There are over a thousand major eco-regions in the world. Of these, 200 are said to be the richest, rarest and most distinctive natural areas. These areas are referred to as the Global 200. It has been estimated that 50,000 endemic plants which comprise 20% of global plant life, probably occur in only 25 ‘hot spots’ in the world. These hotspots harbor many rare and endangered species. Two criteria help in defining hotspots namely rich endemism and the degree of threat. To qualify as hotspots an area must contain at least 0.5 per cent or 1500 of the world’s 3, 00,000 plants species as endemics (Myers et al., 2000).

Ecosystem diversity: There are a large variety of different ecosystem on earth, each having their own complement of distinctive inter linked species based on differences in the habitat. Ecosystem diversity can be described for a specific geographical region or a political entity such as a country, a state or a taluk. Distinctive ecosystems include landscapes like forests, grasslands, deserts, mountains etc as well as aquatic ecosystems like rivers, lakes and seas. Each region also has man-modified areas such as farmland or grazing pastures. It refers to the variation in the structure and functions of the ecosystem. It describes the number of niches, trophic levels and various ecological processes that sustain energy flow, flood webs and the recycling of nutrients. It has focus on various biotic interactions and the role and functions of keystone species (species determining the ability of large number of other species to persist in the community).

MODULE 2

Environmental Pollution

Air and Water pollution: Causes—effects and control measures—Municipal Solid Waste and its Management —Biomedical waste—E-waste—construction and demolition waste. Noise pollution: Sources of noise—Effects and control methods.

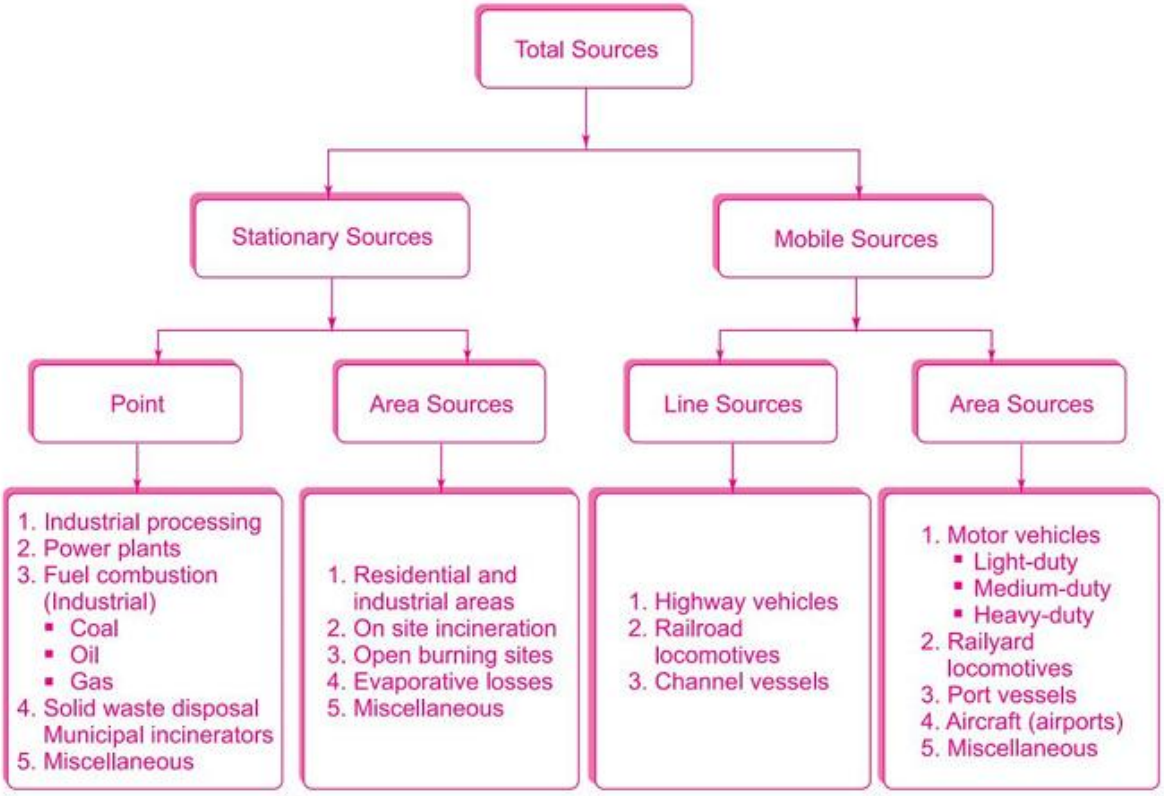
ENVIRONMENTAL POLLUTION

AIR POLLUTION

Air pollution is the presence in the air of substances generally originating from the activities of humans in sufficient concentrations and sufficient duration to interfere with the health, comfort, safety or full use and enjoyment of property.

Sources of Air Pollution

The sources of air pollution can be broadly classified into natural and anthropogenic. The natural sources include volcano, forest fire and pollens. The anthropogenic sources include everything involving human activities. The other major classifications are shown in the below figure.



Classification of Air Pollution sources

The sources, effects and characteristics of some of the major air pollutants are

Carbon Monoxide (CO)	Ozone (O_3)	Nitrogen Dioxide (NO_2)	Sulphur Dioxide (SO_2)	Suspended Particulate Matter (SPM)	Lead (Pb)
The result of incomplete combustion of fuels from industries or automobiles	Produced in the atmosphere when gases or vapours of organic chemicals, called hydrocarbon, combine with nitrogen oxide compounds in the presence of sunlight	NO_2 and NO_x are produced when fossil fuels are burned, especially in power plants and motor vehicles	Produced when sulphur containing fuel is burned, primarily in power plants and diesel engines	Originate from the burning of fuels by industry and diesel vehicles, and from earth-moving activities like construction and mining	Most common sources are indoors: old lead-containing paint and soil; other air pollution sources include lead smelters, incineration of lead batteries and burning lead-contaminated waste oil
If the combustion is complete, then CO_2 is released, which is not an air pollutant	Major sources of organic hydrocarbon gases are refineries, motor vehicles, chemical plants, paints and solvents	Oxides of nitrogen compounds contribute to ozone formation; NO forms acidic particles and liquid nitric acid in the atmosphere; acid rain hurts plants and animals; high levels of NO_2 can cause respiratory problems	Can form acidic particles and sulphuric acid in the atmosphere	Particulate Matter with diameter less than 2.5 microns is denoted as $PM_{2.5}$ and its permissible limit is 60 µgm/m^3. Can cause wheezing and other symptoms in people with asthma or sensitive airways	Exposure to high levels of lead can cause damage to blood, brain, nerves, kidneys, reproductive organs and the immune system
CO interferes with the blood's ability to carry oxygen to the brain, heart and other tissues	Ozone can harm the functioning of lungs	Causes breathing problems			
	An important point to note is that ozone is harmful in the lower atmosphere. Ozone in the upper atmosphere protects us from the UV radiation				

Effect of Air Pollution on Animals, Plants and Property

Animals	▪ Similar to that of human beings ▪ Accumulation of airborne contaminants on the vegetation; when animals consume this, they get poisoned ▪ Reduction in yield from cattle ▪ Symptoms include lack of appetite, rapid weight loss, lameness, diarrhoea and subsequently death
Plants	▪ Mainly, the leaves get affected ▪ Symptoms: • Necrosis – Killing or collapse of tissue • Chlorosis – Reduction in the chlorophyll • Abcission – Dropping of leaves • Epinasty – Downward curvature of leaves due to higher rate of growth on the upper surface
Building Materials and Metals	▪ Leads to erosion and corrosion ▪ Corrosion of building materials due to acid rain and ozone. e.g., the Taj Mahal ▪ Subsequently, leads to economic loss

Air Pollution Control Technologies

The selection of air pollution control device is based on factors such as characteristics of the air pollutant and the desired removal efficiency. Below figure shows some of the popular air pollution control devices and their salient features.

Cyclone Separator	Bag Filter	Electrostatic Precipitator (ESP)	Absorption and Wet Scrubbing Equipment	Catalytic Converter
▪ Employed to collect large size particulate matter from a gaseous stream through the use of centrifugal forces ▪ Dust-laden gas is made to rotate in a decreasing diameter pathway, forcing solids to the outer edge of the gas stream for deposition into the bottom of the cyclone	▪ Separates and collects coarse particulates generated in the machining and treatment process of bulk material, and exhausts clean air ▪ Of use in the food, chemical and other such industries where bulk material is dealt with	▪ Removes fine particles contained in an exhaust gas by electrostatical principle ▪ Removes fine particles contained in an exhaust gas by electrostatical principle ▪ Used for the removal of finest dust particles that cannot be removed by other equipment ▪ Used for the removal of finest dust particles that cannot be removed by other equipment	▪ Removes gases and particulate matter from an exhaust stream by dissolving gaseous contaminants in the liquid stream and by entrapping solids in the liquid	▪ Converts CO to CO_2, hydrocarbons to water and oxides of nitrogen are converted to nitrogen

Air Pollution Control Devices

WATER POLLUTION

Water around the world is getting polluted due to human activities and the availability of potable water in nature is becoming rare day by day.

Sources of Water Pollution

The following are the present major sources of surface and ground water pollution in India.

- Industrial effluents
- Domestic sewage
- Fertilizers and pesticides from agricultural lands
- Leachate from solid waste disposal sites

Point and Non-point Sources.

Point sources discharge pollutants at specific locations through pipes, ditches, or sewers into bodies of surface water. Examples include factories, sewage treatment plants (which remove some but not all pollutants), active and abandoned underground coal mines, offshore oil wells, and oil tankers.

Non-point sources are big land areas that discharge pollutants into surface and underground water over a large area, and parts of the atmosphere where pollutants are deposited on surface waters. Examples include runoff into surface water and seepage into the ground from croplands, livestock feedlots, logged forests, urban and suburban lands, septic tanks, construction areas, parking lots, roadways, and acid deposition.

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 rainwater 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 radioactive isotopes: Enter the water courses along with rainwater.
- 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.

Effects of Water pollution

1. Large amount of human waste in water increases the number of bacteria such as Escherichia coli and streptococcus sps which cause gastrointestinal diseases. Water bore diseases diarrhea, typhoid etc.
2. If more organic matter is added to water the O_2 is used up. This causes fish and other forms of O_2 dependent aquatic life dies.
3. Eutrophication due to inorganic pollutants.
4. Excess pesticides cause Biomagnifications.
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 causes thermal pollution not only to decrease the solubility of O_2 but also changes the breeding cycles of various aquatic organisms.

9. Hot water because of thermal pollution not only decreases the solubility of O_2 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, NO_3 contamination causes blue baby disease (Methaemoglobinaceae) and PO_4 contamination causes bone marrow disease.
13. Arsenic poisoning 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 wastewater 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 O_2 rich conditions where bacteria and fungi oxidize the wastes.
- Providing sanitation and wastewater treatment facility.
- Integrated nutrient management (INM) and integrated pest management (IPM) practices will reduce the effects caused due to excess pesticides.

SOLID WASTE MANAGEMENT

The combined effects of population explosion and changing modern living standards have had a cumulative effect in the generation of a large amount of various types of wastes. Solid waste can be classified into different types depending on their source.

- Municipal solid waste (MSW)
- Industrial waste
- Hazardous waste
- Biomedical or hospital waste: as infectious waste.
- Agricultural waste

Municipal Solid Waste (MSW)

The term municipal solid waste (MSW) is generally used to describe most of the non-hazardous solid waste from a city, town or village that requires routine collection and transport to a processing or disposal site. Sources of MSW include private homes, commercial establishments and institutions, as well as industrial facilities. However, MSW does not include wastes from industrial processes, construction and demolition debris, sewage sludge, mining waste or agricultural wastes. MSW is also called as trash or garbage. In general, domestic waste and MSW are used as synonyms. Municipal solid waste contains a wide variety of materials. It can contain food waste (like vegetable and meat material, leftover food, eggshells etc.), which is classified as wet garbage as well as paper, plastic, tetra pack, plastic cans, newspaper, glass bottles, carboard boxes, aluminum foil, metal items, wood pieces, etc., which is classified as dry garbage.

India's urban population slated to increase from the current 330 million to about 600 million by 2030, the challenge of managing municipal solid waste (MSW) in an environmentally and economically sustainable manner is bound to assume gigantic proportions. The country has over 5,000 cities and towns, which generate about 40 million tonnes of MSW per year today. Going by estimates of The Energy Research Institute (TERI), this could well touch 260 million tonnes per year by 2047.

The Functional Elements of MSW Management

The municipal solid waste industry has four components: recycling, composting, landfilling, and waste-to-energy via incineration.

The primary steps are generation, collection, sorting and separation, transfer and disposal/utilisation. Waste generation encompasses activities in which materials are identified as no longer being of value and are either thrown out or gathered together for

disposal. The functional element of Collection includes not only the gathering of solid waste and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a material processing facility, a transfer station or a landfill disposal site. Waste handling and separation involves activities associated with waste management until the waste is placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. Separating different types of waste components is an important step in the handling and storage of solid waste at the source. The types of means and facilities that are now used for the recovery of waste materials that have been separated at the source include curbside collection, drop off and buy back centers. Transfer and transport involves two main steps. First, the waste is transferred from a smaller collection vehicle to larger transport equipment. The waste is then transported, usually over long distances, to a processing or disposal site. Today the disposal of wastes by land filling or land spreading is the ultimate fate of all solid wastes, whether they are residential wastes collected and transported directly to a landfill site, residual materials from materials recovery facilities (MRFs), residue from the combustion of solid waste, compost or other substances from various solid waste processing facilities. A modern sanitary landfill is not a dump; it is an engineered facility used for disposing of solid wastes on land without creating nuisances or hazards to public health or safety, such as the breeding of insects and the contamination of ground water. Municipal solid waste can be used to generate energy. Several technologies have been developed that make the processing of MSW for energy generation cleaner and more economical than ever before, including landfill gas capture, combustion, pyrolysis, gasification, and plasma arc gasification. While older waste incineration plants emitted high levels of pollutants, recent regulatory changes and new technologies have significantly reduced this concern. In USA, EPA regulations in 1995 and 2000 under the Clean Air Act have succeeded in reducing emissions of dioxins from waste-to-energy facilities by more than 99 percent below 1990 levels, while mercury emissions have been by over 90 percent The EPA noted these improvements in 2003, citing waste-to-energy as a power source “with less environmental impact than almost any other source of electricity”.

Municipal solid waste management is more of an administrative and institutional mechanism failure problem rather than a technological one. Until now, MSW management has been considered to be almost the sole responsibility of urban governments, without the

participation of citizens and other stakeholders. The Centre and the Supreme Court, however, have urged that this issue be addressed with multiple stakeholder participation. Cities in India spend approximately 20% of the city budget on solid waste services.

BIOMEDICAL WASTES

Disposal of bio-hazardous materials finds a special place in case of waste management because a considerable amount of waste comes out of hospitals and nursing homes. Proper care is essential to dispose of the bio-hazardous materials because, if not properly disposed of, they can be a major source of air, water and land pollution which is quite harmful to a large number of people.

The Ministry of Environment and Forests has drafted certain rules regarding the classification of bio-medical wastes, as per schedule. 1. According to schedule 1, there are 9 categories of bio-medical wastes.

Bio-Medical Wastes

Categories of Wastes

1. Description Human Anatomical Wastes: Human tissues, organs, body parts etc.
2. Animal Wastes: Animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animals in research, waste generated by veterinary Hospitals, Colleges, discharge from hospitals, animal house.
3. Microbiology and Bio-technology Wastes: Wastes from laboratory culture, stocks or specimen of micro-organisms, live or attenuated vaccines, human animal cell culture used in research and industrial laboratories, waste from production of biological toxin, dishes and devices used for transfer of cultures.
4. Waste Sharps: Needles, syringes, scalpels, blades, glass etc. those are capable of causing puncture and cuts. These include both used and unused sharps. Discarded

medicines and cytotetic drugs; wastes comprising outdated, contaminated and discarded medicines.

5. Soiled Waste: Items contaminated with blood and body fluids, including cotton, dressings, solid plaster cuts, linen, beddings, and other materials.
6. Solid Wastes: Wastes generated from disposable items such as, tubings, catheters, intravenous sets etc.
7. Liquid Waste: Wastes generated from laboratory and washing cleaning, housekeeping and disinfecting activities.
8. Incineration Ash: Ash from incineration of any biomedical wastes.
9. Chemical Waste: Chemicals used in production of biological products, chemicals used in disinfection as insecticides etc.

ELECTRONIC WASTE

Electronic waste, various forms of electric and electronic equipment that have ceased to be of value to their users or no longer satisfy their original purpose. Electronic waste (e-waste) products have exhausted their utility value through redundancy, replacement, or breakage and include both “white goods” such as refrigerators, washing machines, and microwaves and “brown goods” such as televisions, radios, computers, and cell phones. Given that the information and technology revolution has exponentially increased the use of new electronic equipment, it has also produced growing volumes of obsolete products; e-waste is one of the fastest-growing waste streams. Although e-waste contains complex combinations of highly toxic substances that pose a danger to health and the environment, many of the products also contain recoverable precious materials, making it a different kind of waste compared with traditional municipal waste.

Globally, e-waste constitutes more than 5 percent of all municipal solid waste and is increasing with the rise of sales of electronic products in developing countries. The majority of the world's e-waste is recycled in developing countries, where informal and hazardous setups for the extraction and sale of metals are common. Recycling companies in developed countries face strict environmental regulatory regimes and an increasing cost of waste disposal and thus may find exportation to small traders in developing countries more profitable than recycling in their own countries. There is also significant illegal transboundary movement of e-waste in the form of donations and charity from rich industrialized nations to developing countries. E-waste profiteers can harvest substantial profits owing to lax environmental laws, corrupt officials, and poorly paid workers, and there is an urgent need to develop policies and strategies to dispose of and recycle e-waste safely in order to achieve a sustainable future.

Environmental impacts

Although electronics constitute an indispensable part of everyday life, their hazardous effects on the environment cannot be overlooked or underestimated. The interface between electrical and electronic equipment and the environment takes place during the manufacturing, reprocessing, and disposal of these products. The emission of fumes, gases, and particulate matter into the air, the discharge of liquid waste into water and drainage systems, and the disposal of hazardous wastes contribute to environmental degradation. In addition to tighter regulation of e-waste recycling and disposal, there is a need for policies that extend the responsibility of all stakeholders, particularly the producers, beyond the point of sale and up to the end of product life.

There are a number of specific ways in which e-waste recycling can be damaging to the environment. Burning to recover metal from wires and cables leads to emissions of brominated and chlorinated dioxins, causing air pollution. During the recycling process in the informal sector, toxic chemicals that have no economic value are simply dumped. The toxic industrial effluent is poured into underground aquifers and seriously affects the local groundwater quality, thereby making the water unfit for human consumption or for agricultural purposes. Atmospheric pollution is caused by dismantling activities as dust particles loaded with heavy metals and flame retardants enter the atmosphere. These particles either redeposit (wet or dry deposition) near the emission source or, depending on their size, can be transported over long distances. The dust can also enter the soil or water

systems and, with compounds found in wet and dry depositions, can leach into the ground and cause both soil and water pollution. Soils become toxic when substances such as lead, mercury, cadmium, arsenic, and polychlorinated biphenyls (PCBs) are deposited in landfills.

Classification

E-waste can be classified on the basis of its composition and components. Ferrous and nonferrous metals, glass, plastics, pollutants, and other are the six categories of materials reported for e-waste composition. Iron and steel constitute the major fraction in waste electrical and electronic equipment (WEEE) materials, with plastics being the second largest. Nonferrous materials, including metals such as copper and aluminum, and precious metals such as silver, gold, and platinum are third in abundance and have significant commercial value. Toxic materials include lead and cadmium in circuit boards, lead oxide and cadmium in cathode ray tubes, mercury in switches and flat-screen monitors, brominated flame retardants on printed circuit boards, and plastic and insulated cables; when these exceed the threshold quantities, they are regarded as pollutants and can damage the environment if disposed of improperly.

CONSTRUCTION AND DEMOLITION WASTE

Construction waste or debris is any kind of debris from the construction process. Different government agencies have clear definitions. For example, the United States Environmental Protection Agency EPA defines construction and demolition materials as “debris generated during the construction, renovation and demolition of buildings, roads, and bridges.” Additionally, the EPA has categorized Construction and Demolition (C&D) waste into three categories: non-dangerous, hazardous, and semi-hazardous.

Of total construction and demolition (C&D) waste in the United States, 90% comes from the demolition of structures, while waste generated during construction accounts for less than 10%. Construction waste frequently includes materials that are hazardous if disposed of in landfills. Such items include fluorescent lights, batteries, and other electrical equipment.

When waste is created, options of disposal include exportation to a landfill, incineration, direct site reuse through integration into construction or as fill dirt, and recycling for a new use if applicable. In dealing with construction and demolition waste products, it is often hard to recycle and repurpose because of the cost of processing. Businesses recycling materials must compete with often the low cost of landfills and new construction commodities. Data

provided by 24 states reported that solid waste from construction and demolition (C&D) accounts for 23% of total waste in the U.S. This is almost a quarter of the total solid waste produced by the United States. During construction a lot of this waste spends in a landfill leaching toxic chemicals into the surrounding environment. Results of a recent questionnaire demonstrate that although 95.71% of construction projects indicate that construction waste is problematic, only 57.14% of those companies collect any relevant data.

Main causes of waste

Construction waste can be categorized as follows: Design, Handling, Worker, Management, Site condition, Procurement and External. These categories were derived from data collected from past research concerning the frequency of different types of waste noted during each type of these activities. Examples of this type of waste are as follows:

Steel reinforcement

Steel is used as reinforcement and structural integrity in the vast majority of construction projects. The main reasons steel is wasted on a site is due to irresponsible beam cutting and fabrication issues. The worst sites usually end up being the ones that do not have adequate design details and standards, which can result in waste due to short ends of bars being discarded due to improper planning of cuts. Many companies now choose to purchase preassembled steel reinforcement pieces. This reduces waste by outsourcing the bar cutting to companies that prioritize responsible material use.

Premixed concrete

Premixed concrete has one of the lowest waste indices when compared to other building materials. Many site managers site the difficulties controlling concrete delivery amounts as a major issue in accurately quantifying concrete needed for a site.

Pipes and wires

It is often difficult to plan and keep track of all the pipes and wires on a site as they are used in so many different areas of a project, especially when electrical and plumbing services are routinely subcontracted. Many issues of waste arise in this area of the construction process because of poorly designed details and irresponsible cutting of pipes and wires leaving short, wasted pipes and wires.

Improper material storage

The second leading cause of construction waste production is improper material storage. Exposure to the elements and miss handling by persons are due to human error. Part of this human error can lead to illegal dumping and illegal transportation volume of waste from a jobsite.

Recycling and reuse of material

Most guidelines on C&D waste management follow the waste managing hierarchy framework. This framework involves a set of alternatives for dealing with waste arranged in descending order of preference. The waste hierarchy is a nationally and internationally accepted concept used to priorities and guide efforts to manage waste. Under the idea of Waste Hierarchy, there is the concept of the "3R's," often known as "reduce, reuse, recycle." Certain countries adopt different numbers of "R's." The European Union, for example, puts principal to the "4R" system which includes "Recovery" in order to reduce waste of materials. Alternatives include prevention, energy recovery, (treatment) and disposal.

It is possible to recycle many elements of construction waste. Often roll-off containers are used to transport the waste. Rubble can be crushed and reused in construction projects. Waste wood can also be recovered and recycled.

