Environmental Science and Disaster Management

Unit- 1

Introduction:

Environment is derived from the French word Environner, which mean encircle or surrounding. Environment is a complex of many variables, which surrounds man as well as the living organisms. Environmental studies describe the interrelationships among organisms, the environment and all the factors, which influence life on earth, including atmospheric conditions, food chains, the water cycle, etc. It is a basic science about our earth and its daily activities, and therefore, this science is important for one and all.

Scope of environmental studies

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

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

Importance of environmental study

Environmental study is based upon a comprehensive view of various environmental systems. It aims to make the citizens competent to do scientific work and to find out practical solutions to current environmental problems. The citizens acquire the ability to analyze the environmental parameters like the aquatic, terrestrial and atmospheric systems and their interactions with the biosphere and astrosphere.

Importance

- World population is increasing at an alarming rate especially in developing countries.
- The natural resources endowment in the earth is limited.
- The methods and techniques of exploiting natural resources are advanced.
- The resources are over-exploited and there is no foresight of leaving the resources to the future generations.
- The unplanned exploitation of natural resources lead to pollution of all types and at all levels.
- The pollution and degraded environment seriously affect the health of all living things on earth , including man.
- The people should take a combined responsibility for the deteriorating environment and begin to take appropriate actions to space the earth.
- Education and training are needed to save the biodiversity and species extinction.
- The urban area, coupled with industries, is major sources of pollution.
- The number and area extinct under protected area should be increased so that the wild life is protected at least in these sites.
- The study enables the people to understand the complexities of the environment and need for the people to adapt appropriate activities and pursue sustainable development, which are harmonious with the environment.
- The study motivates students to get involved in community action, and to participate in various environmental and management projects.
- It is a high time to reorient educational systems and curricula towards these needs.
- Environmental studies take a multidisciplinary approach to the study of human interactions with the natural environment. It integrates different approaches of the humanities , social sciences, biological sciences and physical sciences and applies these approaches to investigate environmental concerns.
- Environmental study is a key instrument for bringing about the changes in the knowledge, values, behaviors and lifestyles required to achieve sustainability and stability within and among countries.

Ecosystems:

Ecology is the science that deals with the relationships between living organisms with their physical environment and with each other. Ecology can be approached from the viewpoints of (1) the environment and the demands it places on the organisms in it or (2) organisms and how they adapt to their environmental conditions. An ecosystem consists of an assembly of mutually interacting organisms and their environment in which materials are interchanged in a largely cyclical manner. An ecosystem has physical, chemical, and biological components along with energy sources and pathways of energy and materials interchange. The environment in which a particular organism lives is called its habitat. The role of an organism in a habitat is called itsniche.

For the study of ecology it is often convenient to divide the environment into four broad categories.

1. Terrestrial environment - The terrestrial environment is based on land and consists of biomes, such as grasslands, one of several kinds of forests, savannas, or deserts.
2. Freshwater environment - The freshwater environment can be further subdivided between *standing-water habitats (*lakes, reservoirs) and *running-water habitats (*streams, rivers).
3. Oceanic marine environment - The oceanic marine environment is characterized by saltwater and may be divided broadly into the shallow waters of the continental shelf composing the neritic zone
4. Oceanic region - The deeper waters of the ocean that constitute the oceanic

region. Two major subdivisions of modern ecology are

- Ecosystem ecology - which views ecosystems as large units, and
- Population ecology - which attempts to explain ecosystem behavior from the properties of individual units.

In practice, the two approaches are usually merged. Descriptive ecology describes the types and nature of organisms and their environment, emphasizing structures of ecosystems and communities and dispersions and structures of populations. Functional ecology explains how things work in an ecosystem, including how populations respond to environmental alteration and how matter and energy move through ecosystems.

Ecosystems are broadly divided into natural and artificial. *Natural ecosystems* are those that are existing in nature; they are further classified into terrestrial and aquatic. Terrestrial includes hot desert, grass land, tropical and temperate rainforest and *aquatic* includes ponds, river, streams, lakes, estuaries, oceans, mangroves, swamps and bays etc. However these two ecosystems are self-regulating, open system with a free exchange of inputs and outputs with other systems. Artificial ecosystems are simple, human-made, unstable and subjected to human intervention and manipulation. Usually it is formed by clearing a part of theforest or grassland e.g. crop field, agricultural land.