NOISE POLLUTION

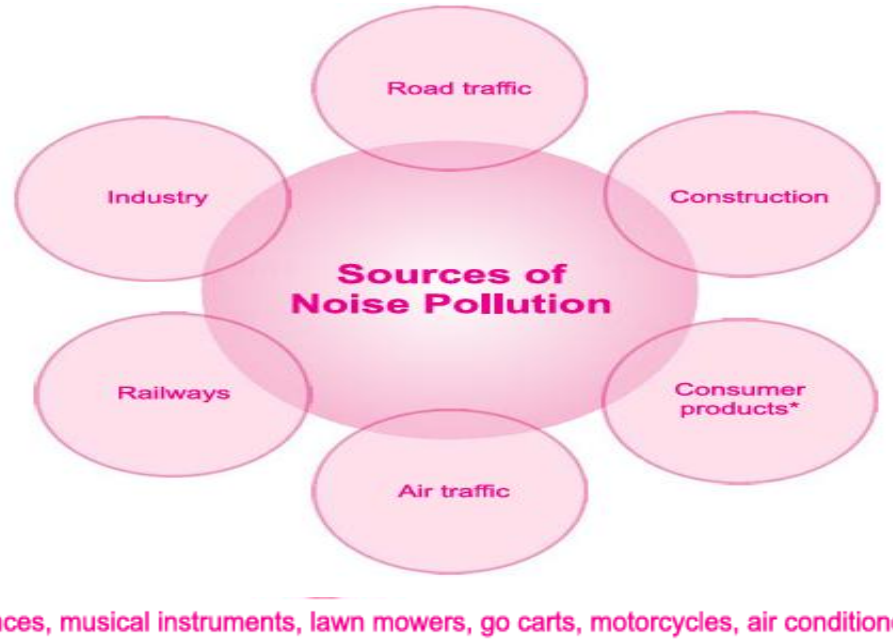
Noise is an unwanted sound. Noise pollution can be defined as unwanted or offensive sounds that unreasonably intrude into our daily activities. In our country urbanization and industrialization have become twin problems. Cities and towns have sprouted up where industries are concentrated. Lack of town' planning had led to residential, commercial, and industrial areas being mixed up. Houses, schools, and hospitals are situated near industries. All the boons of industrialization and civilization such as motors, horns, heavy and light machinery, work and movement, blaring radios, supersonic aeroplanes have

become disturbing and irritant. Subjected to 45 decibels of noise, the average person cannot sleep.

Effects of Noise

1. Constant noise affects a man physically and mentally. Physical effects include blood vessels to contract, skin to become pale, muscles to constrict and rise in blood pressure leading to tension and nervousness.
2. High intensity sound emitted by industrial plants, bottling machines, supersonic aircrafts, when continued for long periods of time not only disturbs but also permanently damages hearing.
3. Offices, industries, and crowded places where constant noise prevails can produce temper tantrums, headaches, fatigue, and nausea.
4. Loud and sudden noise affects the brain. Intermittent noise leads higher incidence of psychiatric illness and a danger to health of pregnant mothers and small infants.
5. Noise has harmful effects on nonliving materials too, e.g. cracks develop under the stress of explosive sound.
6. At 120 decibels the ear registers pain, but hearing damage begins at a much lower level, about 85 decibels. The duration of the exposure is also important. Apart from hearing loss, noise can cause lack of sleep, irritability, heartburn, indigestion, ulcers, high blood pressure, and possibly heart disease.

Sources of Noise



Sources of Noise Pollution

Noise Pollution Control

- The Source Path Receiver Concept Noise pollution can be controlled by either reducing the noise at the source or by preventing its transmission or by protecting the receiver.
- Limited use of loudspeakers and amplifiers.
- Excursing control over noise producing vehicles.
- Industrial workers should be provided with ear plugs.
- Delocalization of noisy industries far away from dwelling units.
- Within a radius of 10 miles of airport, no buildings or factories should be allowed.
- Plants and trees should be planted all around the hospitals, libraries and schools and colleges.
- Personal protection against noise can be taken by using, cotton plugs in the ear.

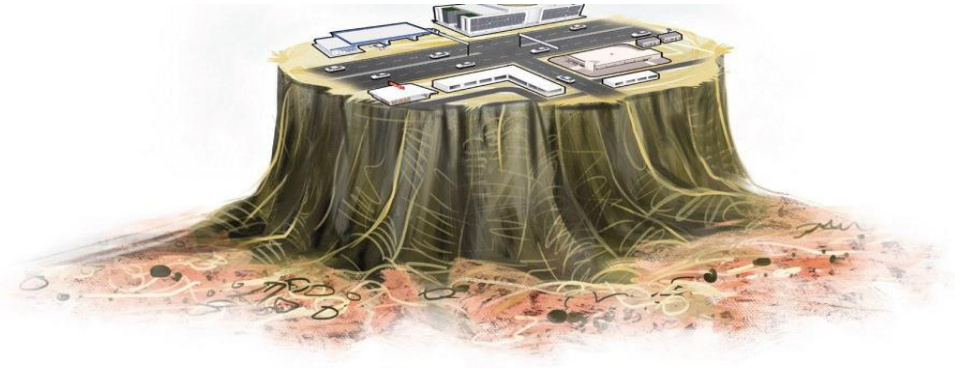
MODULE 3

GLOBAL CHALLENGES

Deforestation—Global Warming: Greenhouse gases from Fossil Fuels— Plastic and textile Pollution—Acid Rain—forest fire—floods and droughts—earthquake and volcanoes—Melting Ice Caps and Sea Level Rise—Ocean Acidification—Food and Water Insecurity —Mining—soil degradation.

DEFORESTATION

A human-caused or natural cause which lead to the cutting down of trees and reduced forest areas is called deforestation. Generally, it is the human activities of urbanization, construction etc., which have been the major cause of deforestation across the world.



Causes of Deforestation

Given below are the major causes of deforestation:

- Commercial or Industrial Agriculture
- Construction of new buildings, roads, and other infrastructural facilities
- Increased Population
- Mining is another important factor for the increased cutting down of trees and forest areas.
- The change in climate is one of the main natural causes which has resulted in loss of forests.
- Natural calamities
- Unsustainable forest management

Effects of Deforestation

Deforestation has impacted the environment and livelihood of many. Discussed below are a few of the main effects of deforestation:

- Loss of habitat for various animal and plant species
- Environmental Disbalance is another side effect of deforestation. Due to the absence of an ample number of trees and forest areas across the globe, the environment and the atmosphere is facing severe climatic changes.

- A lot of people rely on forests for their livelihood. These people are adversely affected due to deforestation.
- It degrades the quality of soil.
- The water cycle gets disturbed.

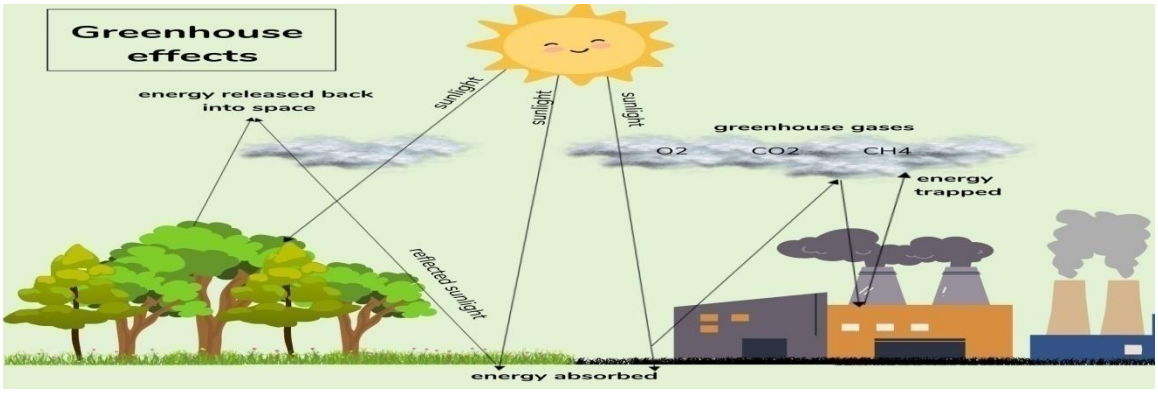
Measures to Curb Deforestation

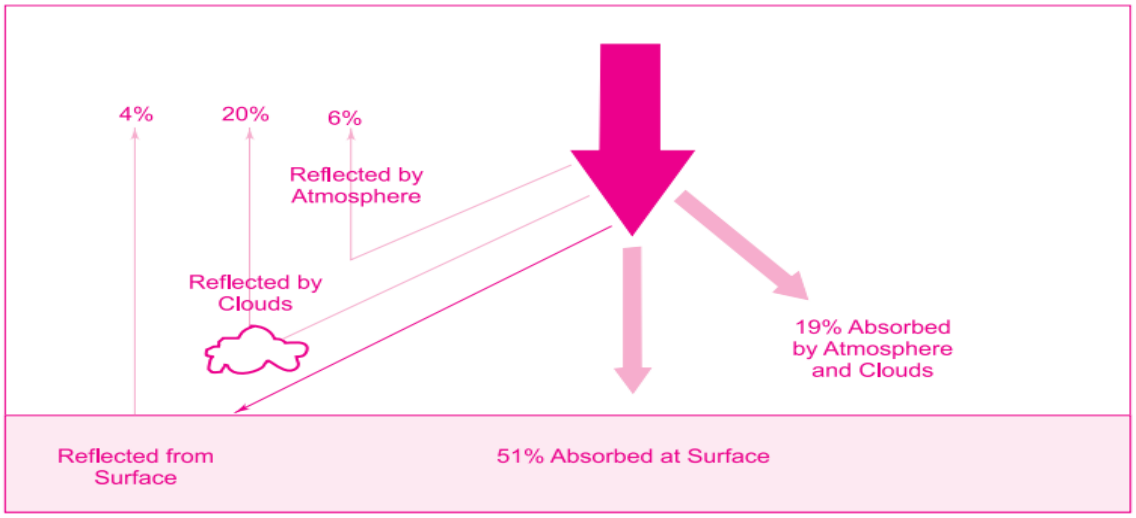
There are certain measures which can be adapted by people in their day to day lives to reduce this loss of trees and forests. Given below are the same:

- Plant a tree whenever and wherever possible.
- Rely on the concept of reducing, reusing, and recycling.
- Try reducing the use of paper since it is obtained through a tree.
- Spread awareness about the importance of afforestation.
- Promote products which ensure reduced or no deforestation.

GLOBAL WARMING AND GREENHOUSE EFFECT

The greenhouse effect is a naturally occurring process that aids the heating of the Earth's surface and atmosphere. It results from the fact that certain atmospheric gases, such as carbon dioxide, water vapour, and methane, are capable of changing the energy balance of the planet by being able to absorb long wave radiation from the earth's surface. The term "greenhouse" is used to describe this phenomenon since these gases act like the glass of a greenhouse to trap heat and maintain higher interior temperatures than would normally occur. Without the greenhouse effect, it is not possible to sustain life on this planet as the average temperature of the Earth would be –18°C rather than the present 15°C.

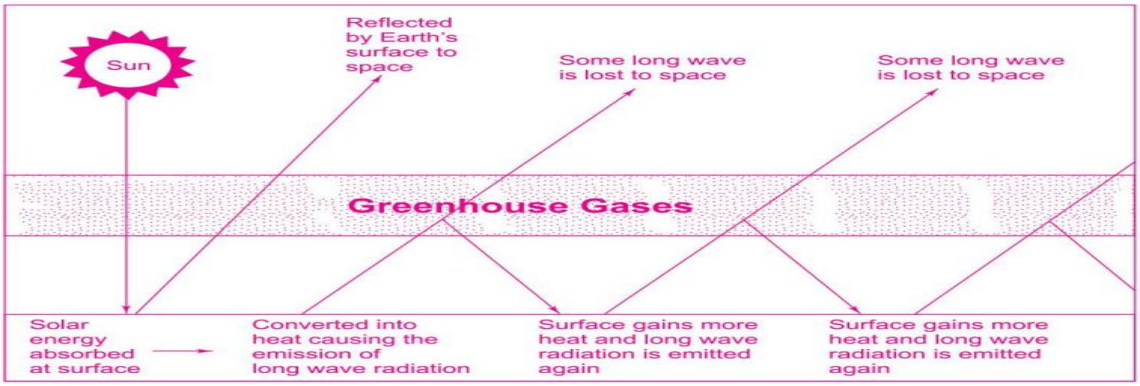




Earth on Radiation Solar of Pattern Absorption and Reflection

On an average, about 51% of the sun's radiation reaches the surface. The amount of heat energy added to the atmosphere by the greenhouse effect is controlled by the concentration of greenhouse gases in the Earth's atmosphere. All of the major greenhouse gases have increased in concentration since the beginning of the industrial revolution. As a result of these higher concentrations, scientists predict that the greenhouse effect will be enhanced and the Earth's climate will become warmer and this is referred to as global warming.

A number of gases are involved in the greenhouse effect. These gases include: carbon dioxide (CO2); methane (CH4); nitrous oxide (N2 O); chlorofluorocarbons (CFx Clx); and tropospheric ozone (O3). Of these gases, the single most important gas is carbon dioxide which accounts for about 55% of the change in the intensity of the earth's greenhouse effect.



Greenhouse Effect

Global warming is already having significant and visible harmful effects on our society, health, and climate. Sea level rise is accelerating, and the number of large wildfire incidents is growing around the world. Dangerous heat waves are becoming more common and extreme climate events such as cyclones and droughts are increasing in many countries. It is time we took immediate action to address global warming or else these consequences will continue to intensify, and increasingly affect the entire planet. The good news is that we have the practical solutions at hand to dramatically reduce our carbon emissions, slow the pace of global warming, and pass on a healthier, safer world to our future generations.

PLASTIC POLLUTION

Over 460 million metric tons of plastic are produced every year for use in a wide variety of applications. An estimated 20 million metric tons of plastic litter end up in the environment every year. That amount is expected to increase significantly by 2040. Plastic pollution affects all land, freshwater, and marine ecosystems. It is a major driver of biodiversity loss and ecosystem degradation and contributes to climate change. As plastic pollution is a transboundary issue, a global plastics treaty is needed to ambitiously reduce plastic production, phase out harmful subsidies, eliminate products and chemicals of concern, and adopt strong national plans and rigorous reporting and compliance mechanisms.

What is the issue?

Plastic is a synthetic, organic polymer made from fossil fuels, such as gas and petroleum. Over 460 million metric tons of plastic are produced every year, according to the United Nations Environment Programme. Plastic is used in almost all consumer and industrial activities, from construction and vehicles to electronics and agriculture.

Discarded improperly, plastic waste pollutes and harms the environment, becoming a widespread driver of biodiversity loss and ecosystem degradation. It threatens human health, affects food and water safety, burdens economic activities, and contributes to climate change.

Macro-plastics (pieces larger than 0.5 mm) made up 88% of global plastic leakage to the environment in 2019, around 20 million metric tons, polluting all ecosystems. Much of the world's plastic pollution is generated by single-use products such as bottles, caps, cigarettes, shopping bags, cups, and straws.

Pollution sources are mainly land-based, coming from urban and stormwater runoff, littering, industrial activities, tyre abrasion, construction, and agriculture. In the marine environment, plastic pollution originates primarily from land runoff, but includes paint shed from shipping, discarded fishing gear, and more.

Due to solar radiation, wind, currents and other natural factors, plastic breaks down into microplastic (smaller than 5 mm) and nanoplastic (smaller than 100 nm) particles. 'Primary' microplastic particles are also shed by products such as synthetic textiles and tyres, through abrasion. Nano plastics are able to cross cell membrane walls and enter living organisms.

Many nations lack the capacities and facilities to properly manage plastic products and waste, and the burden often falls on the local level. That impact is disproportionately felt by islands, developing countries, Indigenous peoples, local communities, women, and children. This problem is deepened by the global trade of plastic products and waste to locations where infrastructure is not sufficient for safe and environmentally sound management.

Impact of Plastic Pollution

Impacts On Human Health

Microplastics have been found in human blood and placentas and in food and drinks, including tap water, beer, and salt. Several chemicals used in the production of plastic materials are known to be carcinogenic and can cause developmental, reproductive, neurological, and immune disorders.

Impacts On Economies

The build-up of plastic litter can have a negative impact on aspects of a country's economy and trade systems, with income declines in sectors such as small- and medium-enterprises, the informal sector, tourism, fisheries, agriculture, and water safety. IUCN's research on these economic impacts demonstrates examples and possible solutions.

Impacts On Species and Ecosystems

All land, freshwater, and marine ecosystems are affected by plastic pollution. Natural ecosystems provide a broad range of services that are not only fundamental for conservation, but also key for economies and human well-being. For example, healthy mangroves provide coastal protection services, whereas wetlands are important for freshwater provision.

The most visible impacts of plastic debris are the ingestion, suffocation, and entanglement of species. Wildlife such as birds, whales, fish, and turtles mistake indigestible plastic waste for food and die of starvation as their stomachs become filled with it. It also causes internal and external injuries that reduce the ability to swim and fly. Domesticated farm animals are also affected by plastic pollution. Floating plastics transport invasive alien species, one of the leading causes of biodiversity loss and species extinction.

Plastic pollution can also seep carcinogenic chemicals (such as those contained in certain plastic products or fireproofing coatings) into the soil. These can run into groundwater or rivers, affecting exposed people and ecosystems.

Impacts On Climate

Climate impacts begin with oil and gas extraction, the refining of these products into plastics, and then plastic pollution itself. Incinerated plastic waste releases greenhouse gases and other pollutants into the atmosphere, including carbon dioxide, dioxins, and methane.

Control Majors to Reduce Plastic Pollution

The removal of legacy plastics and prevention of pollution requires that fewer plastic products be made, that the circularity of supply and value chains be increased, and that consumer behavior be changed. It also involves public and private investment and the development of infrastructure along the full lifecycle of plastics, including circular economy solutions like reuse, refill, etc.

Despite positive efforts from countries to tackle plastic pollution, such as bans on certain forms of single-use plastics, a global plastics treaty is essential because plastic pollution is transboundary and a main driver of biodiversity loss.

To best address the triple planetary crisis and ensure the proper implementation of the Global Biodiversity Framework (GBF); the Paris Agreement; the Sustainable Development Goals (SDGs); and initiatives under the broader chemicals, waste, and pollution agenda; a

future plastics treaty needs a common approach and requires collective action on a global scale.

Biodiversity has come to play a prominent role in international law, including in multilateral environmental agreements. A focus on the connections between plastic pollution, biodiversity loss, and the degradation of ecosystems at the global, regional, and national levels is important for effective action. The protection and restoration of biodiversity, and nature per se, must be incorporated in the legally binding control measures and enforcement terms of a future treaty.

TEXTILE POLLUTION

Textile is a general term used to refer to fibers, yarns, fabrics, or anything that is made from them through several processes such as weaving, knitting, and nonwoven. In the textile industry, there are normally several work sectors such as spinning, weaving, dyeing, finishing, apparel, and also research and development. Very often, the fabric manufacturing or processing sector impacts the environment, especially in wet processing such as dyeing and finishing.

One of the basic needs of humans is clothes. Hence, it makes the textile industry always in high demand. In 2019, the global textile market size was valued at USD 961.5 billion. It is estimated to exhibit a compound annual growth rate (CAGR) of 4.3% from 2020 to 2027 owing to the increasing demands for apparel, especially in developing countries such as China, India, Mexico, and Bangladesh (Market Analysis Report, 2022). Even though the demand for the products from the textile industry increases, the drawback it gives to the environment is massive as it is one of the main causes of pollution (Imtiazuddin and Tiki, 2018). There are three major types of pollution caused by the textile industry namely water, air, and soil pollution.

Many countries have been impacted by pollution from the textile industry. India is the most contaminated country affected by the textile industry where around 10-25% of textile dyes have been found in wastewater from the textile industry and 2-20% of dyes are directly discharged as aqueous effluents during the process.

Impacts of textile industry on the environment

The textile industry has been condemned as being one of the world's worst offenders in terms of pollution because it requires a great amount of two components:

Chemicals: as many as 2,000 different chemicals are used in the textile industry, from dyes to transfer agents

Water: a finite resource that is quickly becoming scarce and is used at every step of the process both to convey the chemicals used during that step and to wash them out before beginning the next step. The water becomes full of chemical additives and is then expelled as wastewater, which in turn pollutes the environment:

1. By the effluent's heat.
2. By its increased pH.
3. Because it's saturated with dyes, de-foamers, bleaches, detergents, optical brighteners, equalizers, and many other chemicals used during the process.

Traditionally produced fabrics contain residuals of chemicals used during their Manufacture - chemicals that evaporate into the air we breathe or are absorbed through our skin. Some of the chemicals are carcinogenic or may cause harm to children even before birth, while others may trigger allergic reactions in some people. Cotton is the second-most damaging agricultural crop in the world; 25 percent of all Pesticides used globally are put on cotton crops. Most cotton is irrigated, and the combination of chemical application (through pesticides and fertilizers) with irrigation is a direct conduit for toxic chemicals to circulate in groundwater worldwide. Dye bath effluents may contain heavy metals, ammonia, alkali salts, toxic solids, and large amounts of pigments - many of which are toxic. About 40 percent of globally used colorants contain organically bound chlorine, a known carcinogen. Natural dyes are rarely low impact, depending on the specific dye and mordant used. Mordants (the substance used to "fix" the color onto the fabric) such as chromium are very

toxic and high impact. The large quantities of natural dyestuffs required for dyeing, typically equal to or double that of the fiber's own weight, make natural dyes prepared from wild plants and lichens very high impact manufacturing.

There are a variety of production techniques used in the manufacture of fabrics including weaving, spinning, knitting, wet treatment and sewing. Aside from the energy and water used during manufacturing, there are also inevitable waste products produced, such as wastewater that may be contaminated with chemical products. Manufacturers who employ cleaner production or have environmental management certification should be given preference because this will reduce the impacts associated with manufacturing.

The manufacturing process of fabric or even garment has side effects on the environment. Take for example the garment industry which emits lot of heat and carbon which is equally responsible for carbon emissions into the environment and for the ozone depletion. Chemicals used in the industry are harmful and there the factory rules and regulations need to be stricter. The main Mantra to be followed is the three R's Reduce, Reuse and Recycle.

Inks & Dyes

Wet treatment is the process of de-sizing, pre-washing, mercerizing, bleaching, printing and dying that most fabrics go through. Many of these processes require chemicals and dyes and thus create potentially environmentally hazardous waste products, contribute to climate change and may release Volatile Organic Compounds (VOCs) into the atmosphere. Avoid inks and dyes that contain toxic heavy metals (for example, cadmium and beryllium) and, where possible, preference natural dyes made from plant materials. Also look for dye manufacturers who recycle their waste.

Economic, environmental, and political consequences of cotton manufacture.

The growth of cotton is divided into two segments i.e. organic and genetically modified. Cotton crop provides livelihood to millions of people, but its production is becoming expensive because of high water consumption, use of expensive pesticides, insecticides, and fertilizer. Genetically Modified products aim to increase disease resistance and reduce the water required. The organic sector was worth $583 million. Genetically Modified cotton, in 2007, occupied 43% of cotton growing areas. The consumption of energy in form of water and electricity is relatively high, especially in processes like washing, de-sizing, bleaching, rinsing, dyeing, printing, coating and finishing. Processing is time consuming. The major portion of water in textile industry is used for wet processing of textile (70 per cent).

Approximately 25 per cent of energy in the total textile production like fiber production, spinning, twisting, weaving, knitting, clothing manufacturing etc. is used in dyeing. About 34 per cent of energy is consumed in spinning, 23 per cent in weaving, 38 per cent in chemical wet processing and five per cent in miscellaneous processes. Power dominates consumption pattern in spinning and weaving, while thermal energy is the major factor for chemical wet processing.