Structure and Function of an ecosystem

An ecosystem has two components the biotic components consisting of living things, and the abiotic portion, consisting of elements that are not alive. The nonliving constituents are said to include the following category, habitat, gases, solar radiation, temperature, moisture and inorganic and organic nutrients. The living organisms may be sub divided into producers, consumers and decomposers. Abiotic Components include basic inorganic and organic components of the environment or habitatof the organism. The inorganic components of an ecosystem are carbon dioxide, water nitrogen, calcium phosphate all of which are involved in matter cycle (biogeochemical cycles). The organic components of an ecosystem are proteins, carbohydrates, lipids and amino acids, all of which are synthesized by the biota (flora and fauna) of an ecosystem and are reached to ecosystem as their wastes, dead remains etc. the climate 'microclimate' temperature, light soil etc. are abiotic components of the ecosystems.

Functions of an Ecosystem

Ecosystem function is the capacity of natural processes and components to provide goods and services that satisfy human needs, either directly or indirectly. Ecosystem functions are subset of ecological processes and ecosystem structures. Each function is the result of the natural processes of the total ecological sub-system of which it is a part. Natural processes, in turn, are the result of complex interactions between biotic (living organisms) and abiotic (chemical and physical) components of ecosystems through the universal driving forces of matter and energy. **There are fourprimary groups of ecosystem functions** (1) regulatory functions, (2) habitat functions, (3) production functions and (4) information functions. This grouping concerns all ecosystems, not only for forests.

General characterization of ecosystem functions are:

Regulatory functions: this group of functions relates to the capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems through bio-geochemical cycles and other bio-spherical processes. In addition to maintaining the ecosystem (and biosphere health), these regulatory functions provide many services that have direct and indirect benefits to humans (i.e., clean air, water and soil, and biological control services).

Habitat functions: natural ecosystems provide refuge and a reproduction habitat to wild plants and animals and thereby contribute to the (in situ) conservation of biological and genetic diversity and the evolutionary process.

Production functions: Photosynthesis and nutrient uptake by autotrophs converts energy, carbon dioxide, water and nutrients into a wide variety of carbohydrate structures which are then used by secondary producers to create an even larger variety of living biomass. This broad diversity in

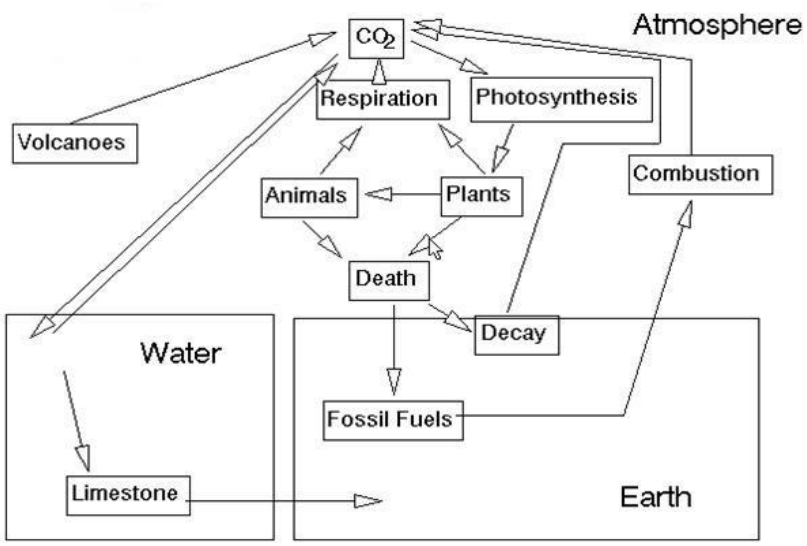
Carbohydrate structures provides many ecosystem goods for human consumption, ranging from food and raw materials to energy resources and genetic material.

Information functions: Since most of human evolution took place within the context of an un domesticated habitat, natural ecosystems contribute to the maintenance of human health by

Carbon Cycle

Carbon, the basic building block of life molecules, is circulated through the carbon cycle. This cycle shows that carbon may be present as gaseous atmospheric CO_2, dissolved in groundwater as HCO_3 or molecular $CO_2(aq)$, in underlying rock strata as limestone ($CaCO_3$), and as organic matter, represented in a simplified manner as (CH_2O). Photosynthesis fixes inorganic carbon as biological carbon, which is a constituent of all life molecules.

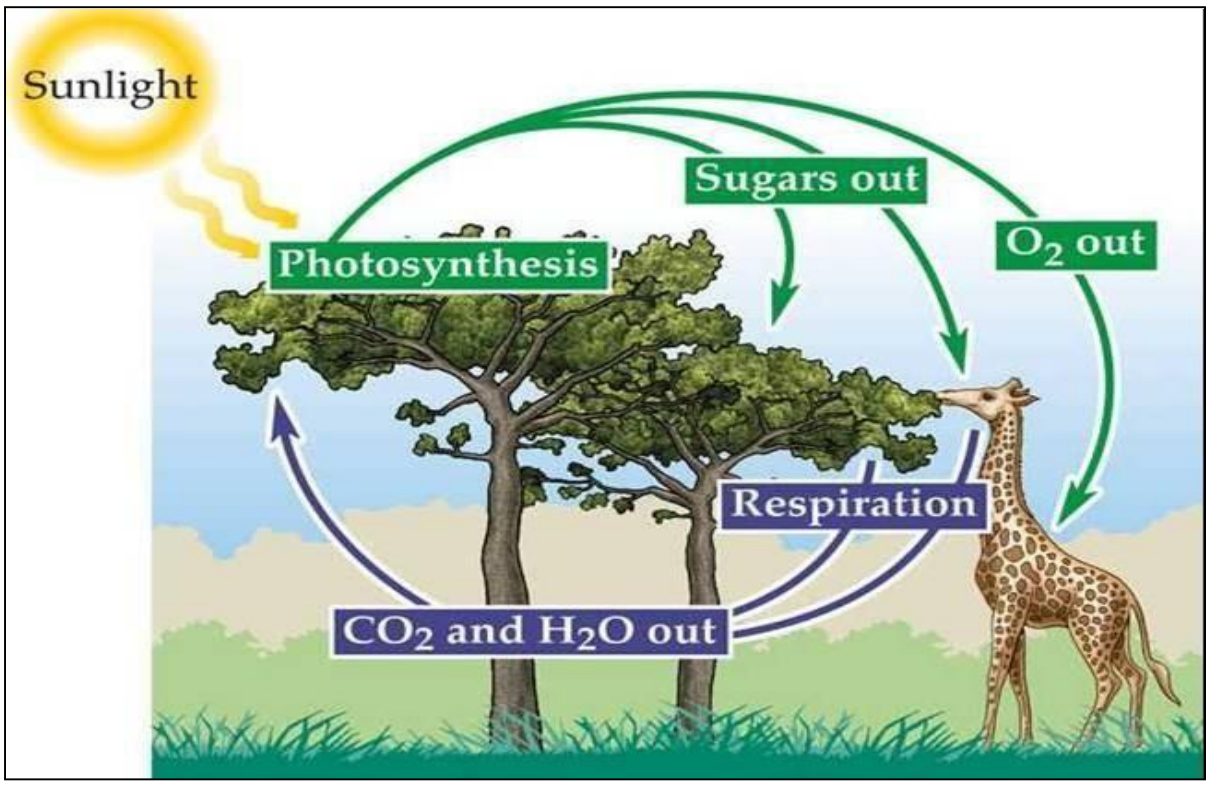
An important aspect of the carbon cycle is that it is the cycle by which energy is transferred to biological systems. Organic or biological carbon, (CH_2O), is an energy-rich molecule that can react biochemically with molecular oxygen, O_2, to regenerate carbon dioxide and produce energy. This can occur in an organism as shown by the "decay" reaction or it may take place as combustion, such as when wood is burned.



Oxygen Cycle

The oxygen cycle involves the interchange of oxygen between the elemental forms of gaseous O_2 in the atmosphere and chemically bound O in CO_2, H_2O, and organic matter. Elemental oxygen becomes chemically bound by various energy-yielding processes, particularly combustion and metabolic processes in organisms. It is released during photosynthesis.