Pollution Prevention and Control

Pollution prevention programs should focus on reduction in water use and on more efficient use of process chemicals. Process changes might include the following:

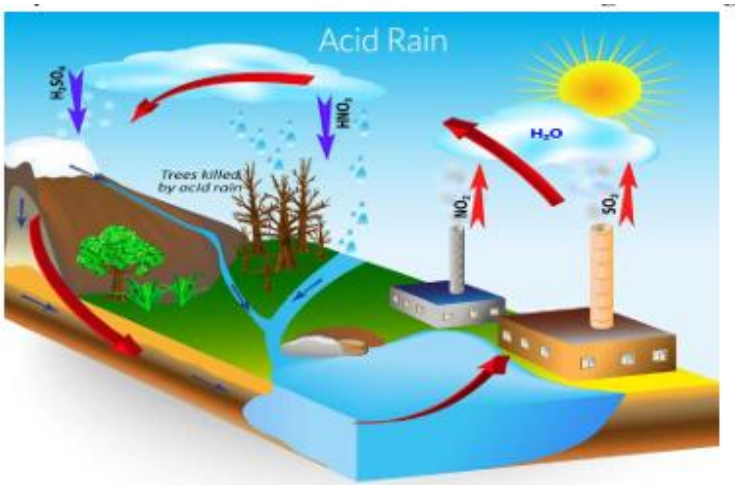
- Avoid the use of less-degradable surfactants (in washing and scouring operations) and spinning oils.
- Consider the use of transfer printing for synthetics. Use water-based printing pastes, where feasible.
- Consider the use of pad batch-dyeing.
- Use jet dyers instead of winch dyers where feasible.
- Avoid the use of benzidine-based azoic dyes and dyes containing cadmium and other heavy metals. Chlorine based dyes should not be used.
- Do not use mercury, arsenic, and banned pesticides in the process.
- Control the makeup of chemicals and match process variables to type and weight of fabric.

Acid Rain

Acid rain means the rainwater is turning chemically acidic i. e the rainwater with pH value lower than 5.7 is called acid rain. The problem begins with the production of sulfur dioxide and Nitrogen oxide. From the burning of fossil fuels such as coal, natural gas, and oil, and from certain kind of manufacturing.

The process that leads to acid rain begins with the burning of fossil fuels. Burning or combustion is a chemical reaction in which oxygen forms the air combines with carbon, nitrogen, sulfur, and other elements in the substance being burned. The new compound formed are gases called oxide. When sulfur and nitrogen are present in the fuel. There reaction with oxygen yield various sulfur dioxide and nitrogen dioxide compounds, all over the world the major contribution of these is from power plants, especially those that burn

coal. Later oil refineries and metal smelting are also the contributors. Nitrogen oxides enter the atmosphere from many sources with motor vehicles emitting the largest share.



Once in the atmosphere sulfur dioxide and nitrogen oxide undergoes complex reaction with water vapor and other chemicals to yield sulfuric acid, nitric acid and other pollutants called nitrate and sulphates. The acid compound is carried out by air current and wind, sometimes over long distance. When clouds or fog form in acid laden air they two are acidic, and so the rain or snow that falls from them.

Wet Acid Rain

Coal, fuel wood or petroleum products have Sulphur and nitrogen. These elements, when burnt in atmospheric oxygen, are converted into their respective oxides (SO_2 and NO_3), which are highly soluble in water. By anthropogenic and by natural sources, oxides of Sulphur and nitrogen enter the atmosphere.

Reactions

Reaction with Sulphur

$$S + O_2 \rightarrow SO_2$$

$$2SO_2 + O_2 \rightarrow 2SO_3$$

$$SO_3 + H_2O \rightarrow H_2SO_4$$

Besides formation of sulfuric acid, sulfurous acid is also formed.

$$SO_2 + H_2O \rightarrow H^+ + HSO_3^-$$

In case of Nitrogen Oxides released from vehicle and other sources Nitric acid is formed.

Reaction with Nitrogen

$$NO + O_3 \rightarrow NO_2 + O_2$$

$$NO_3 + NO_2 \rightarrow N_2O_5$$

When air is saturated with water droplets (humid conditions), N2O5 invariably reacts with water vapors to form droplets of HNO3.

$$N_2O_5 + H_2O \rightarrow 2HNO_3$$

Besides some HNO_2 is also formed

$$N_2O_3 + H_2O \rightarrow 2HNO_2$$

HNO_3 and H_2SO_4 thus formed combine with HCl to generate precipitation, which is commonly referred to as acid rain.

Effects of Acid rain – The primary reason for concern is that acid deposition acidifies streams, and taken on course, sandy soils low in lime: The effect is seen particularly in headwater areas and in wet montane environments, wherever sulphate loading from anthropogenic sources is strong. The chemical and physical consequences of lake acidification include increased leaching of calcium from terrestrial soils, mobilization of heavy metals such as aluminium, zinc, and manganese and an increase in the transparency of lake waters. The biological consequences include market changes in communities of aquatic plants and animals, with a progressive lessening of their diversity. Acid deposition may further impoverish forests soils, developed on sandy substrata poor in lime. As a consequence of accelerated leaching of nutrients, such as phosphorous, potassium, magnesium and calcium from these soils, forest productivity would eventually be reduced. Moreover, the acid sulphate particles that contribute to acid precipitation are in the size range that penetrates deep into the lung, and they may well exacerbate lung diseases and increase mortality rates, the acidic water kills fishes in pond. The bacteria and green algae are killed by acidifiedwater. Acid rain damages the leaves ultimately forests. Photosynthesis is reduced. Acid rain leaches the soil nutrients such as calcium, potassium, iron, magnesium etc. they are washed away from forest soil. The forest growth is affected. The activity of nitrogen fixing bacteria present is root nodule is inhibited and hence the fertility of soil is reduced. Acid rain corrodes monuments like Taj mahal, statues etc.

Forest Fire

There has been a constant rise in forest fires in 2021 in some of the world's coldest regions. This is an impact of climatic change and global warming.

According to a report from Down to Earth, wildfires have emitted around 1.76 billion tonnes of carbon dioxide in November 2021. Forest departments claim that many fire incidents are man-made, sometimes caused deliberately.

Forest fires are wildfires that spread uncontrollably, burning plants, animals, grasslands and brushlands that fall in their path. The wind spreads the fire rapidly, causing significant air pollution.

Generally, fires that continue for longer or are highly inflammable are caused by climatic changes. There are also instances of forest fires caused by humans, lightning and extreme drought.

Forest fires have become a global concern as many countries face significant life and property losses. Moreover, the carbon dioxide released into the air due to forest fires causes lung and skin infections in humans.

In India, forest fires generally occur during March and April when the ground is filled with dry logs, hay, weeds, woods and leaves. In some instances, the friction from rubbing branches leads to forest fires, when the temperature is high or extremely dry. Burning of forests for livelihood or excessive irrigation falls under forest fire causes. Reckless behavior like a carelessly discarded cigarette butt or matchstick can lead to big accidents. According to the Indian Express, the Similar Forest fire was caused by villagers burning dry leaves to collect mahua flowers.

Major Forest Fires in 2021

Wildfires in Siberia affected the western region around Tyumen and Omsk in early 2021. As per the Moscow Times, nearly 40 million acres of land have burned down in Siberia. The eastern part of the region, like the Sakha Republic in the northeast, suffered major damage.

North America saw extreme temperature and heat waves in July and August. Lytton city in Canada recorded a temperature of 49.6 degrees Celsius, causing a series of wildfires.

The Mediterranean region suffered major wildfires leading to an increase in PM levels up to 2.5. Turkey, Tunisia and Italy suffered the worst wildfires.

Instances in India

- The Himachal Pradesh and Nagaland-Manipur border saw prolonged fires in January.
- There was a major wildfire between February and March in the Simlipal National Park in Odisha.
- According to the Indian Express, Southern Chhattisgarh, Central Odisha, Western Maharashtra, and areas of Andhra Pradesh and Telangana are highly prone to forest fires.
- Bandhavgarh Forest Reserve in Madhya Pradesh and sanctuaries in Gujarat also witnessed forest fires.
- According to the Indian Express, Uttarakhand witnessed nearly 1,000 forest fires over the last six months, up to April 2021.

Effects of Forest Fire

- Forest fires can impact the economy as many families and communities depend on the forest for food, fodder and fuel.
- It burns down the small shrubs and grasses, leading to landslides and soil erosion.
- Burning of forests causes smoke and poisonous gas emissions that result in significant health issues in humans.
- Loss of trees can disrupt the climatic conditions and break down the carbon chain.
- Wildfires damage the habitat of animals, causing them to wander in cities. Many die in the fires, unable to escape.
- These fires destroy the vegetation, soil quality and overall flora and fauna.

Flood and Droughts

Water is an essential resource for survival of life, however excess of it can cause calamity and lack of it can cause disaster. Excess of water than required can cause flood and on the other hand water deficit can cause drought. Flood and drought are extreme negative situations caused due to water imbalances. These disasters though mainly natural have

substantial human intervention triggering the impact. Flood and drought have occurred in the past as well, but its frequency has increased in the recent years due to changing climatic pattern. Floods and Droughts have huge impact on earth and lives and deaths of living communities.

Flood Situation

Drought Condition

Natural disasters including floods and droughts can strike any part of the world but evidence show their impact is disastrous in developing countries than the developed one's, mainly due to the availability of their advanced warning system and proper disaster management system. For instance, as per report from ((Centre for Research on the Epidemiology of Disasters (CRED, 2004)), USA has faced maximum number of disaster events including typhoons and floods (506 reported events) between 1974-2003, with 4.5 million victims, whereas India experienced 303 disaster events during the same period, but the number of victims was much higher approx. 1932 million people.

FLOOD: happens when water quantity of any region exceed the normal requirement level damaging the physical, infrastructural, economic and social set up of the affected area. Heavy rainfall mainly causes flood in an area when the natural watercourse fails to

channelize the excess water. When the banks of the river fail to contain the heavy flow of water due to heavy rainfall, inundation occurs; even high storms during tsunamis or cyclones can cause inundation near coastal areas. Places without proper drainage system also get flooded during heavy rainfall.

DROUGHT: is also an extreme situation, which happens due to insufficiency of precipitation over a longer period causing damages to crops. Definition of drought varies in different countries and regions depending on the average precipitation level of the country such as countries or regions generally receiving lesser annual average rainfall don't consider 5 to 6 days without rainfall as drought however similar condition is called a drought situation in countries receiving higher rainfall throughout the year.

CAUSES OF FLOOD: Flood can cause due to any of the following or combination of the following reasons:

EXCESSIVE PRECIPITATION: Heavy precipitation or rainfall in an area than normal along with poor drainage system can cause flood like situation. Flood can occur in both cases of heavy rainfall for shorter duration and continuous light rainfall for many days.

RIVER RUNOFF: Excessive supply of water in the upstream due to heavy rainfall or otherwise can cause the downstream river water to run into the land or flood plain areas causing inundation.

STRONG COASTAL WIND OR CYCLONE OR TSUNAMI: Strong coastal winds have the capacity to carry water from the sea to the land causing inundation in the coastal areas.

Besides, Cyclones and strong winds can also bring heavy rainfall, causing flood on inland areas as well.

BREAKAGE OF DAMS OR EMBANKMENTS: Embankments or levees are built alongside the river to prevent overflowing of water or avoid flood like situation on the adjoining land. However, breakage or leakage on the embankment can lead to overflowing of river water on the flood plain also heavy water flow can break embankment and cause flood. Similarly, dams, which are built to capture water flowing down from upland can cause floods if broken due to excessive pressure of the stored water, even at times extra water from dams are knowingly released to avoid possible breakage or leakages, which can also cause flood like situation in the lower lands.

BREAKDOWN OF ICE DAM: Ice dams occurs when glaciers or ice blocks restrict flow of river water during freezing weather. This stored water behind ice sheets/ blocks or proglacial lakes when released due to ice melting is more powerful than normal river water flow and can cause inundation at the lower catchment areas. e.g The Flood in Russel Fjord in Alaska USA in 1986 caused due to breakage of Ice dam.

VOLCANIC ERUPTIONS: Volcanic eruptions have caused floods in country like Iceland where volcanic vent covered by thick layer of ice/ glacier got melted due to emission of hot lava. The melting glaciers turns into fast flowing water down the steep volcanoes causing inundation in the nearby areas.

TYPES OF FLOODS FLASH FLOODS: Flash Flood appears very fast and due to its sudden arrival; the term flash has been added to these types of floods. Flash floods cover smaller area but with high intensity, usually due to heavy rainfall or breakdown of Ice dams. Because of its higher speed and sudden appearance this flood causes more damages and is dangerous. Flash flood can even transport heavy rock, boulders, and other heavy items due it its high speed. Besides, its capacity to carry debris makes this flood more dangerous as can damage both life and property.

SLOW ON-SET FLOOD: This type of flood last long and spread over larger areas and occurs mainly due to overflowing of rivers or other water bodies. Since many coastal areas and flood plains repeatedly get inundated during rainy seasons, people for safety moves up to higher grounds during this period. The after effect of this flood is more dangerous as people die due to diseases and famine.

RAPID ON SET FLOOD: This type of flood occurs fast and last for a shorter period almost for a day or two. This flood is associated with heavy rainfall and as it appears fast the chances of damages to property and life are high as people get less time to prepare before the flood appears.

THE OTHER TYPES OF FLOODS ARE:

ICE DAMMED FLOOD: Ice Dam Flooding happens when flowing water, which were initially restricted by block of ice flow again due to melting of ice or spilling over of the piled-up water above the ice wall into the nearby plain areas. This flowing water is more powerful and dangerous than simple flowing river as this water carry big pieces of ice and thus with flooding of the plain area, this ice loaded water can damage property and life.

COASTAL FLOODS: This is a common type of flood in coastal areas. This flood is caused by high storms and waves in the oceans and mainly the area near the ocean edges gets inundated. Even Tsunamis, cyclones, hurricanes, and tornadoes with low pressure center, which pulls the water from the ocean towards the center of the storm carries the dome of water while moving towards the land and when reaches the coast this water loaded storm causes flooding and resultant damages. Even fast-moving waves or storms are destructive at times breaks past beaches and causes flooding at the coastline.

STORM SURGE FLOOD: This is more devastating than the coastal flood as the storm rises above normal high tides mainly due to strong winds and lower atmospheric pressure. Storm surges the causes huge damages to large areas near the coasts. These storm surges up to a height of 20 feet or more. Major hurricanes with huge storms have caused damages to property and life in the past including the recent past, where hurricane Katrina caused huge damages along the gulf coast in Texas and state of Florida.

BREAKAGE OF WEAKLY CONSTRUCTED DAMS: Over filling up of dams can break the walls of the dam when weakly constructed and cause flash floods in the downstream regions. **PROBLEMS OF FLOODING:**

THE ECONOMIC IMPACT OF FLOODING: Floods like flash flood, storm surge causes huge damages to properties and infrastructure of the affected areas. Houses, bridges, farms, roads, electric poles and vehicles are mostly destroyed causing huge economic losses to both public and government. Many people losses their livelihood due to floods impact on agricultural fields, industries etc. Due to damages in communication lines, infrastructure and transport networks business takes hit not only in the flood affected areas but also in the adjoining localities. The long time after effects of flood are felt in terms of lack of clean drinking water, disruption in power supply, reduction in purchasing power of people due to loss of income, rise in prices of basic items etc. Even rebuilding the infrastructure, rehabilitation of people and bringing the normalcy in economic activities takes lot of time

causing further economic losses. For instance, the flood in Chennai, India in November 2015 is estimated to have caused $3billion losses. As per estimation by NOAA the flooding in 2011 in USA caused a loss of about $ 8.41 billion. Besides if floods occurrence is regular many people and business moves out of the place leading to mass migration, development in these places cripples as government and private business fear of similar devastations in future due to recurring nature of flood. The following table shows the impact of flooding on India's GDP.

ENVIRONMENT IMPACT OF FLOODING: Flooding has its impact (both negative and positive) on the environment. Unlike the economic impact of flooding, which is mainly negative, flooding has some positive impact on environment. Such as refueling of surface and ground water storage. This replenishment of water supply helps in improving the soil quality and thus crop production. But the negative impact of flooding on the environment is quite dangerous as the flood water brings along with it different types of pollutants, chemicals, debris including uprooted trees, stones etc. This polluted water contaminates the clean water due to breakdown of water pipes and drainage systems. Besides, due to flooding many animals loses their natural habitats and contaminated water impacts the health of livestock as well as wild animals. Reduction in biodiversity level happens due to death and displacement of many animals during and after flood. As noticed in Australia's Queensland in 2011, where heavy flooding resulted in death of many animals. The flood water once receded leave behind debris and sediments, which also hampers the water quality. In 2011, Tsunami struck Japan and many coastal areas got flooded including the Fukushima, where waves caused level 7 meltdown of the power plant and release of radiations due to cooling system failure by Tsunami. Nuclear radiation release has long term negative impact on the health of people, animals, and the environment.

IMPACT OF FLOODING ON HUMAN AND ANIMAL: The direct impact of flooding is experienced maximum by humans and animals. Flash flooding or sudden arrival of huge floods causes many damages to people and animal including loss of lives and properties. Many animals and people are forced to migrate to safer places. Post flooding rise in diseases also impacts human and animals badly. Many people become homeless due to flood havoc. In addition to the physical impacts people also suffer psychologically. The flood victims can remain traumatized for longer period as they see all the devastation in front of their eyes. Also, by losing home and other properties the security level of people decreases

they become vulnerable to many threats. The stress to rebuild the life post devastations takes further toll on human's life. The following table shows the loss of human and cattle life in India due to flood from 1953 to 2016.

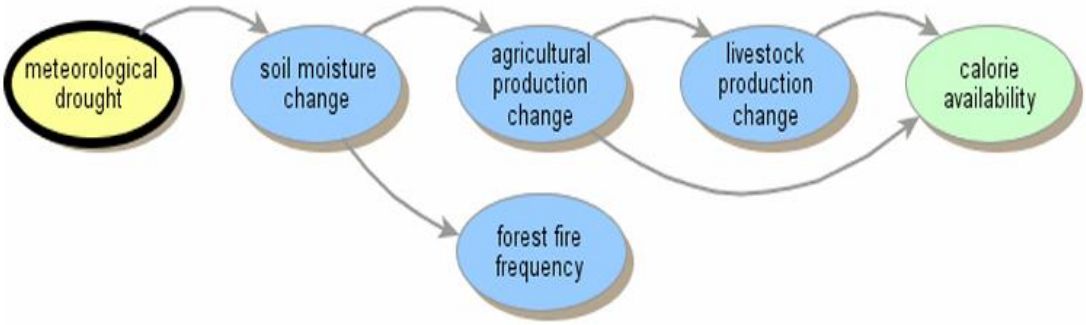
DROUGHT:

Increasing temperatures and changes in rainfall patterns are expected to increase the frequency and intensity of drought in many regions. When rainfall is less than normal for several weeks, months, or years, the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought. The term "drought" can have different meanings to different people, depending on how a water deficiency affects them.

Drought is described in terms of various statistics that summarize drought duration, intensity, and severity.

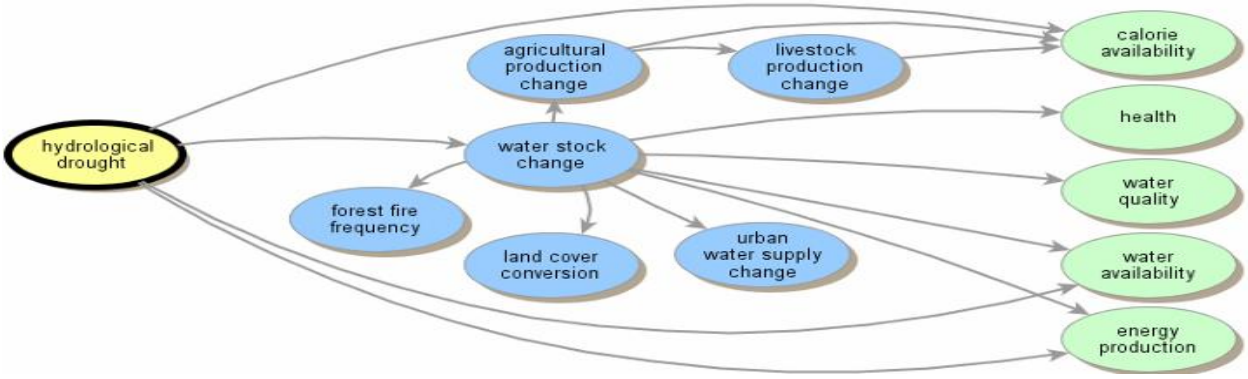
Droughts are generally classified into four categories: Meteorological drought refers to a precipitation deficiency, possibly combined with increased potential evapotranspiration, extending over a large area, and spanning an extensive period of time. Soil moisture drought is a deficit of soil moisture (mostly in the root zone), reducing the supply of moisture to vegetation. Soil moisture drought is also called agricultural drought because it is strongly linked to crop failure.

HYDROLOGICAL DROUGHT is a broad term related to negative anomalies in surface and subsurface water. Examples are below-normal groundwater levels or water levels in lakes, declining wetland area, and decreased river discharge.



Impacts of meteorological drought

Drought affected land.



Impacts of Hydrological drought

SOCIOECONOMIC DROUGHT is associated with the impacts of the three above-mentioned types. It can refer to a failure of water resources systems to meet water demands and to ecological or health-related impacts of drought. It can be noted that more types of drought impacts are related to hydrological drought than to meteorological drought.

A groundwater or hydrological drought typically refers to a period of decreased groundwater levels that varies regionally and locally based on due to differences in groundwater conditions and groundwater needs for humans and the environment. Reduced groundwater levels due to drought or increased pumping during drought can result in decreased water levels and flows in lakes, streams, and other water bodies. Decreased groundwater flow to surface waters can affect aquatic ecosystems that rely on a continuous supply of groundwater to sustain aquatic habitats and stream flow. The ground water has important role in keeping water balance on the earth. The fresh water found beneath the surface which is beyond the soil-root zone is known as ground water. It is the largest potential freshwater in the hydrological cycle. Ground water level in most of the countries decreasing

due to overconsumption. Ground water systems are a possible backup source of water during periods of drought.

It is not unusual for a given period of water deficiency to represent a more severe drought of one type than another type. For example, a prolonged dry period during the summer may substantially lower the yield of crops due to a shortage of soil moisture in the plant root zone but have little effect on groundwater storage replenished the previous spring on the other hand, a prolonged dry period when maximum recharge normally occurs can lower ground-water levels to the point at which shallow wells go dry. If ground-water storage is large and the effects of existing ground-water development are minimal, droughts may have limited. In the absence of ground-water development and continuous Ground-water withdrawals may reduce the water flows in lakes, streams, and other water bodies can cause low water level. Likewise, reduced freshwater discharges to coastal areas during droughts may cause seawater inundation towards land beyond limits that may lead to renewed land subsidence. A common response to droughts is to drill more wells. Increased use of ground water lead to permanent, unanticipated change in the level of ground-water development. Ground water systems tend to respond much more slowly to short-term variability in climate conditions than surface- water systems. As a result, assessments of ground-water resources and related model simulations commonly are based on average conditions, such as average annual recharge or average annual discharge to streams.

The effect of potential long-term changes in climate, including changes in average conditions and in climate variability, also merits consideration. Climate change could affect ground-water sustainability in several ways, including:

(1) changes in ground-water recharge resulting from changes in average precipitation and temperature or in the seasonal distribution of precipitation,

(2) more severe and longer lasting droughts,

(3) changes in evapotranspiration resulting from changes in vegetation, and

(4) possible increased demands for ground water as a backup source of water supply.

Climate can be a key, but underemphasized, factor in ensuring the sustainability and proper management of ground- water resources. Management and conservation of water resources are critical to human welfare. The high demands for water of an increasing world population have focused our attention on water resources quality and quantity management. Climate change is likely to have significant effects on hydrological regimes,

affecting both water quantity and water quality. Drought is arguably the biggest single threat from climate change. Its impacts are global. Drought triggered crisis in many middle east and African countries. Relief failures and poor drought forecasting caused several deaths in Horn of Africa during 2011 and 2012. The consequence is an increasing demand on a decreasing availability of water resources. Hydrological drought is crucial for various hydrological studies such as water quality management, determination of minimum downstream flow requirement for hydropower and ecological needs, irrigation system design and wastewater treatment.

LACK OF PRECIPITATION: When the level of precipitation is less than about 75% of the normal average, over a long period of time, drought happens. The drought condition is more prevalent when agriculture.

DROUGHT AND ITS CAUSES:

If flood happens due to excess of water than drought due to lack of it and dryness and resultant lack of agricultural production leads to drought situation.

The major causes of drought are:

REDUCTION OF SURFACE WATER FLOW: When the flow of surface water bodies like streams and rivers reduces or the rivers get dried up due to storage of water in dams/ reservoirs in the upstream for hydro power plants and irrigation facilities, drought like situation happen in the downstream regions of the river.

DEFORESTATION: Hydrological cycle (including evaporation, precipitation, and condensation) of the earth is maintained by plants and trees. Trees have water retention capabilities, can control evaporation, and maintain ground water level. Deforestation due to excessive population growth and various economic activities has exposed the surface to erosion and reduced the level of ground water and the ability of the earth surface to hold water, as a result with prolong period of dryness, desertification and drought crises appears.

GLOBAL WARMING: Rise in global temperature due to increase in greenhouse gases has impacted the climate drastically as a result many areas goes dry and forest catches fires leading to desertification and drought like condition.

TYPES OF DROUGHTS:

Droughts conditions can be classified as agricultural, meteorological, hydrological and socio economical drought. The drought condition act as indicators for government agencies,

authorities, and municipalities to develop a relief plan and provide related assistance to effected public.

AGRICULTURAL DROUGHT: This drought condition impacts the country's economy drastically. Farmers are badly affected with agricultural drought when soil moisture decreases and water demand for crop production surpasses the water supply level impacting crop growth. Decline in crop growth and production ultimately hampers the food supply and economy. Agricultural drought condition happens when the soil moisture reduces due to hot and dry weather with less rainfall leading to lack of agricultural production.

HYDROLOGICAL DROUGHT: This is a drought condition where in the water level of all the surface water bodies including dams, lakes, reservoirs, rivers etc. falls below an established standard. Even when demand or usage of water is more than the supply or availability of water in the reserves hydrological drought happens.

METEOROLOGICAL DROUGHT: This drought condition is due to natural factors like lower level of precipitation, lack of moisture in the atmosphere, dryness for longer period and high temperature. Meteorological drought if persist for longer time period can cause serious

water crises and related problems. This drought can stretch from a small period to longer period.

PROBLEMS OF DROUGHT:

The impact of drought can be felt beyond the physical boundary of drought hit areas. As drought condition is associated with lack of water, it impacts not only the society but also the economy and the environment.

Environmental Impact of Drought

Water is required for production of goods and service, thus lack of it impacts people, business, and governments. Water is prime factor for agricultural and related field, crop production largely depends on the water supply, and hence shortage of it hampers production of both crops and livestock. Farmers or crop producers bear the brunt directly as lower crop production means direct loss of profit margin and income. Loss of income mainly of the farmer impacts their social life. Lower production and higher demand for food supply can lead to price rise of basic commodities, which have direct impact on the buyers especially the lower income group. Also, in case of shortages of basic commodities, things might be imported, again costing the government. Business might take a hitting if drought conditions persist for a long time such as most manufacturing industries, agricultural product industries, and water recreational business depends on water, so lack of it can force the business to stop operation in the affected areas. Thus, many people can become jobless.

Besides, drought condition and associated dryness also increases the chances of wind erosion and birth of various diseases and epidemics as well, which costs individuals, community and the nation at large.

Lower precipitation, high temperature and dryness increase the chances of forest fires, which damage the habitat for both animal and human. Forest fire and damages to plants and other vegetation impact both public and the government. In addition, shortage of water or dryness of the surface water like rivers can impacts hydro power generation as well as transportation through waterways.

SOCIAL IMPACT:

Drought has its direct impact on the people and the society and many indirect long-term impacts. For our basic daily activities including cooking, eating, bathing, and cleaning we need water, thus its shortage or lack of it can directly impact our lives. Water is directly related to our health as well; we need clean and fresh water for drinking and cooking. Polluted and stale water can cause serious health implications and spread diseases across the society.

Due to lack of water supply agricultural and live stocks production takes a hitting causing lack of food production. When the supply is low the price rises impacting the poor people of the society most. Without proper watering of plants, the quality of food also reduces and so does the nutritional values of the food. This lower quality food supply affects health of both human and animal and makes them vulnerable to diseases and health issues.

If drought conditions persist people prefer to migrate to other places leaving their property and at times their families. Many farmers in case of agricultural droughts must leave their farms and take up odd jobs in other areas or towns.

Water, its supply and shortages have triggered many disputes between nations, states, and neighboring people. For instance, in India disputes between states regarding water is not very uncommon like Kaveri River water dispute between Karnataka and Tamil Nadu, Yamuna water usage issues between Delhi, UP and Haryana etc. these disputes cause social unrest.

ENVIRONMENTAL IMPACT:

Droughts like conditions impact the environment drastically. If the rivers, streams, and other water bodies do not get fresh water supply through precipitation or melting snow the ecosystem of such aquatic bodies can be drastically impacted. Many waterborne organisms and animals die due to lack of water supply. Lakes, Ponds, and rivers, which get replenished with fresh rainwater, might also die if shortage of precipitations last for longer period. Soil erosion due to high temperature and dryness can remove the productive topsoil

leading to lower biological production and land degradations. Many animals and organisms lose their habitat threatening their extinctions.

EARTHQUAKE

An earthquake (also known as a quake, tremor, or temblor) is the shaking of the surface of the Earth, with sudden release of energy in the form of seismic waves on the surface of the earth. The point inside the crust where the pressure is released is called the focus. The point on the Earth's surface above the focus is called the epicenter. When earthquake occurs beneath the sea it causes tsunami. The study of earthquakes is called as seismology and the instrument used to measure seismic waves is called as seismometer or seismograph.

Causes of earthquake:

According to the theory of plate tectonics, Earth is composed of many individual plates that move and interact, constantly changing and reshaping Earth's outer layer. Plates do not always move smoothly against each other and sometimes get stuck. This builds up pressure. When this pressure is eventually released, an earthquake tends to occur. Volcanoes and earthquakes both result from the movement of tectonic plates. Volcanoes, tides can also trigger seismicity. Underground nuclear testing and dams can also cause seismic waves.

Effects of Earthquakes:

1. Soil Liquefaction: Due to earthquakes granular material (such as sand) temporarily loses its strength and transforms from a solid to a liquid (Soil liquefaction). This causes rigid structures, like buildings and bridges, to tilt or sink into the liquefied deposits.

2. Landslides and avalanche: Earthquakes can produce slope instability leading to landslides and avalanche.
3. Tsunamis: When earthquakes occur under sea it causes tsunami. Most destructive tsunamis are caused by earthquakes of magnitude 7.5 or more.
4. Floods: These are secondary effects of earthquakes, as they may occur if dams are damaged.
5. Fires: Earthquakes can cause fires by damaging electrical power or gas lines
6. Destabilization: It destabilizes ecological and social structure of nation. Essential services also got disrupted.
7. Loss of life and property: An earthquake may cause injury and loss of life, general property damage and collapse or destabilization of buildings. The aftermath may bring disease, lack of basic necessities, mental consequences such as panic attacks and depression to survivors etc. E.g. Earthquake in 2005 with Epicenter at Muzaffarabad killed 80,000 people and injured around 1,00,000 and 3.5 million people were dislodged.

Management and mitigation methods:

- Earthquakes cannot be stopped or predicted accurately but certain management techniques could be followed to minimize its effect:

1. Construction of buildings which can tolerate earthquakes. This can be done by:

- By keeping weak spots in building to absorb vibrations.
- To keep pads or floats beneath buildings.
- Wooden house to be preferred in earthquake prone area.

2. Soil testing should be done so that stability of building is assured.

3. Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes.

4. Preparedness and safe building construction can reduce extent of damage and loss.

5. Establishment of GPS station in the earthquake prone region to assess future crustal movements.

- J&K falls in seismic zones IV (high) and V (very high). So, we need to be more aware about precautionary measures against earthquake.

VOLCANOES

Volcanoes are ruptures in the crust of our planet Earth that allow hot gases, molten lava and some rock fragments to erupt by opening and exposing the magma inside. In this piece of article, we will be discussing how and why volcanoes erupt.

How Do Volcanoes Erupt?

It is so hot deep within the earth that some rocks slowly melt and turn into a thick flowing matter known as magma. Since it is lighter than solid rock, the magma rises and collects in magma chambers. Eventually, some magma pushes through fissures and vents on the earth's surface. Hence, a volcanic eruption occurs, and the erupted magma is known as lava.

We need to understand the Earth's structure to know how volcanoes erupt. At the top lies the lithosphere, the outermost layer that consists of the upper crust and mantle. The thickness of the crust ranges from 10 km to 100 km in mountainous locations and mainly consists of silicate rock.

Why Do Volcanoes Erupt?

The Earth's mantle within the crust is classified into different sections depending on individual seismology. These include the upper mantle, which ranges between 8 – 35 km to 410 km; the transition zone ranges from 400 to 660 km; the lower mantle lies between 660 – 2891 km.

The conditions change dramatically from the crust to the mantle location. The pressures rise drastically, and temperatures rise up to 1000 ^{o}C. This viscous and molten rock gets collected into large chambers within the Earth's crust.

Since magma is lighter than surrounding rock, it floats up towards the surface and seeks out cracks and weakness in the mantle. It finally explodes from the peak point of a volcano after reaching the surface. When it is under the surface, the melted rock is known as magma and erupts as ash when comes up.

Rocks, lava and ash are built across the volcanic vent with every eruption. The nature of the eruption mainly depends on the viscosity of the magma. The lava travels far and generates broad shield volcanoes when it flows easily. When it is too thick, it makes a familiar cone volcano shape. If the lava is extremely thick, it can build up in the volcano and explode, known as lava domes.

Causes of Volcanic Eruption

We know that the mantle of the Earth is too hot, and the temperature ranges from 1000° Celsius to 3000° Celsius. The rocks present inside melt due to high pressure and temperature. The melted substance is light in weight. This thin lava comes up to the crust since it can float easily. Since the density of the magma between the area of its creation and the crust is less than the enclosed rocks, the magma gets to the surface and bursts. The magma is composed of andesitic and rhyolitic components along with water, sulfur dioxide, and carbon dioxide in dissolved form. By forming bubbles, excess water is broken up with magma. When the magma comes closer to the surface, the level of water decreases, and the gas/magma rises in the channel. When the volume of the bubbles formed is about 75%, the magma breaks into pyroclasts and bursts out.

The three main causes of volcanic eruptions are:

- The buoyancy of the magma
- Pressure from the exsolved gases in the magma.
- Increase in pressure on the chamber lid.

MELTING ICE CAPS AND SEA LEVEL RISE

A warming climate holds important implications for other aspects of the global environment. Because of the slow process of heat diffusion in water, the world's oceans are likely to continue to warm for several centuries in response to increases in greenhouse concentrations that have taken place so far. The combination of seawater's thermal expansion associated with this warming and the melting of mountain glaciers is predicted to lead to an increase in global sea level of 0.28–1.01 meters (11–39.8 inches) by 2100. However, the actual rise in sea level could be considerably greater than this. It is probable

that the continued warming of Greenland will cause its ice sheet to melt at accelerated rates. In addition, this level of surface warming may also melt the ice sheet of West Antarctica. Paleoclimatic evidence suggests that an additional 2 °C (3.6 °F) of warming could lead to the ultimate destruction of the Greenland Ice Sheet, an event that would add another 5 to 6 meters (16 to 20 feet) to predicted sea level rise. Such an increase would submerge a substantial number of islands and lowland regions. Coastal lowland regions vulnerable to sea level rise include substantial parts of the U.S. Gulf Coast and Eastern Seaboard (including roughly the lower third of Florida), much of the Netherlands and Belgium (two of the European Low Countries), and heavily populated tropical areas such as Bangladesh. In addition, many of the world's major cities such as Tokyo, New York, Mumbai, Shanghai, and Dhaka are located in lowland regions vulnerable to rising sea levels. With the loss of the West Antarctic ice sheet, additional sea level rise would approach 10.5 meters (34 feet).

While the current generation of models predicts that such global sea level changes might take several centuries to occur, it is possible that the rate could accelerate as a result of processes that tend to hasten the collapse of ice sheets. One such process is the development of moulins large vertical shafts in the ice that allow surface meltwater to penetrate to the base of the ice sheet. A second process involves the vast ice shelves off Antarctica that buttress the grounded continental ice sheet of Antarctica's interior. If those ice shelves collapse, the continental ice sheet could become unstable, slide rapidly toward the ocean, and melt, thereby further increasing mean sea level. Thus far, neither process has been incorporated into the theoretical models used to predict sea level rise.

OCEAN ACIDIFICATION

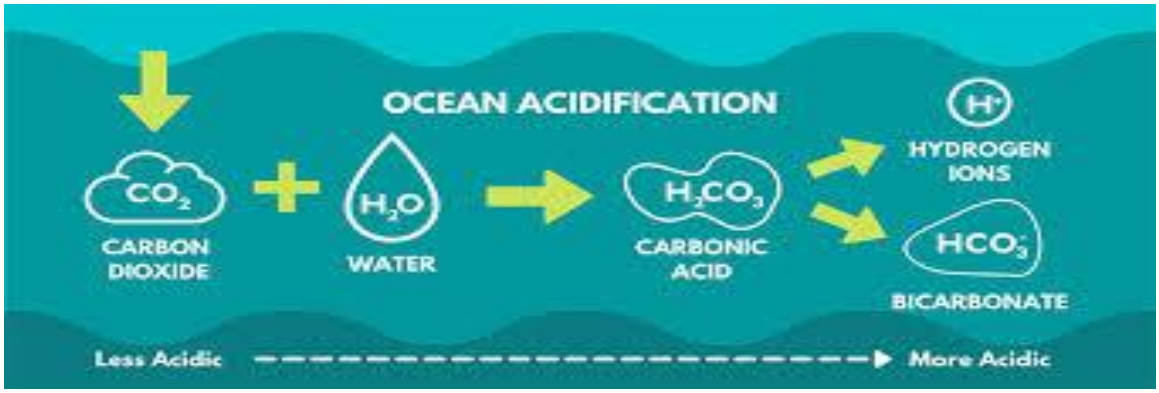
Ocean Acidification is an increase in the level of acid in the ocean. The primary reason suggested by the scientists for this is the heavy release of carbon dioxide into the environment, which is being absorbed by the ocean. Ocean acidification is directly affecting each and every life in the ocean.

Ocean acidification directly depends on the level of carbon dioxide absorbed by the ocean. The more the absorption of carbon dioxide, the more acidic the ocean becomes. Let us understand the primary cause of ocean acidification, its effects, reactions explaining the phenomenon, and other essential facts which will help us understand the gravity of this danger.

What is Ocean Acidification?

Ocean acidification begins with the heavy release of carbon dioxide into the atmosphere. It is a phenomenon happening in the oceans across Earth. The acidic level of the oceans is gradually increasing because of the high carbon dioxide intake. The carbon dioxide absorbed by the ocean reacts with the water to produce carbonic acid, which further dissipates into H+ ions and bicarbonate ions. This is the primary cause of Ocean Acidification.

On the release of high H+ ions, the pH value of the water decreases, making it acidic in nature, and the ocean salinity decreases. It is measured that the amount of carbon dioxide in the ocean has decreased the average pH value (a scale used to measure the acidic or basic nature) of the ocean from 8.25 to 8.14 between 1751 to 2021.



pH Value of Ocean

Ocean acidification directly relates to the pH value of the ocean. The pH value refers to the amount of H+ ion present in the aqueous solution. The pH scale carries values between 0 to 14, where 7 represents neutral. The acidic nature increases on going towards 0 from 7, whereas the basic nature increases on going 14 from 7. The pH scale is indirectly proportional to the number of H+ ions in the aqueous solution.

A recent study shows that the current average pH value of the ocean is near 8.14, which means that over the years acidity of the ocean or the ocean acidification has increased to a great extent as it is a logarithmic value. A small change in the pH scale corresponds to 10 fold change in the H+ ions.

Causes of Ocean Acidification

The primary cause of ocean acidification is the release of high H+ ions into the ocean. The H+ ions are released after the reaction of carbon dioxide and water. The complete reaction that occurs in the ocean is shown below:

$CO_2(aq) + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons HCO_3^- + H^+ \rightleftharpoons CO_3^{2-} + 2\ H^+$

The amount of H^+ ions has increased because of excess carbon dioxide being trapped by the ocean from the atmosphere. The concentration of carbon dioxide in the atmosphere has drastically increased because of the excessive fuel burned and other human activities.

The increase of the CO_2 in the atmosphere is majorly caused by:

- The burning of fossil fuels
- Increase in the concentration of carbon dioxide in the oceans
- The industrial revolution led to an increase in pollution
- Increase in the concentration of carbon dioxide in the atmosphere
- The loss of biodiversity
- Increase in the concentration of hydrogen ions due to the chemical reaction.
- Lack of eco-friendly laws and regulations
- A decrease in carbonate ions

Effects of Ocean Acidification

Ocean acidification is considered a cause of worry because it directly impacts the ocean ecosystem. Various drastic impacts of it can be seen or predicted in the future. Some of them are as follows:

- The increase in CO_2 decreases the amount of carbonate, directly impacting the lives of various organisms in the ocean.
- Coral reefs are degrading.
- It directly impacts marine life as various shelled animals, such as clams, starfish, urchins, etc., cannot easily build their shells.
- Impacts the ocean deposits
- Loss of marine plants.
- Loss of marine animals.
- Loss of marine biodiversity
- Disturbance in the food chain
- Impacts the Ocean relief
- The local economy is decreased due to the lack of fish and other marine products.
- A decline in tourism.

Ocean Acidification Solutions

The adverse effects of ocean acidification are noticeable and suggest controlling carbon dioxide emissions into the atmosphere. If the released amount of carbon dioxide in the atmosphere is controlled, less absorption of it will occur in the ocean, which will help in buffering. This buffering will normalize the pH level of the ocean.

Here are a few solutions for ocean acidification control:

- Reducing the use of fossil fuels
- Increasing the use of eco-friendly fuels
- Use of technology for reducing pollution
- Making strict regulations
- Spreading awareness
- Promotion of environmentally friendly initiatives
- Using Geo-engineering to control the pH value.

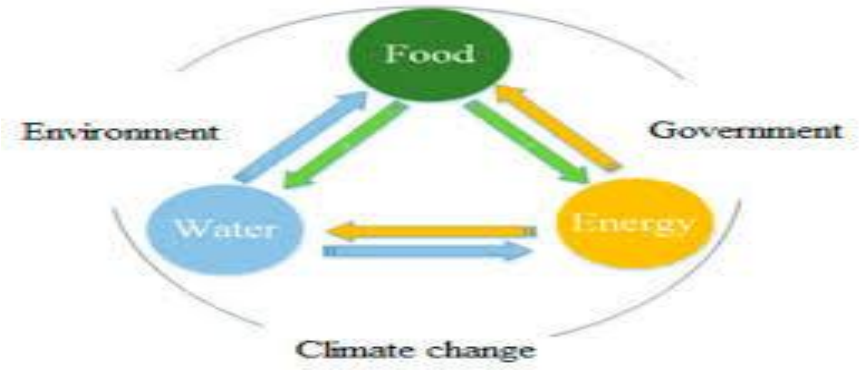
WATER AND FOOD INSECURITY

At the core of food security is access to healthy food and optimal nutrition. Food access is closely linked to food supply, so food security is dependent on a healthy and sustainable food system. The food system includes the production, processing, distribution, marketing, affordability, and consumption of food.

Within the context of demographic growth, increased competition for water, and improved attention to environmental issues, water for food remains a core issue that can no longer be tackled through a narrow sectoral approach.

While world population has rapidly increased from 7 billion and rising to over 9 billion by 2050, the use of freshwater for human consumption, agriculture, industry, and other uses has increased six fold. To feed an increasing number of people, food production will have to double but the amount of water and arable land available remains the same.

In addition, climate change and extreme weather events increasingly pose a threat to agricultural systems. Thus, new adaptive forms of water management in agriculture, including rainfed and irrigated agriculture, watershed management, inland fisheries and aquaculture, and livestock and rangeland management need to be explored and implemented in a comprehensive way.



- Agriculture is the predominant user of water: In most countries, and with no improvements in land and water productivity, water demand for agriculture is expected to increase more than the current levels of 70% (global average).
- Changing food consumption patterns: The demand for more food will continue to increase not only because of population growth but as a result of increased incomes and changing consumption patterns that are geared towards consumption of meat and other animal products.
- Climate change poses additional stress on food production systems: More frequent and severe droughts and floods are already apparent in many regions, and this is impacting on the extent and productivity of both irrigated and rainfed agriculture.

- Governance, institutions, and right policies: Food production relays heavily on water, however other factors such as right governance frameworks, improved seeds and inputs, post-harvest handling, energy, and policies (agricultural subsidies and trade policies) all play a critical role in achieving food security.

MINING

Mining is the extraction of valuable geological materials and minerals from the surface of the Earth. Mining is required to obtain most materials that cannot be grown through agricultural processes, or feasibly created artificially in a laboratory or factory.

Ores recoveredbymininginclude metals, coal, oilshale, gemstones, limestone, chalk, dimens ionstone, rocksalt, potash, gravel, and clay. The ore must be a rock or mineral that contains valuable constituent, can be extracted, or mined and sold for profit. Mining in a wider sense includes extraction of any non-renewable resource such as petroleum, natural gas, or even water.

Modern mining processes involve prospecting for ore bodies, analysis of the profit potential of a proposed mine, extraction of the desired materials, and final reclamation or restoration of the land after the mine is closed. Mining materials are often obtained from ore bodies, lodes, veins, seams, reefs, or placer deposits. The exploitation of these deposits for raw materials is dependent on investment, labor, energy, refining, and transportation cost.

Mining operations can create a negative environmental impact, both during the mining activity and after the mine has closed. Hence, most of the world's nations have passed regulations to decrease the impact; however, the outsized role of mining in generating business for often rural, remote, or economically depressed communities means that governments often fail to fully enforce such regulations. Work safety has long been a concern as well, and where enforced, modern practices have significantly improved safety in mines. Unregulated, poorly regulated or illegal mining, especially in developing economies, frequently contributes to local human rights violations and environmental conflicts. Mining can also perpetuate political instability through resource conflicts.

Environmental effects of mining can occur at local, regional, and global scales through direct and indirect mining practices. Mining can cause erosion, sinkholes, loss of biodiversity, or the contamination of soil, groundwater, and surface water by chemicals emitted from mining processes. These processes also affect the atmosphere through carbon emissions which contributes to climate change.

Some mining methods (lithium mining, phosphate mining, coal mining, mountaintop removal mining, and sand mining) may have such significant environmental and public health effects that mining companies in some countries are required to follow strict environmental and rehabilitation codes to ensure that the mined area returns to its original state. Mining can provide various advantages to societies, yet it can also spark conflicts, particularly regarding land use both above and below the surface.

Mining operations remain rigorous and intrusive, often resulting in significant environmental impacts on local ecosystems and broader implications for planetary environmental health. To accommodate mines and associated infrastructure, land is cleared extensively, consuming significant energy and water resources, emitting air pollutants, and producing hazardous waste.

According to The World Counts page " The number of resources mined from Earth is up from 39.3 billion tons in 2002. A 55 percent increase in less than 20 years. This puts Earth's natural resources under heavy pressure. We are already extracting 75 percent more than Earth can sustain in the long run.".

SOIL DEGRADATION

Soil degradation, a significant environmental issue, refers to the loss of soil quality due to incorrect usage or poor management, generally for industrial, agricultural, or urban reasons. The foundation of all terrestrial life is soil, a critical natural resource. It is essential for our health to prevent soil degradation.

The following factors may contribute to soil degradation or deterioration:

- Physical factors include erosion of fertile topsoil by water or wind.
- Chemical factors include waterlogging, nutritional depletion, or toxicity brought on by acidity or alkalinity.
- Biological factors that influence soil microbial activity and microflora.

Other elements, including deforestation, heavy cultivation on marginal land, unsuitable farming techniques like monoculture, inadequate manuring, misuse or overuse of fertilizers, excessive irrigation, overgrazing, soil fragility, unfavorable weather, and mining, may increase the degradation of the soil.

Water erosion is one of the leading causes of degradation and is regarded to be the worst because it affects over 87% of the area concerned.

Cause of Soil Erosion

Following are the important causes of soil erosion:

Rainfall and Flooding

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

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

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

Agriculture

The farming practices are the major cause of soil erosion. The agricultural activities disturb the ground. The trees are cleared, and the land is ploughed to sow new seeds. Since most of the crops are grown during the spring season, the land lies fallow during winters. Most of the soil is eroded during winters.

Also, the tyres of tractors make grooves on the land, making a natural pathway for water. Fine soil particles are eroded by wind.

Grazing

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

Logging and Mining

A large number of trees are cut down to carry out the logging process. Trees hold the soil firmly. The canopy of the trees protects the soil from heavy rainfall. The leaf litter that protects the soil from erosion, is also lost during logging.

Mining activities also disturb the land and leave the soil more prone to erosion.

Construction

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

Rivers and Streams

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

Heavy Winds

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

Effects of Soil Erosion

The major effects of soil erosion include:

Loss of Arable Land

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

Clogging of Waterways

The agricultural soil contains pesticides, insecticides, fertilizers, and several other chemicals. This pollutes the water bodies where the soil flows.

The sediments accumulate in the water and raise the water levels resulting in flooding.

Air Pollution

The dust particles merge in the air, resulting in air pollution. Some of the toxic substances such as pesticides and petroleum can be extremely hazardous when inhaled. The dust

plumes from the arid and semi-arid regions cause widespread pollution when the winds move.

Desertification

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

Destruction of Infrastructure

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

Soil Erosion Prevention

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

1. Plant trees on barren lands to limit erosion of soil.
2. Add mulch and rocks to prevent the plants and grass underneath to prevent soil erosion.
3. Mulch matting can be used to reduce erosion on slopes.
4. Put a series of fibre logs to prevent any water or soil from washing away.
5. A wall at the base of the slope can help in preventing the soil from eroding.
6. Every household should have a proper drainage system so that water flows down into proper water collecting systems.

Control of Soil Erosion

Formation of soil is an extremely slow process, and it takes 200-1000 years to form one inch of topsoil. In view of this, it is very necessary to conserve the soil and prevent its erosion. Following are some important methods of controlling soil erosion.

(i) Rotation of Crops: This procedure ensures that some part of the land is continually covered by vegetation.

(ii) Tillage at right angle to the slope of land: This is known as contour farming. This procedure creates a series of ridges that slow down the flow of water and thus prevent the soil erosion. This method is useful on gentle slopes.

(iii) Strip Farming: This is used on steep slopes. The procedure involves alternating strips of closely sown crops. Alternative bands of wheat and soya beans are commonly sown. The closeness of the strips retards the flow of water and so prevents soil erosion.

(iv) Using wind Brakes: It is the practice of planting trees or other plants that protect the bare soil from the full force of winds. Wind brakes decrease the speed of wind and hence reduce the quantity of soil that the wind can carry away. Thus, soil erosion by wind is reduced.

Key Points of Soil Erosion

- It is the natural process of wearing away topsoil, but human activities have accelerated the process.
- It is usually caused due to the removal of vegetation, or any activity that renders the ground dry.
- Farming, grazing, mining, construction, and recreational activities are some of the causes of soil erosion.
- The effects of soil erosion are not just land degradation. It has led to a drastic increase in pollution and sedimentation in rivers that clogs the water bodies resulting in a decline in the population of aquatic organisms.
- Degraded lands lose the water holding capacity resulting in floods.

The health of the soil is of utmost importance to the farmers and the population that depends upon agriculture for food and employment. There are several challenges to resist soil erosion, but there are solutions to prevent it as well.

MODULE 4

CONSERVATION OF NATURAL RESOURCES

Reforestation—use of renewable energy resources—Treatment of Industrial Effluents—In-Situ conservation of Biodiversity—wetlands and Marine conservation—organic farming—Vermi composting of organic waste—rainwater harvesting: Roof-top rain water harvesting.

REFORESTATION

Ex situ conservation activities have been carried out through establishment of gene banks. They have become particularly important for the conservation of crop varieties or Improvement of crops and & a forestation programmes. The UNEP has advocated for in-situ and ex-situ conservation efforts. However, funds for ex-situ conservation have been enhanced recently. A special emphasis has been given to a forestation since forest is a good source of food, fodder, fiber, and pulp. Moreover, they help in maintaining climatic stability and biodiversity. It has been shown that degraded lands can be effectively used and restored by planting forests. Using trees of wide adaptability and productivity for this purpose clonal propagation method have been prescribed rather than using seeds of uncertain genetic quality. Clonal micro propagation can be achieved through techniques of tissue culture. It has been estimated that multiplication state of 100-200 per year is technically possible for many species towards this objective genotype capable of growing well on degraded land have been selected for mass propagation/multiplication.

The clonal multiplication involves 4 steps.

1. Maintaining an aseptic culture.
2. Shoot multiplication using apical meristem or buds.
3. Rooting of in vitro forms shoots.
4. Acclimatization and transfer of micro propagated plantlets to the field.

According to an estimate in 1990, 500 million plants of diverse nature were produced through micro propagation in 60 countries. In New Zealand large number of micro propagation plantlets – Pine trees (Pinus radiata) are being used and it is estimated that 2 million plantlets were in the field in the year 1992.

Use of renewable energy resources

Renewable energy offers numerous economic, environmental, and social advantages. These include:

- Reduced carbon emissions and air pollution from energy production
- Enhanced reliability, security, and resilience of the power grid
- Job creation through the increased production and manufacturing of renewable energy technologies
- Lower energy costs
- Expanded energy access for remote, coastal, or isolated communities.
- Less global warming
- Improved public health.
- Inexhaustible energy
- Reliability and resilience

TREATMENT OF INDUSTRIAL EFFLUENTS

Industrial effluent is wastewater that is produced by industries as an undesirable by-product. It can contain a variety of pollutants, including organic matter, inorganic compounds, heavy metals, and toxic chemicals. Industrial effluent treatment is important to protect the environment and public health.

There are a variety of methods for industrial effluent treatment. The most common methods are:

1. Physical treatment: This method removes suspended solids and other large particles from the effluent. Physical treatment methods include screening, sedimentation, and filtration.
2. Chemical treatment: This method uses chemicals to neutralize acids and alkalis, remove dissolved solids, and oxidize organic matter. Chemical treatment methods include precipitation, flocculation, and oxidation.
3. Biological treatment: This method uses microorganisms to break down organic matter. Biological treatment methods include activated sludge, trickling filters, and rotating biological contactors.

4. Advanced treatment: This method uses more specialized techniques to remove specific pollutants. Advanced treatment methods include membrane filtration, reverse osmosis, and ozonation.

The choice of treatment method will depend on the specific pollutants in the effluent, the desired level of treatment, and the budget. In some cases, a combination of methods may be used.

In addition to the treatment methods mentioned above, there are a few other things that can be done to control industrial effluent. These include:

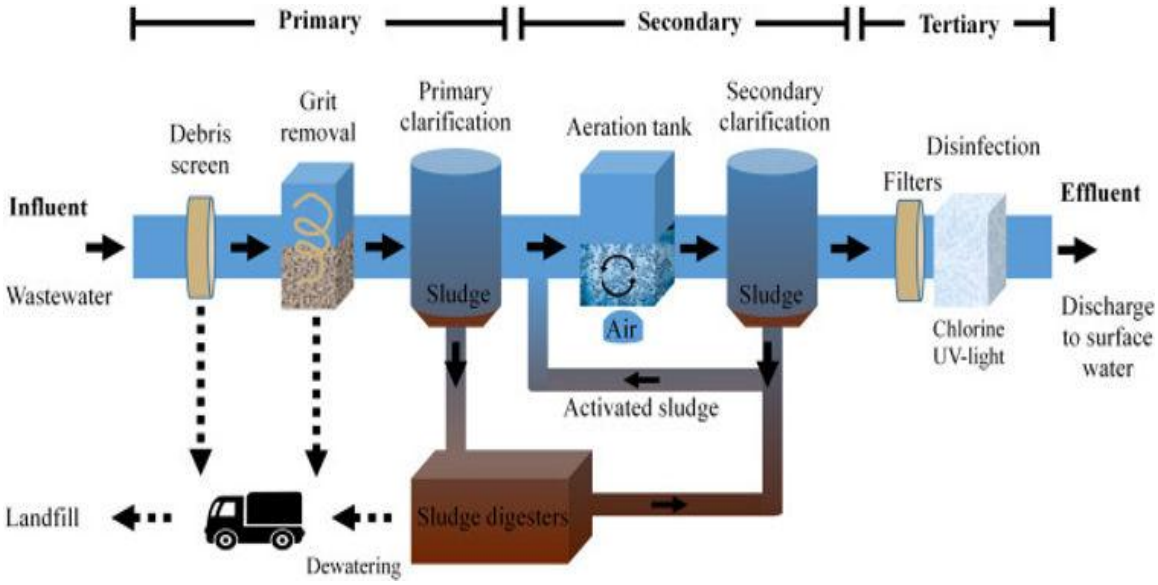
- Reducing the number of pollutants generated by the industry.
- Using cleaner production technologies.
- Recycling and reusing water.
- Landfilling or incineration of hazardous wastes.

Industrial effluent treatment is an important part of protecting the environment and public health. By using the right methods, industries can effectively treat their effluent and prevent it from contaminating the environment.

Here are some additional details about the different methods of industrial effluent treatment:

1. Physical treatment: This method is often used as a first step in effluent treatment. It is relatively inexpensive and can remove a significant amount of suspended solids and other large particles. Physical treatment methods are not very effective at removing dissolved solids or organic matter.
2. Chemical treatment: This method is used to remove specific pollutants, such as acids, alkalis, and heavy metals. Chemical treatment methods can be very effective, but they can also be expensive and produce harmful byproducts.
3. Biological treatment: This method is the most effective way to remove organic matter from effluent. Biological treatment methods are relatively inexpensive and produce no harmful byproducts. However, they can take a long time to be effective and require careful monitoring.
4. Advanced treatment: This method is used to remove specific pollutants that are not effectively removed by other methods. Advanced treatment methods can be very expensive and require specialized expertise.

The choice of treatment method will depend on the specific pollutants in the effluent, the desired level of treatment, and the budget. In some cases, a combination of methods may be used.



CONSERVATION OF BIODIVERSITY

In 1999, the Ministry of Environment and Forests prepared a National Policy and Macro level Action Strategy on Biodiversity through a consultative process and formulated a macro level statement of policies, gaps and strategies needed for conservation and sustainable use of biological diversity.

Benefits of Biodiversity conservation

- Conservation of biological diversity leads to conservation of essential ecological diversity to preserve the continuity of food chains.

- The genetic diversity of plants and animals is preserved.
- It ensures the sustainable utilization of life support systems on earth.
- It provides a vast knowledge of potential use to the community.
- A reservoir of wild animals and plants is preserved, thus enabling them to be introduced, if need be, in the surrounding areas.
- Biodiversity conservation assures sustainable utilization of potential resources.

IN-SITU AND EX-SITU CONSERVATION

Conservation can broadly be divided into in-situ and ex-situ conservation. In-situ means 'on site', hence the in-situ conservation is the conservation of species diversity within normal and natural habitats and ecosystems. Whereas in ex-situ conservation the biodiversity is conserved out of their natural habitats. Zoos, botanical gardens and seed banks are examples of ex-situ conservation.

In Situ Conservation

- Faced with the conflict between development and conservation, many nations find it unrealistic and economically not feasible to conserve all their biological wealth.
- On a global basis, this problem has been addressed by eminent conservationists. They identified for maximum protection certain 'biodiversity hotspots' regions with very high levels of species richness and high degree of endemism (that is, species confined to that region and not found anywhere else).
- Initially 25 biodiversity hotspots were identified but subsequently nine more have been added to the list, bringing the total number of biodiversity hotspots in the world to 34.
- These hotspots are also regions of accelerated habitat loss. Three of these hotspots – Western Ghats and Sri Lanka, Indo-Burma and Eastern Himalayas cover our country's exceptionally high biodiversity regions.
- Although all the biodiversity hotspots put together cover less than 2 percent of the earth's land area, the number of species they collectively harbour is extremely high and strict protection of these hotspots could reduce the ongoing mass extinctions by almost 30 per cent. • In India, ecologically unique and biodiversity-rich regions are legally protected as biosphere reserves, national parks, sanctuaries, reserved forests, protected forests and nature reserves.

- India now has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries.
- Plantation, cultivation, grazing, felling trees, hunting and poaching are prohibited in biosphere reserves, national parks and sanctuaries.

Preservation and Conservation

The terms preservation and conservation are often understood in the same sense but confused, but there is a difference between them. Preservation implies complete protection and leaving the natural resources totally untouched. Conservation implies the management of resources on a sustainable yield basis.

Thus, conservation is the process of protecting the environment while taking reasonable benefits out of it without causing major damages to it. For example, in animal populations safety does not lie entirely in numbers. Wildlife sometimes can be overprotected. The results of allowing a deer herd, deprived of its natural predators, to multiply beyond the carrying capacity of its habitat have been documented in the past. Poor growth, weakened physical condition, and starvation are sure to follow. The severely damaged forest takes many years to recover, reducing its value for not only deer, but other wildlife as well.

Project Tiger

This project was launched in 1972 to save the tiger from the brink of extinction. The tiger is at the apex of the ecological pyramid. Thus, the wellbeing of the tiger is synonymous with the health of the ecosystem.

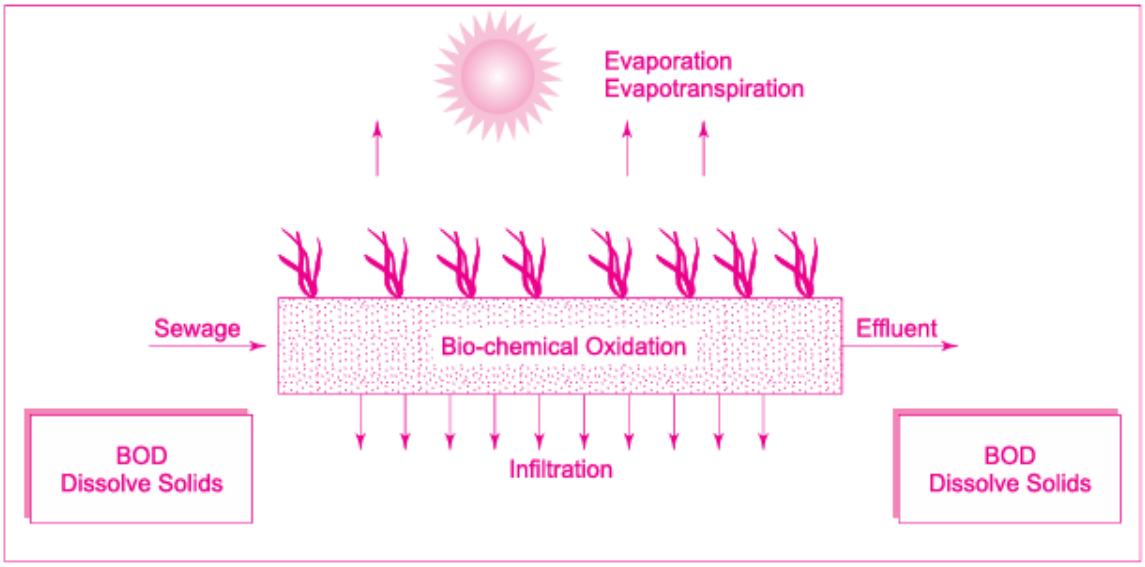
Project Elephant

The government of India launched this project in 1991-92 with the objective of saving the Asiatic elephant. The project covers the major elephant populations extending over 12 states. Besides this in-situ conservation measures, India has a comprehensive ex-situ conservation programme. There are 33 botanical gardens, 275 zoos, deer parks, safari parks, aquaria, etc. A number of premier bodies like Zoological Survey of India, Botanical Survey of India and institutes like Wildlife Institute of India, Indian Council for Forestry Research and Education, Indira Gandhi National Forest Academy, Salim Ali School of Ornithology are engaged in wildlife education and research.

CONSTRUCTED WETLANDS

Constructed wetlands are engineered marshes that duplicate natural processes to cleanse water. The engineered aquatic treatment systems of constructed wetlands are classified into two basic types: Free Water Surface (FWS) and Subsurface Flow (SF) wetlands. Both types

consist of a channel or a basin with some sort of barrier to prevent seepage and utilize emergent aquatic vegetation as part of the treatment system. The difference between FWS and SF is the fact that the second type uses some kind of media as a major component.



Marine Conservation

Marine conservation is also known as ocean conservation. The health of all life on Earth depends (directly or indirectly) on a healthy ocean. As humans began to realize their increasing impacts on the ocean, the field of marine conservation arose in response. This article discusses the definition of marine conservation, techniques used in the field, and some of the most important ocean conservation issues.

Marine Conservation Definition

Marine conservation is the protection of marine species and ecosystems in oceans and seas worldwide. It involves not only protection and restoration of species, populations, and habitats but also mitigating human activities such as overfishing, habitat destruction, pollution, whaling and other issues that impact marine life and habitats.

A related term you may encounter is marine conservation biology, which is the use of science to solve conservation issues.

Brief History of Ocean Conservation

People became more aware of their impacts on the environment in the 1960s and 1970s. Around this same time, Jacques Cousteau brought the wonder of the oceans to people through television. As scuba diving technology improved, more people took to the undersea

world. Whale song recordings fascinated the public, helped people recognize whales as sentient beings, and led to whaling bans.

Also in the 1970's, laws were passed in the U.S. regarding protection of marine mammals (Marine Mammal Protection Act), protection of endangered species (Endangered Species Act), overfishing (Magnuson Stevens Act) and clean water (Clean Water Act), and establishing a National Marine Sanctuary Program (Marine Protection, Research and Sanctuaries Act). In addition, the International Convention for the Prevention of Pollution from Ships was enacted to reduce ocean pollution.

In more recent years, as ocean issues came to the forefront, the U.S. Commission on Ocean Policy was established in 2000 to "develop recommendations for a new and comprehensive national ocean policy." This led to the creation of the National Ocean Council, which is charged with implementing the National Ocean Policy, which establishes a framework for managing the ocean, Great Lakes, and coastal areas, encourages more coordination between the Federal, state and local agencies charged with managing ocean resources, and using marine spatial planning effectively.

Marine Conservation Techniques

Marine conservation work can be done by enforcing and creating laws, such as the Endangered Species Act and Marine Mammal Protection Act. It can also be done by establishing marine protected areas, studying populations through conducting stock assessments and mitigating human activities with the goal of restoring populations.

An important part of marine conservation is outreach and education. A popular environmental education quote by conservationist Baba Dioum states that "In the end, we

will conserve only what we love; we will love only what we understand; and we will understand only what we are taught."

Marine Conservation Issues

- Current and emerging issues in marine conservation include:
- Ocean acidification
- Climate change and warming ocean temperatures.
- Sea level rise
- Reducing bycatch in marine fisheries and entanglements in fishing gear.
- Establishing marine protected areas to protect important habitats, commercially and/or recreationally valuable species and feeding and breeding areas.
- Regulating whaling
- Protecting coral reefs through studying the problem of coral bleaching.
- Addressing the worldwide problem of invasive species.
- Marine debris and the issue of plastics in the ocean.
- Dealing with the problem of shark finning.
- Oil spills (an issue the public became well aware of thanks to the Exxon Valdez and Deepwater Horizon spills).
- The ongoing debate of the appropriateness of cetaceans in captivity.
- Studying and protecting endangered species (e.g., North Atlantic right whale, vaquita, sea turtles, monk seals and many other threatened and endangered species).

ORGANIC FARMING

Organic farming can be defined as an agricultural process that uses biological fertilizers and pest control acquired from animal or plant waste. Organic farming was initiated as an answer to the environmental sufferings caused using chemical pesticides and synthetic fertilizers. In other words, organic farming is a new system of farming or agriculture that repairs, maintains, and improves the ecological balance.

Advantages of Organic Farming

- Economical: In organic farming, no expensive fertilizers, pesticides, or HYV seeds are required for the plantation of crops. Therefore, there is no extra expense.
- Good return on Investment: With the usage of cheaper and local inputs, a farmer can make a good return on investment.
- High demand: There is a huge demand for organic products in India and across the globe, which generates more income through export.
- Nutritional: As compared to chemical and fertilizer-utilised products, organic products are more nutritional, tasty, and good for health.
- Environment-friendly: The farming of organic products is free of chemicals and fertilizers, so it does not harm the environment.

Disadvantages of Organic Farming

- Incompetent: The major issue of organic farming is the lack of inadequate infrastructure and marketing of the product.
- Less production: The products obtained through organic farming are less in the initial years as compared to that in chemical products. So, farmers find it difficult to accommodate large-scale production.
- Shorter shelf life: Organic products have more flaws and a shorter shelf life than that of chemical products.
- Limited production: Off-season crops are limited and have fewer options in organic farming.

Types of Organic Farming

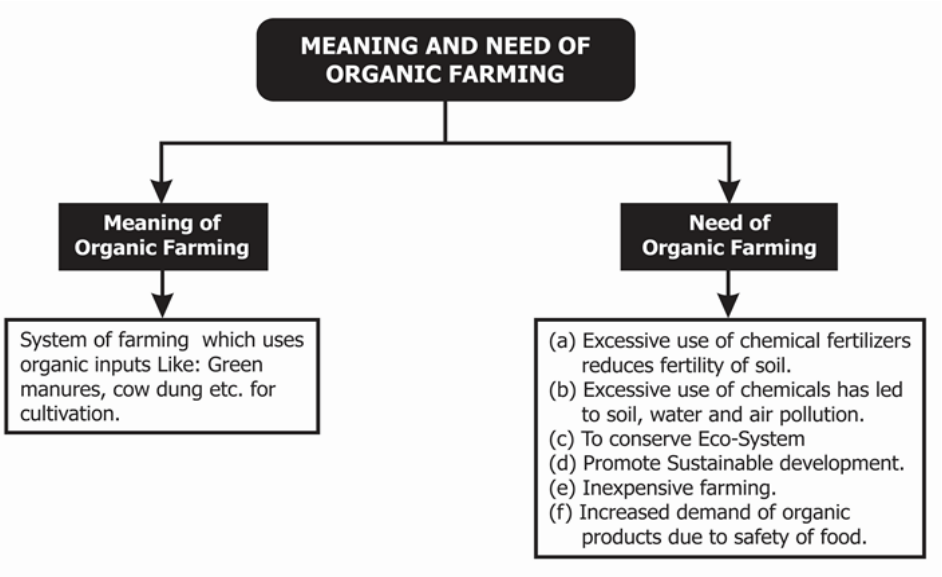
Organic farming is divided into two types, namely:

1. Integrated organic farming.
2. Pure organic farming

Pure organic farming means avoiding all unnatural chemicals. In this process of farming, all the fertilizers and pesticides are obtained from natural sources such as bone meal or blood meal.

Integrated organic farming includes the integration of pest management and nutrients management to achieve ecological requirements and demands.

Meaning and Importance of Organic Farming



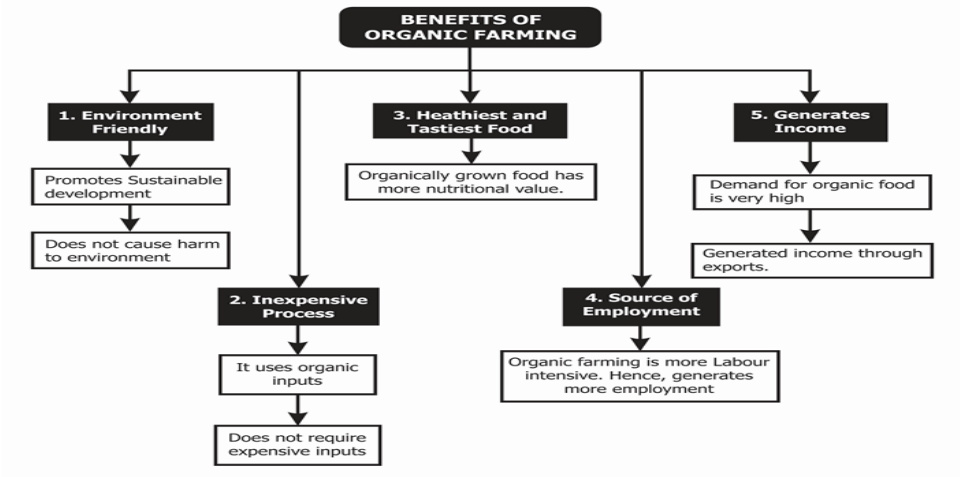
Meaning of organic farming

System of farming that uses organic inputs like green manures, cow dung, etc., for cultivation.

Need of organic farming

- Excessive use of chemical fertilizers reduces the fertility of soil.
- Excessive use of chemicals has led to soil, water, and air pollution.
- To conserve ecosystem.
- To promote sustainable development.
- Inexpensive farming.
- Increased demand of organic products due to safety of food.

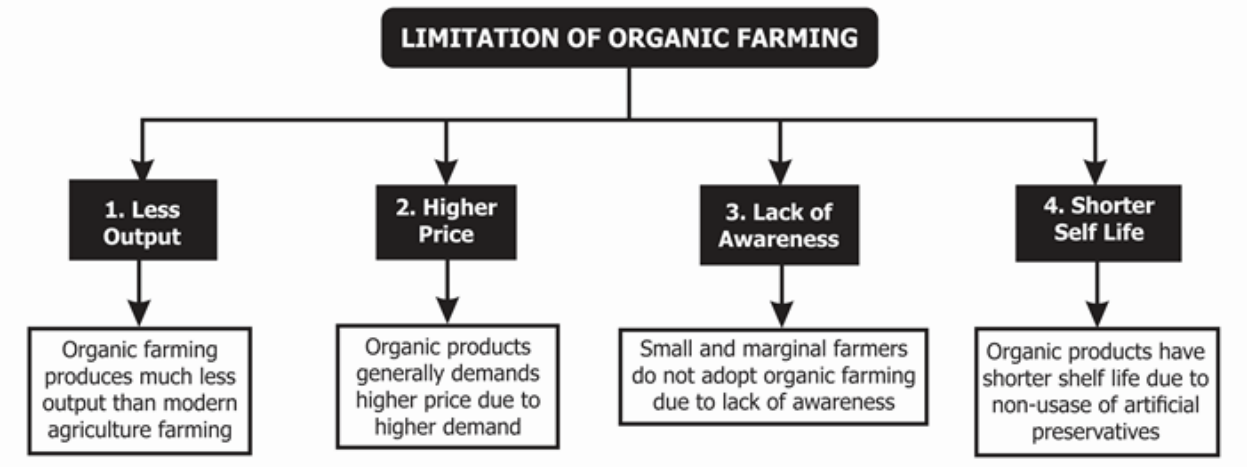
- Benefits of Organic Farming



Benefits of organic farming

- Environment-friendly.
- Promotes sustainable development.
- Healthy and tasty food.
- Inexpensive process.
- It uses organic inputs.
- Generates income.
- Generates income through exports.
- Source of employment.
- Organic farming is more labor intensive. Hence, it generates more employment.

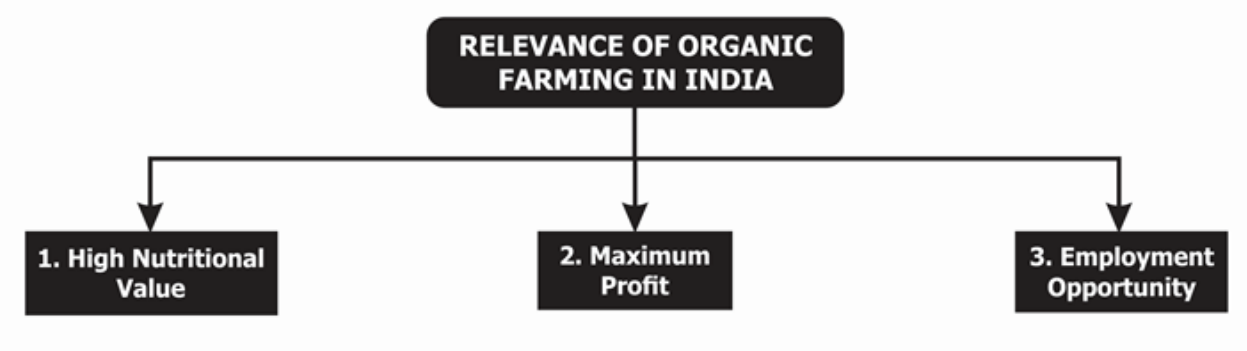
Limitations of Organic Farming



- Less output.

- Higher price.
- The lack of awareness.
- Organic products generally demand a higher price due to a higher demand.
- Shorter shelf life.
- Organic products have a shorter shelf life due to the absence of artificial preservatives.

The relevance of Organic Farming



- High nutritional value.
- Maximum profit.
- Employment opportunity.

VERMI COMPOSTING OF ORGANIC WASTE.

Vermicomposting is a process in which the earthworms convert the organic waste into manure rich in high nutritional content.

Vermicomposting is the scientific method of making compost, by using earthworms. They are commonly found living in soil, feeding on biomass and excreting it in a digested form.

Vermiculture means “worm-farming”. Earthworms feed on the organic waste materials and give out excreta in the form of “vermicasts” that are rich in nitrates and minerals such as phosphorus, magnesium, calcium, and potassium. These are used as fertilizers and enhance soil quality.

Vermicomposting comprises two methods:

Bed Method: This is an easy method in which beds of organic matter are prepared.

Pit Method: In this method, the organic matter is collected in cemented pits. However, this method is not prominent as it involves problems of poor aeration and waterlogging.

Advantages Of Vermicomposting

The major benefits of vermicomposting are:

- Develops roots of the plants.
- Improves the physical structure of the soil.
- Vermicomposting increases the fertility and water-resistance of the soil.
- Helps in germination, plant growth, and crop yield.
- Nurtures soil with plant growth hormones such as auxins, gibberellic acid, etc.

Disadvantages of Vermicomposting

Following are the important disadvantages of vermicomposting:

- It is a time-consuming process and takes as long as six months to convert the organic matter into usable forms.
- It releases a very foul odour.
- Vermicomposting is high maintenance. The feed has to be added periodically and care should be taken that the worms are not flooded with too much to eat.
- The bin should not be too dry or too wet. The moisture levels need to be monitored periodically.
- They nurture the growth of pests and pathogens such as fruit flies, centipede and flies.

Vermicomposting turns the kitchen waste and other green waste into dark, nutrient-rich soil. Due to the presence of microorganisms, it maintains healthy soil.

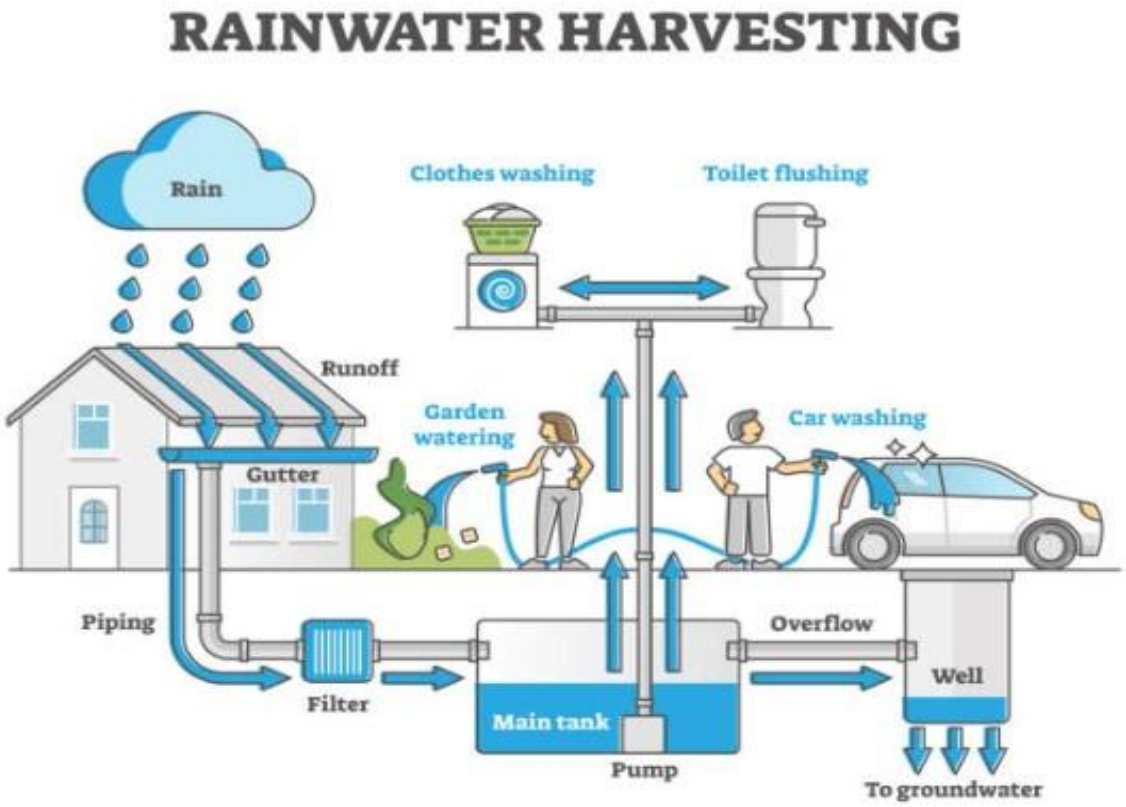
Vermicomposting is an eco-friendly process that recycles organic waste into compost and produces valuable nutrients.

RAINWATER HARVESTING: Roof-top rainwater harvesting

In the present scenario management and distribution of water has become centralized. People depend on government system, which has resulted in disruption of community participation in water management and collapse of traditional water harvesting system.

As the water crisis continues to become severe, there is a dire need of reform in water management system and revival of traditional systems. Scientific and technological studies need to be carried out to assess present status so as to suggest suitable mitigative measures for the revival to traditional system/wisdom. Revival process should necessarily be backed by people's initiative and active public participation.

Living creatures of the universe are made of five basic elements, viz., Earth, Water, Fire, Air and Sky, Obviously, water is one of the most important elements and no creature can survive without it. Despite having a great regard for water, we seem to have failed to address this sector seriously. Human being could not save and conserve water and it sources, probably because of its availability in abundance. But this irresponsible attitude resulted in deterioration of water bodies with respect to quantity and quality both. Now, situation has arrived when even a single drop of water matters. However. " Better late than never", we have not realized the seriousness of this issue and initiated efforts to overcome those problems.



System of collection rainwater and conserving for future needs has traditionally been practiced in India. The traditional systems were time-tested wisdom of not only appropriate technology of Rainwater Harvesting, but also water management systems, where conservation of water was the prime concern. Traditional water harvesting systems were Bawaries, step wells, jhiries, lakes, tanks etc. These were the water storage bodies to domestic and irrigation demands. People were themselves responsible for maintenance to water sources and optimal use of water that could fulfill their needs.

What is Rainwater harvesting?

The term rainwater harvesting is being frequently used these days, however, the concept of water harvesting is not new for India. Water harvesting techniques had been evolved and developed centuries ago.

Ground water resource gets naturally recharged through percolation. But due to indiscriminate development and rapid urbanization, exposed surface for soil has been reduced drastically with resultant reduction in percolation of rainwater, thereby depleting ground water resource. Rainwater harvesting is the process of augmenting the natural

filtration of rainwater into the underground formation by some artificial methods. "Conscious collection and storage of rainwater to cater to demands of water, for drinking, domestic purpose & irrigation is termed as Rainwater Harvesting."

Why harvest rainwater?

This is perhaps one of the most frequently asked question, as to why one should harvest rainwater. There are many reasons but following are some of the important ones.

- To arrest ground water decline and augment ground water table
- To beneficiate water quality in aquifers
- To conserve surface water runoff during monsoon
- To reduce soil erosion
- To inculcate a culture of water conservation

How to harvest rainwater:

Broadly there are two ways of harvesting rainwater:

(i) Surface runoff harvesting

(ii) Roof top rainwater harvesting

1. Surface runoff harvesting:

In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

2. Roof top rainwater harvesting (RTRWH):

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system. This method is less expensive and very effective and if implemented properly helps in augmenting the ground water level of the area.

Methods of Roof Top Rainwater Harvesting

Storage of Direct use

In this method rainwater collected from the roof of the building is diverted to a storage tank. Excess water could be diverted to recharge system. Water from storage tank can be used for secondary purposes such as washing and gardening etc.

Recharging ground water aquifers

Ground water aquifers can be recharged by various kinds of structures to ensure percolation of rainwater in the ground instead of draining away from the surface. Commonly used recharging methods are:

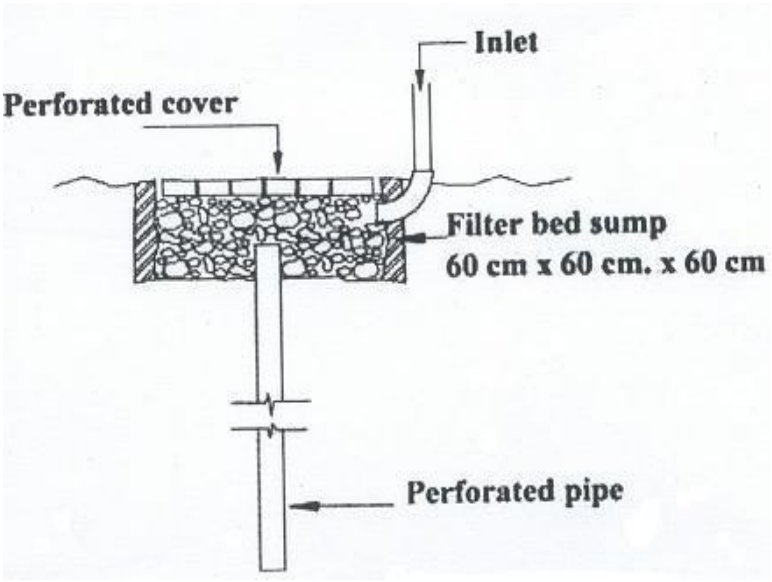
- Recharging of bore wells
- Recharging of dug wells.
- Recharge pits
- Recharge Trenches
- Soak ways or Recharge Shafts
- Percolation Tanks
- Recharging of bore wells

Recharge Pits

Recharge pits are small pits of any shape rectangular, square, or circular, contracted with brick or stone masonry wall with weep hole at regular intervals. to of pit can be covered with perforated covers. Bottom of pit should be filled with filter media.

Soak away or Recharge Shafts

Soak away or recharge shafts are provided where upper layer of soil is alluvial or less pervious. These are bored hole of 30 cm dia. up to 10 to 15 m deep, depending on depth of pervious layer. Bore should be lined with slotted/perforated PVC/MS pipe to prevent collapse of the vertical sides. At the top of soak away required size sump is constructed to retain runoff before the filters through soak away. Sump should be filled with filter media.



Recharging of dug wells.

Dug well can be used as recharge structure. Rainwater from the rooftop is diverted to dug wells after passing it through filtration bed.

Recharge Trenches

Recharge trench in provided where upper impervious layer of soil is shallow. It is a trench excavated on the ground and refilled with porous media like pebbles, boulder, or brickbats. it is usually made for harvesting the surface runoff.

Percolation tanks

Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation to recharge the ground water. These can be built in big campuses where land is available, and topography is suitable.

Do's and Don'ts

Harvested rainwater is used for direct usage or for recharging aquifers. It is most important to ensure that the rainwater caught is free from pollutants. Following precautionary measures should be taken while harvesting rainwater:

- Roof or terraces uses for harvesting should be clean, free from dust, algal plants etc.
- Roof should not be painted since most paints contain toxic substances and may peel off.
- Do not store chemicals, rusting iron, manure or detergent on the roof.
- Nesting of birds on the roof should be prevented.
- Terraces should not be used for toilets either by human beings or by pets.
- Provide gratings at mouth of each drainpipe on terraces to trap leaves debris and floating materials.
- Provision of first rain separator should be made to flush off first rains.
- Do not use polluted water to recharge ground water.
- Ground water should only be recharged by rainwater.
- Before recharging, suitable arrangements of filtering should be provided.
- Filter media should be cleaned before every monsoon season.
- During rainy season, the whole system (roof catchment, pipes, screens, first flush, filters, tanks) should be checked before and after each rain and preferably cleaned after every dry period exceeding a month.

- At the end of the dry season and just before the first shower of rain is anticipated, the storage tank should be scrubbed and flushed off all sediments and debris.

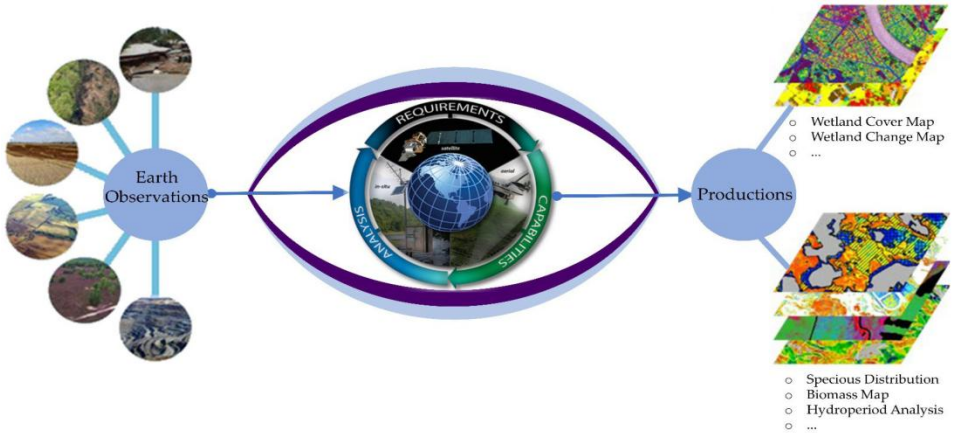
MODULE 5

Latest Development in Environmental Pollution Mitigation Tools (concepts and application)

Application of RS and GIS in pollution management—environment impact assessment—5R's of Waste Management—Concept of Carbon Footprint—Carbon Credit and Carbon trading. Sustainable habitat: Green buildings—Green materials—Energy efficiency—Sustainable transports. Environmental management system—Environmental audit—ISO 14001 series—Environmental stewardship- NGO's.

APPLICATION OF RS AND GIS IN POLLUTION MANAGEMENT

"Remote Sensing" is the science and art of acquiring information (spectral, spatial, temporal) about material objects, area, or phenomenon, without coming into physical contact with the objects, or area, or phenomenon under investigation. Without direct contact, some means of transferring information through space must be utilized. In remote sensing, information transfer is accomplished by use of electromagnetic radiation (EMR). Remote sensing technology has many attributes that would be beneficial to detecting, mapping, and monitoring invaders. Remote Sensing using space-borne sensors is a tool, par excellence, for obtaining repetitive (with a range from minutes to days) and synoptic (with local to regional coverage) observations on spectral behavior of various environments. i.e., Land surface changes (degradation), water quality, soil and atmosphere etc. Integrated GIS and remote sensing have already successfully been applied to map the distribution of several plant and animal species, their ecosystems, landscapes, bio-climatic conditions and factors facilitating invasions Remote sensing (satellite) imagery is available for most of the world since 1972. The multidate nature of satellite imagery permits monitoring dynamic features of landscape environments and thus provides a means to detect major land cover changes and quantify the rates of change. The interpretation and analysis of Landsat TM image since 1987, provided a comprehensive information of the area especially regarding the various land uses and the associated environmental problems. The use of remote sensing is becoming increasingly frequent in environmental studies. In the 1970s and 1980s satellite images were mostly used in simple interpretations or as a map background.



Multispectral remote sensing

Multispectral remote sensing is generally based on acquisition of image data of Earth's surface simultaneously in multiple wavelengths. Due to that, we can use the fact that different types of surfaces reflect the light of different wavelengths with various intensity. Different spectral behavior is leading to detailed classification of specific types of land surfaces (depending on the spatial, spectral and radiometric resolution of the used sensor). Multispectral remote sensing involves the acquisition of visible, near infrared, and short-wave infrared images in several broad wavelength bands. Different materials reflect and absorb differently at different wavelengths. As such, it is possible to differentiate among materials by their spectral reflectance signatures as observed in these remotely sensed images, whereas direct identification is usually not possible. NASA's Landsat, one of the more common multispectral imagers, is widely used for monitoring a wide range of landscape scale properties. Prior to the Hyperion and other airborne hyperspectral data, mostly multispectral remote sensing data were used to map the feasibility of environmental impacts in almost the world. Multispectral satellite data are highly useful for monitoring temporal changes and continuous monitoring of environmental impacts due to mining activities. Similarly Synthetic Aperture Radar images are useful in detecting land use morphological changes due to mining activities.

Hyperspectral remote sensing

The hyperspectral data has significant advantages over the multispectral data, which has hundreds of contiguous spectral bands with narrow spectrum. The high spectral resolution and reflectance spectra allow direct identification of individual materials based upon the reflectance characteristics. It allows measurements of materials spectra, making it possible to identify an area specific mineral, rocks, soils and vegetation of the changes over time with high resolution. Due to its unique capability to resolve mineral absorption features, it has been successfully applied for the detection of my waste.

GEOGRAPHIC INFORMATION SYSTEM

Geographic information systems (GIS) are used to collect, store, analyse, disseminate, and manipulate information that can be referenced to a geographical location. GIS can be used to representative application areas of foster effective short-and-long term decision making, socioeconomic and environmental problems, transportation, local government and business. Burrough and McDonnell (1998) have defined GIS is a powerful set of tools for collecting, storing, retrieving, transforming and displaying spatial data from the real world for

a particular set of purposes. Application of GIS is revolutionizing planning and management in the field of environment. The technology that has given vast scope to the applicability of remote sensing and field-based analysis is 'Geographic Information System (GIS). The field and science of GIS have been transformed over the last two decades. Once considered a Cinderella technology in selected disciplines and application domains, GIS has grown quite rapidly to become a multi-billion industry and a major player in the broader field of the ubiquitous information technology. Advancements in computer hardware and software, availability of large volumes of digital data, the standardization of GIS formats and languages, the increasing interoperability of software environments, the sophistication of geoprocessing functions, and the increasing use of real-time analysis and mapping on the Internet have increased the utility and demands for the GIS technology. Apart from that, researchers, resource planners and policy makers are realizing the power of GIS and its unique ability to enhance environmental issues. GIS can be a powerful tool for understanding these processes and for managing potential impacts of human activities on environment.

APPLICATIONS

In the present review, an approach has been made to review the applications of Remote sensing and Geographic Information System applications to the mining environment, urban environment management, coastal and marine environment, wasteland environment etc.

MINING ENVIRONMENT

The application of Remote sensing techniques in the mining environmental study has unique advantages, because of its multispectral mode, synoptic view and repetitive coverage. The advancement of high-resolution multispectral satellite data, imaging spectrometry is an excellent tool to study the environmental impacts due to mining activities.

To monitor the land use changes due to opencast strip mining, effect of underground mining and subsidence, evolution of dumping of mine wastes, deforestation, and erosion due to mining activities Remote sensing techniques have successfully applied. The impact due to mining causes rapid and drastic environmental changes. Because of complex problems and frequent changes in the landscape in the mining area, monitoring of these environmental changes is becoming extremely difficult. Mining causes direct landscape changes and in many cases it enables the emission of hazardous substances into the environment. The extent of this change varies from minor to extreme events. Hyperspectral remote sensing techniques could provide vital information on various environmental aspects such as land use, land cover changes, vegetation condition, soil water quality and acid mine drainage locations.

The field and laboratory based radiometric techniques have been successfully used to predict certain properties of water bodies, grasslands, minerals and rocks, forests, crops and several other surface features from their reflectance spectra. Environmental monitoring data obtained from adjacent locations of mining area water quality, mineralogical and geochemical studies. Mularz (1998) mapped the problem of environmental monitoring and land-use/land cover changes over the lignite open-cast mine and power plant area was investigated using airborne remote photography along with Landsat TM and SPOT imageries in the central part of Poland to discriminate, assess and even to measure these destructive phenomena. The degradation of land use due to coal mining using remote sensing techniques at Jharia coal filed have been studied by Prakash and Gupta (1998). The open cast mining activities like lignite and other materials lead to loss of fertile agricultural land, elimination of surface water bodies and ground water depletion in deeper aquifers. Oxidation process at surface of dumped mine waste may produce acid water drainage, which can affect the surface and groundwater quality.

Multi-date infra-red Landsat images were utilized to study the environmental changes in Sierra Leone, West Africa, especially to understand the impact on hydrogeomorphology. An attempt has made to delineate the magnesite ore deposits in Salem using hyperspectral remote sensing data, which reveals that potential of using narrow band hyperspectral data for further mapping of impact mining on environment. The management and controlling factors of environment affected due to mining to be adopted both during production and

after closure. Sufficient data collection and accurate processing should be done with respect to place and time for control and planning the environmental management.

URBAN ENVIRONMENT MANAGEMENT

Floods cause damage to natural resources and environmental quality and indirectly contribute to increasing poverty, which in turn further add to the vulnerability of both natural and human systems mostly urban area compared to the rural areas. The environment and flood linkage has been recognized, and many environmental programs such as reforestation, forest protection, upland fixed cultivation and resettlement, could be implemented through remote sensing and GIS.

GIS has been widely used in characterization and assessment studies which require a watershed-based approach to manage the water level and waste management in the urban locations. Basic physical characteristics of a watershed such as the drainage network and flow paths can be derived from readily available Digital Elevation Models (DEMs). When faced with challenges involving water quality and quantity due to natural as well as human-induced hazards (e.g., droughts, hazard material spills, floods, and urbanization), planning becomes extremely important so as to mitigate their impacts and ensure optimal utilization of the available resources.

Remote sensing can provide an important source of data for urban land use/land cover mapping and environmental monitoring. Numbers of significant studies were made for environmental quality management. Uncontrolled urbanization has been responsible for several problems, our cities facing today, resulting in substandard living environment, acute problems of drinking water, noise and air pollution, disposal of waste, traffic congestion etc. To minimize these environmental degradations in and around cities, the technological development in related fields have to address to these problems caused by rapid urbanization, only then the fruits of development will percolate to the most deprived ones. The modern technology of remote sensing which includes both aerial as well as satellite-based systems, allow us to collect physical data rather easily, with speed and on repetitive basis, and together with GIS helps us to analyze the data spatially, offering possibilities of generating various options (modeling), thereby optimizing the whole planning process. The dynamic nature of urban environmental necessitates both macro and micro level analysis. Therefore, it is necessary for policy makers to integrate remote sensing with urban planning

and management. The trend towards using remotely sensed data in urban studies began with first-generation satellite sensors such as Landsat MSS and was given impetus by a number of second-generation Satellites: Landsat TM, ETM+ and SPOT. The recent advent of a third generation of very high spatial resolution (5m/pixel) satellite sensors is stimulating. The high resolution PAN and LISS III merged data may be used together effectively for urban applications. Data from IRS P-6 satellites with sensors on board especially LISS IV Mono and Multispectral (MX) with 5.8 m/pixel spatial resolution is very useful for intensive urban studies.

COASTAL AND MARINE ENVIRONMENT

Coastal zones in India are constantly undergoing wide-ranging changes in shape and environment due to natural as well as human development activities. Remote sensing technology in recent years has proved to be of great importance in acquiring data for effective resources management and hence could also be applied to coastal environment monitoring and management. The high temporal resolution provided by the satellite data is found to be a major improvement in studying the behavior of suspended sediments in the coastal waters, which would help in understanding the movement of sediments and pollutants.

GIS in addition to providing efficient data storage and retrieval facilities also offers a cheaper option of monitoring forest conditions over time. Remote sensing and GIS are increasingly used in mangrove forestry worldwide to assist in gathering and analyzing images acquired from aircrafts, satellites and even balloons. The notable advantages of using GIS include the ability to update the information rapidly, to undertake comparative analytical work and making this information available as required. The area covered by mangroves in the islands of Andaman was calculated using SPOT 1993 and IRS 1D LISS III 2003 imageries. The change in mangrove area within a span of ten years has presented in the form of a table (IOM report, 2003). Twumasi and Merem (2006) assessed change within a coastal environment in the Niger delta region of Nigeria using remotely sensed satellite imagery and GIS modeling, quickened the analysis of the spatial distribution of environmental change involving land use, land cover classification, forest and hydrology and demographic issues facing the Niger Delta and successful implemented some of the strategies could lead to effective management of the coastal environment in the Niger Delta region. Satellite based remote sensing techniques have proved successful in providing a

comprehensive, reliable and up-to date information on land use/land cover in the offshore areas of east coast of Andhra Pradesh in the most cost effective manner. Environmental Sensitivity Index (ESI) and Reach Sensitivity Index (RSI) identified through modern methods like Digital Image processing and GIS for preparedness in case of oil spill incidents in offshore areas. The combination of remote sensing and GIS technologies provides an ideal solution for understanding the spatial/temporal distribution of oil spills in the marine environment and is considered as the core of the oil spill monitoring system. The advantages of the remote sensing and GIS provides the ability to extract the oil pollution parameters such as location and spill areas including spatial and temporal information allows the users to establish the major cause and source of oil spills and then outline the risk areas to save the marine environment. One of the major advantages of GIS is the ability to extract oil pollution parameters such as location, size and spill areas. Spatial and temporal information (oil spill distribution at sea and its evolution in time) allows the users to establish the major cause and source of oil spills, and then outline the risk area. The products derived from geospatial technologies support informed decision making with respect to marine spatial planning and management.

WASTELAND ENVIRONMENT

Wetlands consist of 3 - 6% of the earth's land surface, while they make available supplies and services such as: water quality maintenance, agricultural production, fisheries, and recreation floodwater, retention, provision of wildlife habitat, and control of soil erosion. Remotely sensed data have been utilized to measure the qualitative and quantitative terrestrial land-cover changes. During last two decades a diversity of remotely sensed data and change detection methods have been developed and assessed. Remote sensing (RS) data and Geographic information systems (GIS) are appropriate tools for monitoring of the wetland distribution area and spatial-temporal dynamic multiplicity. Satellite remote sensed data have been widely utilized for inventorying and monitoring wetlands and can also provide information on surrounding land use and their change over the time successfully utilized the Multi-temporal remote sensing data and GIS for wetland mapping in the southwest of Iran near to the Karkheh River using four Landsat images 1985 (Landsat MSS), 1999 (Landsat ETM+), 2002 (Landsat ETM+) and 2011 (Landsat ETM+) and found that, increase in agricultural activity, climate change and construction engineering projects caused wetland surface area reduction. Satellite remote sensing has many advantages for

inventory and monitoring of wetlands and also provide information on surrounding landuse and their changes over time. Landsat MSS, TM, and SPOT are common data type for wetland classification and its spatial-temporal dynamic change.

Remote sensing has served as an efficient method of gathering data about glaciers since its emergence. The recent advent of Geographic Information Systems (GIS) and Global Positioning Systems (GPS) has created an effective means by which the acquired data are analyzed for the effective monitoring and mapping of temporal dynamics of glaciers. A large number of researchers have taken advantage of remote sensing, GIS and GPS in their studies of glaciers.

ENVIRONMENT IMPACT ASSESSMENT (EIA)

Definitions of EIA

Environmental Impact Assessment is defined as an activity designed to identify the impact on the bio geophysical environment, on man and well-being of legislative proposals, projects, policies, operational procedures and to interpret and communicate information.

EIA is a systematic process of identifying future consequences of a current or proposed action.

Objective of EIA

- To identify, predict and evaluate the economic, environmental and social impact of development activities.
- To provide information on the environmental consequences for decision making
- To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

Environmental Impact Statement (EIS) should contain the following information's/data:

- Description of proposed action (construction, operation and shut down phase) and selection of alternatives to the proposed action.
- Nature and magnitude of the likely environmental effects.
- Possibility of earthquakes and cyclones.
- Possible effects on surface and ground water quality, soil and air quality.
- Effects on vegetation, wildlife and endangered species.
- Economic and demographic factors.

- Identification of relevant human concerns.
- Noise pollution. Efficient use of inputs.
- Recycling and reduction of waste.
- Risk analysis and disaster management.

Importance of EIA:

- EIA is potentially a useful component of good environmental management.
- It is the Government policy that any industrial project has to obtain EIA clearance from the Ministry of Environment before approval by the planning commission.

Environment Impact Assessment in India

The environmental impact assessment in India was started in 1976-77, when the planning commission asked the Department of Science and Technology to examine the river valley projects from environmental angel. This was subsequently extended to cover those projects, which required approval of the Public Investment Board. Then the Govt. of India enacted the Environment (Protection) Act on 23rd May 1986 to achieve the objective the decision that was taken is to make environmental impact assessment statutory. After following the legal procedure, a notification was issued on 27th Jan 94. 10th April 1997 and 27th Jan 2000, making environmental impact assessment statutory for 30 development projects (Schedule I), the mandatory EIA clearance procedure started.

HOW TO IMPLEMENT THE 5 R'S OF WASTE MANAGEMENT

If you want to positively impact the outcome of your recycling program by reducing the amount of waste your company produces, this is the process you really need to consider. Always remember to treat recycling as a last resort and always try to follow the R pyramid in order to ensure that you can be as efficient as possible with your business waste.

Step One: Refuse

The first step of the 5 R process. This can be a difficult one as you will have to practice refusing waste production for your business, however it this will be the most effective way to minimize waste. How? Well, by simply refusing to use single-use plastics or wasteful, non-recyclable products, you can ultimately reduce the amount of waste your business produces on the daily.

Ideally, you will want to talk to your procurement team to work out how you can approach this step most effectively. When you work with vendors or suppliers try to avoid working with

unnecessary product packaging and attempt to opt for reusable or returnable packaging and containers.

By making smarter buying decisions and setting efficient standards early on in the process, this will make it much easier for organizations to 'refuse' using waste that they don't ultimately need or would turn out wasteful.

Step Two: Reduce

This is all about reducing your use of harmful, wasteful and non-recyclable materials to save you money, help the environment and so on. By limiting your dependency on these types of products, this leads to less waste materials ending up in landfill and prevents you from creating negative impacts on the environment.

We would always advise using the minimal amount required to avoid excess waste as these material and energy could then be used for future requirements. Once good example would be when printing a document, print double-sided to slash your waste output in half. Other methods involve reducing the number of single-use plastics, plastic packaging and organic waste.

Step Three: Reuse

Single use plastics such as cups, straws, gloves and now masks have generated a 'throw away', 'one won't hurt' culture. The rate that we all consume plastic products is drastically becoming unimaginable, the plastic crisis has always been one of the world's biggest environmental challenges.

In a race to reduce waste, businesses are prompted to reuse items in the workplace instead of replacing them. All you need to do is start by focusing on a particular area within your business at one time, for instance the work kitchen. Try to replace all the single use utensils and equipment for compostable and reusable options. Once you successful master on environment in your business, find ways to reuse other products such as protective packaging, ink cartridges, food containers and even rechargeable batteries.

Step Four: Repurpose

If you can't refuse, reduce or reuse a particular item, try repurposing it instead. The 'green' community often refers to this method as 'upcycling'. You will quite often be surprised to learn how many everyday objects in the office can serve more than one purpose.

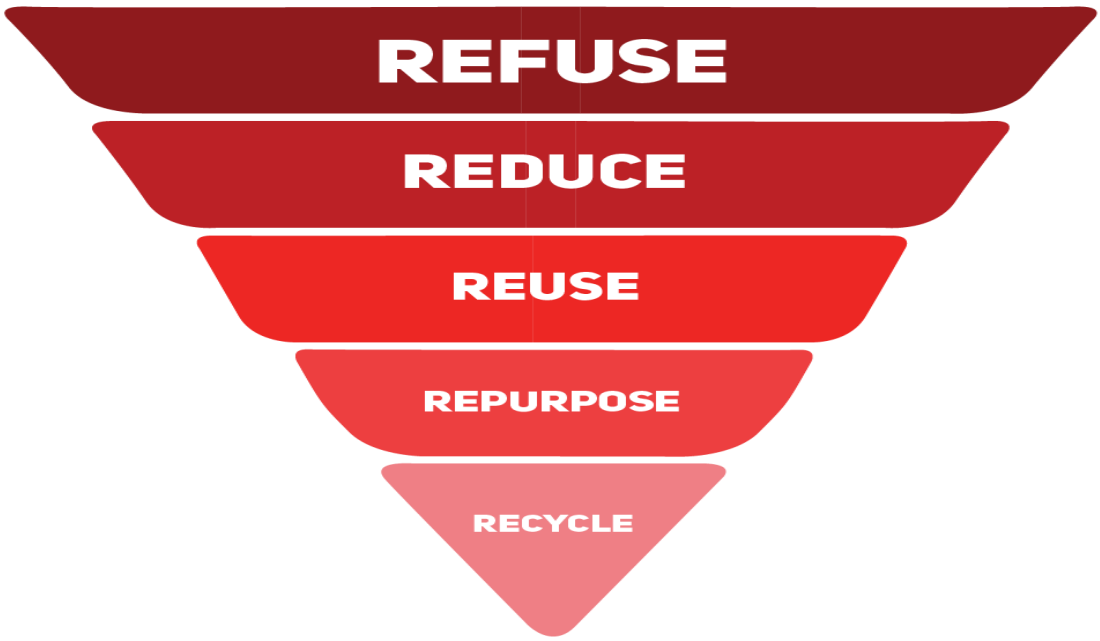
Sometimes, it will involve some imagination and creativity, but there are limitless possibilities with upcycling common objects found in the workplace. Try using leftover

cardboard boxes for storage, leftover cups and mugs as stationary holders and even using binder clips to hold together small wires.

You could even designate a small space to an ‘upcycling station’ and here you can collect and store items that you can reuse for convenient purposes later on. Also, encourage your colleagues and visitors to leave behind their ‘unusable items’ and see what you can come up with to ensure they can still be effectively used.

Step Five: Recycle

Last, but not least at all, we have recycled! Once you’ve ventured through all the other R’s, recycling is the most eco-friendly waste disposal method. If your business doesn’t recycle already, start by compiling cardboard, paper products, plastics, glass and organics. A lot of companies when they start recycling are instantly surprised by the amount of waste they reduce by implementing an effective recycling program.



Refuse, Reduce, Reuse, Repurpose, Recycle – that offers improvement to the environment.

Refuse:

- Refuse to buy or accept products that can harm you, your company and the environment.
- Refuse chemical solvents and use alternatives that are water based.

- Refuse to receive materials from your supplies with unnecessary packaging that you will later have to pay for to dispose.

Reduce:

- Reduce the energy use and stick to the basic requirements.
- Limit the requirements to minimum to reduce the use of resources.
- Control the use of non-renewable natural resources.

Reuse:

- Slowly replace any single use items with reusable ones – like reusable water bottles and mugs.
- Reuse packaging material (pallets, drums, bubble wrap or packaging peanuts).
- Reuse shipping containers (boxes, inserts, cartons).
- Reuse printer cartridges and have them refilled.

Repurpose:

- Repurpose is the process of taking something and using it for a separate purpose.
- Repurpose metal cans, buckets for creative plant containers.
- Repurpose wood crates into benches or shelves.
- Repurpose material shavings to help clean up spills.
- Repurpose HVAC condensate as a source for distilled water.

Recycle:

- All the materials that can be subjected to a chemical process to recycle them should be used as they can be recycled back to the new form again.
- Recycle all the basics you can – paper, plastic, metal and glass.
- Recycle food wastes into compost or as a food for a local farm.
- Recycle all fabrics including ripped clothes.
- Recycle all electronics if possible.

CONCEPT OF CARBON FOOTPRINT

A carbon footprint measures the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event, or product. It is typically measured in equivalent tons of carbon dioxide (CO_2), the most prevalent GHG. The concept is crucial for understanding and managing the impact of human activities on global climate change.

Components of a Carbon Footprint

1. Direct Emissions:

- Energy Use: Emissions from burning fossil fuels for electricity, heating, and transportation.
- Industrial Processes: Emissions from manufacturing, construction, and other industrial activities.

2. Indirect Emissions:

- Supply Chain: Emissions from the production and transport of goods and services purchased.
- Waste: Emissions from the decomposition of waste in landfills or through waste treatment processes.
- Land Use: Changes in land use, such as deforestation or reforestation, that affect carbon storage.

3. Calculation of Carbon Footprint

1. Data Collection:

- Gather data on energy consumption, transportation, waste production, and other relevant activities.

2. Emission Factors:

- Use standardized emission factors that convert activity data (e.g., liters of fuel used) into GHG emissions (e.g., kilograms of CO_2e).

3. Summation:

- Sum the emissions from all activities to get the total carbon footprint.

4. Tools and Methods

- Carbon Calculators: Online tools that estimate carbon footprints based on user inputs.
- Life Cycle Assessment (LCA): A detailed method that assesses the environmental impacts of products throughout their lifecycle.

Reducing Carbon Footprint

1. Energy Efficiency:

- Use energy-efficient appliances and vehicles.
- Implement energy-saving practices in homes and workplaces.

2. Renewable Energy:

- Switch to renewable energy sources like solar, wind, and hydroelectric power.

3. Sustainable Transportation:

- Use public transportation, carpooling, biking, and walking.
- Invest in electric or hybrid vehicles.

4. Waste Reduction:

- Recycle and compost to minimize waste sent to landfills.
- Reduce, reuse, and repurpose materials.

5. Sustainable Consumption:

- Purchase locally-produced and sustainable products.
- Reduce meat consumption, particularly beef and lamb, which have higher carbon footprints.

6. Carbon Offsetting:

- Invest in projects that reduce or remove GHGs from the atmosphere, such as reforestation and renewable energy projects.

Importance of Managing Carbon Footprint

1. Climate Change Mitigation:

- Reducing carbon footprints helps mitigate the adverse effects of climate change, such as extreme weather events, sea-level rise, and loss of biodiversity.

2. Environmental Responsibility:

- Encourages sustainable practices that preserve natural resources and ecosystems.

3. Economic Benefits:

- Energy efficiency and waste reduction can lead to significant cost savings.
- Promotes innovation and development of green technologies.

4. Regulatory Compliance:

- Helps businesses and organizations comply with environmental regulations and standards.

5. Social Responsibility:

- Demonstrates commitment to global sustainability and can enhance reputation and consumer trust.

By understanding and actively managing carbon footprints, individuals and organizations can contribute significantly to the global effort to reduce GHG emissions and combat climate change.

CARBON CREDIT AND CARBON TRADING

Carbon credits and carbon trading are mechanisms designed to reduce greenhouse gas emissions. They are part of international and national policies to combat climate change. Here's a detailed explanation of each:

Carbon Credits

Definition:

A carbon credit is a permit that allows the holder to emit a certain amount of carbon dioxide or other greenhouse gases (GHGs). Typically, one carbon credit equals one ton of CO2 or its equivalent in other GHGs.

Types of Carbon Credits:

1. Verified Emission Reductions (VERs): Generated by voluntary carbon offset projects and verified by independent organizations.

2. Certified Emission Reductions (CERs): Issued under the Clean Development Mechanism (CDM) of the Kyoto Protocol.

Creation:

Carbon credits are created through various methods, including:

- Renewable energy projects (solar, wind, hydro)
- Reforestation and afforestation projects
- Energy efficiency improvements
- Methane capture from landfills

Purpose:

The main aim of carbon credits is to cap the overall level of GHG emissions and allow industries and organizations that exceed their emission limits to purchase credits from those that emit less than their allowance, thus providing a financial incentive for reducing emissions.

Carbon Trading

Definition:

Carbon trading, also known as emissions trading, is a market-based approach to controlling pollution by providing economic incentives for reducing the emissions of pollutants. It works on the principle of cap and trade.

How it Works:

1. Cap: A limit is set on the total amount of certain GHGs that can be emitted by companies or countries.
2. Allocation: Emission permits or allowances are distributed to entities, which can be either given for free or auctioned.
3. Trading: Entities that need to increase their emission allowance must buy credits from those who pollute less. This creates a financial motive to reduce emissions.

Markets:

- Compliance Markets: Established by mandatory national, regional, or international carbon reduction regimes (e.g., EU Emissions Trading System, California Cap-and-Trade Program).
- Voluntary Markets: Operate outside of the regulatory schemes, allowing companies and individuals to voluntarily offset their emissions.

Benefits and Challenges

Benefits:

- Environmental Protection: Provides a mechanism to reduce GHG emissions effectively.
- Economic Incentives: Encourages innovation in low-carbon technologies.
- Flexibility: Allows companies to choose the most cost-effective way to reduce emissions.

Challenges:

- Market Volatility: Prices of carbon credits can be volatile.
- Measurement and Verification: Ensuring accurate measurement and verification of emissions reductions can be complex.
- Market Manipulation: Potential for manipulation and fraud in carbon markets.

Example Systems

- EU Emissions Trading System (EU ETS): The largest and first major carbon market, which caps emissions from more than 11,000 heavy energy-using installations in power generation and manufacturing industries.
- California Cap-and-Trade Program: A major program in the United States that sets a cap on the total amount of greenhouse gases that can be emitted by covered entities.

SUSTAINABLE HABITAT

GREEN BUILDINGS

Green buildings, also known as sustainable buildings, are designed to reduce the overall impact on human health and the natural environment. They achieve this through efficient use of energy, water, and other resources, protecting occupant health and improving productivity, and reducing waste, pollution, and environmental degradation. Here's a detailed overview of green buildings and their importance in creating sustainable habitats:

Key Features of Green Buildings

Energy Efficiency:

- Insulation: High-performance insulation reduces the need for heating and cooling.
- Renewable Energy Sources: Solar panels, wind turbines, and geothermal systems provide clean energy.
- Energy-efficient Lighting: Use of LED lighting and motion sensors to reduce energy consumption.

Water Efficiency:

- Low-flow Fixtures: Faucets, toilets, and showers designed to reduce water usage.
- Rainwater Harvesting: Systems to collect and use rainwater for landscaping and other non-potable uses.
- Greywater Recycling: Treating and reusing water from sinks, showers, and washing machines for irrigation or flushing toilets.

Material Efficiency:

- Sustainable Materials: Use of recycled, reclaimed, or sustainably sourced materials.
- Low VOC (Volatile Organic Compounds): Materials that release fewer pollutants into the indoor environment.

- Durability and Longevity: Materials designed to last longer, reducing the need for replacements.

Indoor Environmental Quality:

- Natural Ventilation: Design strategies to promote airflow and reduce reliance on mechanical ventilation.
- Indoor Plants: Use of indoor plants to improve air quality and enhance the indoor environment.
- Daylighting: Maximizing natural light to reduce the need for artificial lighting and improve occupant well-being.

Waste Reduction:

- Construction Waste Management: Recycling and reusing materials during construction to minimize waste.
- Composting: On-site composting facilities to reduce organic waste.
- Recycling Programs: Facilities to support recycling by building occupants.

Benefits of Green Buildings

1. Environmental Benefits:

- Reduced Carbon Footprint: Lower energy consumption and use of renewable energy reduce greenhouse gas emissions.
- Conservation of Natural Resources: Efficient use of water and materials conserves natural resources.
- Waste Reduction: Minimized waste through recycling and reuse practices.

2. Economic Benefits:

- Lower Operating Costs: Reduced energy and water bills due to efficient systems and renewable energy use.
- Increased Property Value: Higher resale value due to sustainability features and reduced operating costs.
- Incentives and Rebates: Access to government incentives, rebates, and grants for green building practices.

3. Health and Well-being:

- Improved Air Quality: Use of low-VOC materials and natural ventilation enhances indoor air quality.

- Enhanced Comfort: Better thermal comfort and natural lighting improve occupant satisfaction.
- Increased Productivity: Healthier indoor environments can lead to higher productivity and reduced absenteeism.

"GREEN MATERIALS" refers to materials that are environmentally friendly, sustainable, and have a low impact on the environment throughout their lifecycle, from production to disposal. The goal of using green materials is to reduce pollution, conserve resources, and promote sustainability in various industries, particularly in construction, manufacturing, and product design. Here are some key characteristics and examples of green materials:

Characteristics of Green Materials

1. Sustainability: Sourced from renewable resources or recycled materials.
2. Low Environmental Impact: Minimal pollution and energy consumption during production.
3. Non-Toxicity: Free of harmful chemicals and safe for human health.
4. Durability: Long-lasting and resistant to wear, reducing the need for frequent replacement.
5. Recyclability: Can be recycled or safely disposed of without harming the environment.

Examples of Green Materials

1. Bamboo: A fast-growing, renewable resource often used in flooring, furniture, and construction.
2. Recycled Steel: Steel made from recycled scrap metal, reducing the need for raw material extraction.
3. Cork: Harvested from the bark of cork oak trees without harming the tree, used in flooring and insulation.
4. Recycled Plastic: Used in various products, from clothing to building materials.
5. Hemp: Used in textiles, bioplastics, and construction materials like hempcrete.
6. Linoleum: Made from natural materials like linseed oil, wood flour, and cork dust, used in flooring.
7. Rammed Earth: A natural building material made from compacted earth, providing thermal mass and insulation.
8. Straw Bales: Used as a building material with good insulation properties.

9. Reclaimed Wood: Wood salvaged from old structures and repurposed for new projects.
10. Natural Fiber Insulation: Insulation made from materials like sheep's wool, cotton, and cellulose.

Benefits of Using Green Materials

- Environmental Protection: Reduced pollution and resource depletion.
- Health Benefits: Improved indoor air quality and reduced exposure to toxic substances.
- Energy Efficiency: Often better insulation properties, leading to energy savings.
- Economic Savings: Long-term cost savings from durability and energy efficiency.

Applications of Green Materials

- Construction: Building homes, offices, and other structures with sustainable materials.
- Interior Design: Using eco-friendly materials for furniture, flooring, and finishes.
- Manufacturing: Producing goods with recycled or sustainable inputs.
- Packaging: Using biodegradable or recyclable packaging materials.

By prioritizing green materials, industries and individuals can contribute to a more sustainable and environmentally friendly future.

ENERGY EFFICIENCY

Energy efficiency refers to using less energy to perform the same task or produce the same outcome. It encompasses various practices, technologies, and strategies aimed at reducing energy consumption while maintaining or improving performance.

Key Aspects of Energy Efficiency

1. Building Design and Insulation:

- Insulation: Proper insulation of walls, roofs, and floors to reduce heat loss in winter and heat gain in summer.
- Windows and Doors: Using energy-efficient windows and doors to minimize thermal transfer.
- Lighting: Implementing LED lighting and smart lighting systems that adjust based on occupancy and daylight availability.

2. Heating, Ventilation, and Air Conditioning (HVAC):

- Efficient HVAC Systems: Using high-efficiency HVAC systems that consume less energy.
- Programmable Thermostats: Installing smart thermostats to optimize heating and cooling schedules.
- Regular Maintenance: Ensuring regular maintenance of HVAC systems to maintain peak efficiency.

3. Appliances and Equipment:

- Energy-Efficient Appliances: Using appliances that have high energy efficiency ratings (e.g., ENERGY STAR certified).
- Smart Appliances: Utilizing smart appliances that can adjust their operation based on usage patterns.

4. Industrial Processes:

- Process Optimization: Streamlining industrial processes to minimize energy waste.
- Energy Recovery: Implementing systems to recover and reuse waste energy.
- Efficient Motors and Drives: Using energy-efficient motors and variable speed drives.

5. Transportation:

- Fuel-Efficient Vehicles: Using vehicles that have high fuel efficiency or are powered by alternative energy sources (e.g., electric vehicles).
- Public Transportation: Promoting the use of public transportation and carpooling to reduce individual energy consumption.
- Active Transportation: Encouraging walking and cycling as alternatives to motorized transport.

6. Renewable Energy Integration:

- Solar Panels: Installing solar panels to generate electricity from renewable sources.

- Wind Turbines: Using wind turbines to produce clean energy.
- Energy Storage Systems: Implementing battery storage systems to store excess energy for later use.

Benefits of Energy Efficiency

1. Cost Savings:
- Reduced energy bills due to lower energy consumption.
- Lower operational costs for businesses and industries.
2. Environmental Impact:
- Decreased greenhouse gas emissions, contributing to the fight against climate change.
- Reduced air and water pollution.
3. Resource Conservation:
- Lower demand for finite energy resources such as coal, oil, and natural gas.
- Enhanced sustainability of energy resources.
4. Energy Security:
- Reduced dependence on imported energy, enhancing national energy security.
- Increased resilience against energy price fluctuations and supply disruptions.
5. Improved Comfort and Health:
- Better indoor air quality and thermal comfort in buildings.
- Enhanced quality of life due to a cleaner environment and reduced pollution.
6. Economic Growth:
- Creation of jobs in the energy efficiency sector (e.g., manufacturing, installation, maintenance).
- Stimulating innovation and development of new technologies.

Strategies for Implementing Energy Efficiency

1. Energy Audits:
- Conducting energy audits to identify areas where energy efficiency can be improved.
- Implementing recommended measures from energy audits.
2. Incentives and Policies:
- Government incentives such as tax credits, rebates, and grants for energy-efficient upgrades.

- Regulations and standards that promote energy efficiency in various sectors.

3. Education and Awareness:

- Raising awareness about the benefits and practices of energy efficiency.
- Providing training and resources to individuals and businesses on how to improve energy efficiency.

4. Technology and Innovation:

- Investing in research and development of new energy-efficient technologies.
- Encouraging the adoption of innovative solutions and practices.

Energy efficiency is a crucial component in the global effort to reduce energy consumption, lower emissions, and achieve a sustainable future. By implementing energy-efficient practices and technologies, individuals, businesses, and governments can contribute to a more efficient and environmentally friendly energy landscape.

SUSTAINABLE TRANSPORT

Sustainable transport refers to the systems, vehicles, and practices that minimize environmental impact, promote energy efficiency, and ensure social and economic benefits. The goal is to create transportation solutions that meet current mobility needs without compromising the ability of future generations to meet their own.

Key Elements of Sustainable Transport:

1. Reduction of Emissions:

- Electric Vehicles (EVs): Use electric motors powered by batteries, reducing greenhouse gas emissions.
- Hybrid Vehicles: Combine internal combustion engines with electric propulsion to improve fuel efficiency and reduce emissions.
- Biofuels: Derived from organic materials, they can be used in place of conventional fuels to reduce carbon footprint.

2. Energy Efficiency:

- Public Transportation: Buses, trams, and trains can move large numbers of people more efficiently than individual cars.
- Cycling and Walking: Non-motorized transport modes that require no fuel and produce no emissions.
- Carpooling and Ride-Sharing: Reduces the number of vehicles on the road, leading to less traffic congestion and lower emissions.

3. Infrastructure and Urban Planning:

- Transit-Oriented Development (TOD): Urban development designed to maximize access to public transport.
- Complete Streets: Streets designed for safe and accessible use by all modes of transport, including pedestrians, cyclists, and public transit.
- Bike Lanes and Bike Sharing Programs: Encourage cycling by providing safe and convenient infrastructure and shared bicycles.

4. Innovative Technologies:

- Autonomous Vehicles: Potential to reduce traffic congestion and improve fuel efficiency through optimized driving patterns.
- Smart Grids and Charging Infrastructure: Support for EVs through widespread, efficient, and renewable energy-powered charging stations.
- Internet of Things (IoT) and Big Data: Improve traffic management and reduce congestion through real-time data collection and analysis.

Examples of Sustainable Transport Initiatives:

1. Electric and Hybrid Buses: Many cities are replacing diesel buses with electric or hybrid buses to reduce urban air pollution.

2. Bike Sharing Programs: Cities like Copenhagen, Amsterdam, and New York have implemented extensive bike-sharing programs.
3. High-Speed Rail: Countries like Japan, France, and China have developed high-speed rail networks as a more sustainable alternative to air travel for short to medium distances.
4. Car-Free Zones: Some cities, such as Madrid and Oslo, have designated areas where cars are banned to reduce emissions and promote pedestrian-friendly environments.
5. Congestion Pricing: Cities like London and Singapore have implemented congestion pricing to reduce traffic in city centers and encourage the use of public transport.

Benefits of Sustainable Transport:

1. Environmental:

- Reduced greenhouse gas emissions and air pollutants.
- Lower energy consumption and dependence on fossil fuels.
- Preservation of natural habitats and reduction in noise pollution.

2. Economic:

- Lower transportation costs for individuals and governments.
- Job creation in green transport industries.
- Increased property values in areas with good public transport.

3. Social:

- Improved public health through reduced air pollution and increased physical activity.
- Enhanced accessibility and mobility for all societal groups.
- Better quality of life through reduced traffic congestion and improved urban spaces.

Challenges to Implementing Sustainable Transport:

1. Initial Costs: High upfront investments required for infrastructure development and new technologies.
2. Public Acceptance: Resistance to change and adaptation of new transport modes by the public.
3. Policy and Regulation: Need for supportive policies, regulations, and incentives to promote sustainable transport.

4. Integration: Ensuring seamless integration of various transport modes for efficient and convenient mobility.

Sustainable transport is essential for creating a more livable, efficient, and environmentally friendly future. By investing in and prioritizing these systems and practices, cities and countries can work towards achieving long-term sustainability goals.

ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

An Environmental Management System (EMS) is a framework that helps an organization achieve its environmental goals through consistent control of its operations. The assumption is that this increased control will improve the environmental performance of the company. The most widely used framework for an EMS is the International Organization for Standardization (ISO) 14001 standard.

Key Components of an EMS

1. Environmental Policy: A statement by the organization of its intentions and principles in relation to its overall environmental performance which provides a framework for action and for setting its environmental objectives and targets.
2. Planning: This involves identifying environmental aspects and impacts, legal and other requirements, and setting environmental objectives and targets.

- Environmental Aspects: Elements of an organization's activities, products, or services that can interact with the environment.
- Environmental Impacts: Any change to the environment, whether adverse or beneficial, wholly, or partially resulting from an organization's activities, products, or services.
- Legal and Other Requirements: Identifying relevant environmental legislation and other requirements to which the organization subscribes.

3. Implementation and Operation: Establishing roles and responsibilities, training, communication, documentation, control of documents, operational control, and emergency preparedness and response.
4. Checking and Corrective Action: Monitoring and measurement, evaluating compliance, non-conformance and corrective and preventive action, control of records, and internal EMS audits.
5. Management Review: Periodic review by top management to ensure the EMS is suitable, adequate, and effective.

Benefits of an EMS

- Improved Environmental Performance: Through systematic control and management of environmental aspects.
- Compliance: Helps ensure compliance with legal and other requirements.
- Prevention of Pollution: Encourages proactive measures to prevent pollution.
- Resource Conservation: Promotes efficient use of resources which can lead to cost savings.
- Enhanced Corporate Image and Market Share: Demonstrates commitment to the environment which can improve relationships with customers, regulators, and the community.

Steps to Implement an EMS

1. Commitment and Policy: Obtain commitment from top management and develop an environmental policy.
2. Planning: Identify legal requirements and environmental aspects, establish objectives and targets, and develop programs to achieve these objectives and targets.
3. Implementation: Develop the capabilities and support mechanisms necessary to achieve the EMS policy, objectives, and targets.
4. Evaluation: Monitor and measure progress against the environmental policy, objectives, and targets; identify areas for improvement.
5. Review and Improve: Review the system and its performance, and make improvements where necessary.

ENVIRONMENTAL AUDIT

Environmental audit was firstly initiated in the US in the 1970. European countries and Asian countries have started auditing in the 1980 and 1990 respectively. Compared to the history of the environmental movement, environmental audit is still at the developing stage. There is no universal format and definition. Different people have different interpretations of environmental audit. However definitely/ audit is different from environmental impact assessment, and it is essential and important assessment assesses the potential environment effects of a proposed facility based primarily on professional judgement while

auditing is a systematic monitoring of environmental performance of a company's existing operations and practices by data collection and with evidence in support.

Although there is no fixed definition, there is a broad definition of environmental auditing by the International Chamber of Commerce (ICC) which is widely adopted. According to the ICC definition in its 1989 Position Paper on Environmental Auditing:

"Environmental audit is a management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental organization, management/ and equipment are performing with the aim of helping to safeguard the environment by:

- facilitating management control of environmental practices
- assessing compliance with company policies, which would include meetingregulatory requirements."

Scope of Environmental Audit

Environmental audit is a voluntary program set by a company to measure the company's environmental performance. The scope of an audit could vary from one company to anther or from site to site depending on the nature of the business and the expectation of the organization. Auditing can only be beneficial to a company while an appropriate and carefully planned audit is employed. Otherwise environmental audit will involve a lot of resources but yield only an unmanageable mass of data which recording non-compliance and does not assist in the management decision.

The scope of environmental audit covers a wide range, from a whole company and all its activities to just a short and small audit on the performance of a piece of equipment. Audits can involve evaluation of the organization's past, current and planned activities, or products and services as well. The scope of environmental audit can be broadly classified into four streams:

- Geographical
- Functional
- Divisional
- Compliance.

1. Geographical

It is difficult for any company to initiate an audit program on all of their plants or divisions where too little is known on auditing approach. The scope of an initial environmental audit

can be confined to a single site for a world-wide company or a multi-functional company. An audit can be firstly implemented in a developed country where the resources and support for carrying out an audit are more available.

Usually there would be more pressure for better environmental performance from either government or the public and because of stringent regulations. The benefits of having positive environmental attitudes will be greater. The audit can be considered as a trial for the whole organization. A prototype framework based on the currently implemented environmental audit on the site can be developed which would then be suitable for implementation to other sites within the company.

2. Functional

A company may opt to audit on a selective basis so that audit can be concentrated on particular activities and operations. Environmental impacts of manufacturing sectors and industrial activities are of especial concern to the public. Environmental audit can be focused on discharging of pollutants into environmental media, namely air, water, and land. The environmental audit can be confined to the examination of the discharges of contaminants into the atmosphere, (for example S02, NOx, C02, dust, artificial chemicals like CFCs into air or discharge of nutrients into river) or concentrated on monitoring either a particular site or for the whole company. The organizational activities and their impacts to the environment should therefore be identified at an early stage for designing the scope of an audit. The selection of a functional group or plant for audit also depends on the plant age, size, location, number of past non-compliance problems and type of processes involved, possible expansion of the operation and possible sale.

3. Divisional

The nature of the company will govern the scope of an environmental audit. The prior commitment of the management group in the company could increase the extent of auditing area, for example from an office to a plant For an international company' the operation and activities may not be the same type or in the same geographic area, or in the same country. The auditing could start at one division and then apply the environmental audit with amendment to other divisions.

4. Compliance

Obviously, a company doing environmental audit does not aim at environmental protection in the first place. Under the requirements of all the statutory standards and legislation, the

environmental performance of the company has to be reasonably good to ensure compliance so as to avoid the legal liabilities and penalties. Compliance with regulations could be an initial step in a company's long-term environmental program. Auditing can be applied on reviewing compliance to particular regulations instead of all of the identified requirements due to the limited resources of the company and based on the urgency and importance of particular process. There could be more immediate benefits for ensuring compliance of one standard than another.

The development of environmental program within the company can go beyond the legislation compliance to having their own standards and objectives for compliance. The auditing could be developed to be a review of compliance of the company's policy and objectives which could be more stringent for assurance of environmental management.

Objectives of Environmental Audit

- Increase attention and knowledge of an organization's operation

All industrial, commercial and domestic activities involve consumption of natural resources. People always forget the cost of natural resources, especially naturally occurring resources which have great value but are of little financial cost to the business. Some natural resources are public goods for example, fresh air, clean water streams and land. They have no agreed and defined values. The value of such abundant resources will be ignored or sometimes, as there are subsidies by the government, the cost of resources cannot reflect their true value. Through the audit of the site activities are identified and by the collection of factual data, the consumption of resources related to any processes or activities of company could be known and more effective control of consumption can be implemented.

- To assist management and improve environmental performance

After increasing the understanding of the organisation's operation, the next objective of audit is to assist a management group and its facility or production manager in improving the environmental performance of the organization with the help of the collected information. Weaknesses identified in the environmental audit are corrected and recommendations in the audit report have to be implemented.

- To reduce cost and optimize resources

Close monitoring and auditing of litigation and non-compliance will facilitate immediate remediation and therefore save the company from prosecution and fines. Moreover, dose

monitoring of the production efficiency, i.e. amount of input resources per products, will enhance optimization of resources.

- To demonstrate commitment of management to environmental performance

Auditing involves reporting the results showing the commitment of the company to environmental issues to a variety of groups: shareholders, investors and the general public. Different groups could have the prescription of the extent of environmental work being done and the achievements.

- To educate and motivate the workforce.

Staff involved in internal auditing either being the auditors or the ones being audited, will increase environmental awareness among the company. Reporting the achievements in newsletters will also increase the support for environmental programs.

ISO14000

ISO 14000 is a set of standards created to help companies around the world reduce their adverse impact on the environment. It's a framework for improved and more environmentally conscious quality management systems by organizations large and small.

The ISO 14000 series of standards was introduced in 1996 by the International Organization for Standardization (ISO) and most recently revised in 2015. (ISO is not an acronym. The short form of the organization's name is derived from the ancient Greek word *ísos*, meaning equal or equivalent.)

Adopting the standards is strictly optional. Companies can get ISO 14000 certified. More than 400,000 organizations around the world have obtained certification, according to the latest ISO survey.

Understanding ISO 14000

ISO 14000 is meant to be a step-by-step guide for establishing and then achieving environmentally friendly objectives for business practices and products. The purpose is to help companies manage processes efficiently while minimizing environmental effects.

A separate set of standards, called ISO 9000, introduced in 1987, focuses on the best management practices for quality assurance. The two systems can be implemented concurrently.

ISO 14000 includes standards that cover aspects of management practices inside facilities, in the immediate environment around the facilities, and during the life cycle of the actual product. This includes understanding the impact of the raw materials used to create the product as well as the impact of its eventual disposal.

ISO 14000 Standards

The core of the ISO 14000 standards is contained in ISO 14001, which lays out the guidelines for putting an environmental management system (EMS) in place. Then there's ISO 14004, which offers additional insight and specialized standards for implementing an EMS.

Obtaining certification is a process that can take several years. Safety Culture, a software company that specializes in improving workplace safety & risk management, suggests companies conduct an internal audit to evaluate their compliance before undergoing the formal accreditation process.

Here are the key standards included in ISO 14000:

- ISO 14001 and ISO 14002: Specification of Environmental Management Systems
- ISO 14004: Guideline Standard
- ISO 14015, ISO 14016, and ISO 14017: Environmental Auditing and Related Activities
- ISO 14020, ISO 14021, and ISO 14024: Ecoabeling
- ISO 14030 and ISO 14031: Environmental Performance Evaluation
- ISO 14040 – ISO 14043: Life Cycle Assessment

Benefits of ISO 14000

Obtaining ISO 14000 certification can be considered a sign of a commitment to the environment, which can be used as a marketing tool for companies. It may also help companies meet environmental regulations that are imposed by governments in which they do business.

ISO 14000 certification can open the doors to new business. Some companies prefer to use suppliers that are ISO 14000–certified suppliers.

Their customers may also pay more for products that are environmentally friendly.

On the cost side, meeting the ISO 14000 standards can help reduce costs, as it stresses the efficient use of resources, limiting waste, recycling, and even finding new uses for previously disposed of byproducts.

Following the guidelines in ISO 14000 does not guarantee that an organization is meeting all of the regulations that may be imposed by the government under whose jurisdiction it operates.

In the U.S., the Environmental Protection Agency and some state agencies participated in the creation of ISO 14001, the core piece of ISO 14000. It includes information about environmental management systems in general, and ISO 14000 in particular, on its website.

What Is the Difference Between ISO 9000 and ISO 14000?

ISO has created a number of manuals for the implementation of sound business practices that are acceptable globally. Each of these manuals is updated regularly and sector-specific versions are available for industries with challenges.

The organization describes ISO 9000 as a family of standards for quality management systems. It can be seen as an overall guide to ethical management and leadership. ISO 14000, of which ISO 14001 is a key piece, was created as a handbook for organizations that seek to minimize environmental impact of their actions.

ENVIRONMENTAL STEWARDSHIP-NGO'S

Environmental stewardship refers to the responsible use and protection of the natural environment through conservation and sustainable practices. It involves a variety of actions and strategies aimed at preserving the earth's resources, ecosystems, and biodiversity for future generations. Here are some key aspects of environmental stewardship:

Key Aspects of Environmental Stewardship

1. Conservation of Natural Resources:

- Reducing the consumption of non-renewable resources (like fossil fuels).
- Promoting the use of renewable resources (such as solar and wind energy).
- Implementing water conservation techniques to preserve freshwater supplies.

2. Sustainable Practices:

- Encouraging sustainable agriculture and forestry practices.
- Supporting sustainable fisheries and marine conservation.
- Promoting sustainable urban development and green building practices.

3. Pollution Prevention and Waste Management:

- Reducing air, water, and soil pollution through regulation and innovation.

- Implementing waste reduction strategies like recycling and composting.
- Managing hazardous waste responsibly to prevent environmental contamination.

4. Habitat and Biodiversity Protection:

- Preserving natural habitats and protecting endangered species.
- Restoring damaged ecosystems and rehabilitating wildlife populations.
- Supporting biodiversity through conservation programs and protected areas.

5. Climate Change Mitigation and Adaptation:

- Reducing greenhouse gas emissions through clean energy initiatives.
- Enhancing carbon sequestration through reforestation and soil management.
- Developing strategies to adapt to the impacts of climate change, such as rising sea levels and extreme weather events.

6. Environmental Education and Advocacy:

- Raising awareness about environmental issues through education and outreach.
- Advocating for environmental policies and regulations at local, national, and global levels.
- Engaging communities in environmental stewardship activities and initiatives.

7. Corporate Social Responsibility (CSR):

- Encouraging businesses to adopt environmentally friendly practices.
- Promoting corporate transparency and accountability regarding environmental impacts.
- Supporting corporate initiatives that contribute to sustainability and environmental protection.

Examples of Environmental Stewardship Initiatives

1. Community Clean-up Programs:

- Organizing local clean-up events to remove litter and pollutants from natural areas.
- Partnering with schools and community organizations to educate and involve residents in environmental activities.

2. Tree Planting Campaigns:

- Conducting reforestation and afforestation projects to increase green cover.
- Engaging volunteers in planting trees in urban and rural areas to enhance biodiversity and reduce carbon dioxide levels.

3. Energy Efficiency Projects:

- Implementing energy-saving measures in homes, offices, and industries.
- Encouraging the use of energy-efficient appliances and renewable energy sources.

4. Sustainable Agriculture Practices:

- Promoting organic farming and the use of eco-friendly agricultural techniques.
- Supporting local food systems and reducing the carbon footprint of food production and transportation.