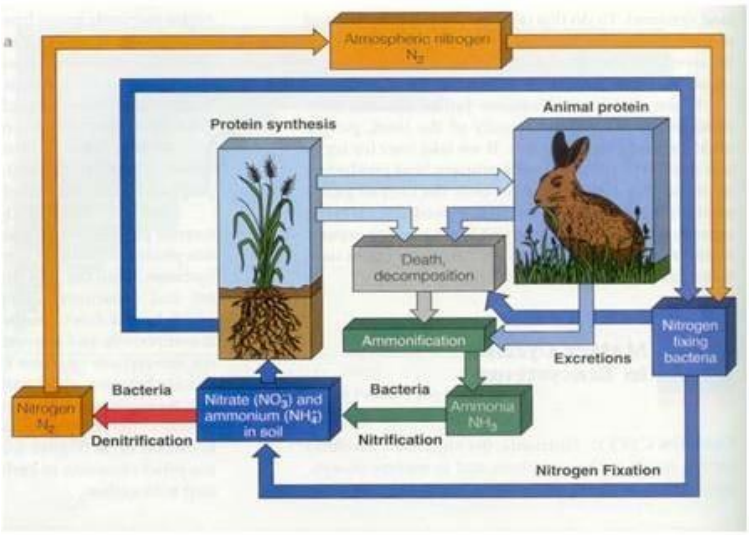
Oxygen Cycle



Nitrogen Cycle

Nitrogen, though constituting much less of biomass than carbon or oxygen, is an essential constituent of proteins. The atmosphere is 78% by volume elemental nitrogen, N_2 and constitutes an inexhaustible reservoir of this essential element. The N_2 molecule is very stable so that breaking it down to atoms that can be incorporated in inorganic and organic chemical forms of nitrogen is the limiting step in the nitrogen cycle. This does occur by highly energetic processes in lightning discharges such that nitrogen becomes chemically combined with hydrogen or oxygen as ammonia or nitrogen oxides. Elemental nitrogen is also incorporated into chemically bound forms or fixed by biochemical processes mediated by microorganisms. The biological nitrogen is returned to the inorganic form during the decay of biomass by a process called mineralization.

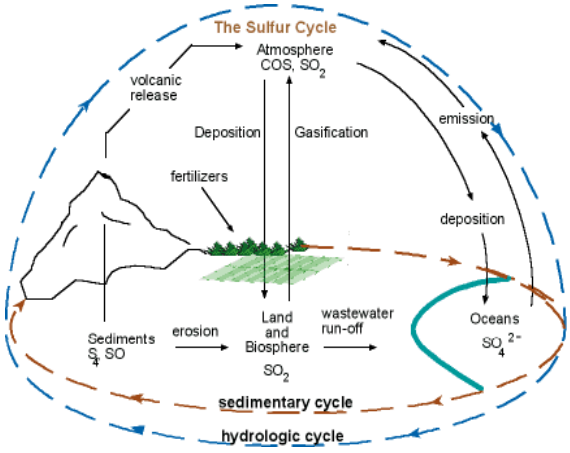
Nitrogen Cycle



Sculpture Cycle

The sulfur cycle is relatively complex. It involves several gaseous species, poorly soluble minerals, and several species in solution. It is involved with the oxygen cycle in that sulfur combines with oxygen to form gaseous sulfur di oxide (SO_2) an atmospheric pollutant, and soluble sulfate ion, (SO_4^{2-}). Among the significant species involved in the sulfur cycle are gaseous hydrogen sulfide, H_2S; mineral sulfides, such as PbS; sulfuric acid, H_2SO_4, the main constituent of acid rain; and biologically bound sulfur in sulfur-containing proteins.

Sulfur cycle



It should be obvious that material cycles, often based on elemental cycles, are very important in the environment.

Ecosystem:

Our environment consisting of both living and non-living systems, influence each other in form, function and property which is necessary to maintain life. The composition of the living and the non-living systems are the building blocks of an ecosystem.

Producers

In an ecosystem, producers are those organisms that use photosynthesis to capture energy by using sun light, water and carbon dioxide to create carbohydrates, and then use that energy to create more complex molecules like proteins, lipids and starches that are crucial to life processes. Producers, which are mostly green plants, are also called autotrophs.

Producers funnel into the ecosystem the energy needed for its biological processes. The carbohydrates and other organic chemicals formed by the producers are utilized by the heterotrophs, or consumers; first by the herbivores who eat the plants--the primary consumers--then by the predators who eat the herbivores--the secondary, tertiary, and so on consumers. But at each step, much energy is lost. Less than 10 percent of the energy stored in plants is converted to herbivore mass. The loss from herbivore to predator is similar. Thus energy needs to be added to the eco system continuously.

Consumers

Consumers are organisms (including humans) that get their energy from producers, regarding the flow of energy through an ecosystem. For example, producers, (such as plants), make their own food by the process of photosynthesis. An organism ate this plant, than it would be a primary consumer. The animal that eats *this* animal is known as the second order consumer. Scientifically, all consumersare either herbivores, carnivores, omnivores or detrivores (decomposers and other organism that break down organic matter). These 'orders' are known as trophic levels.

Decomposers

Decomposers eventually convert all organic matter into carbon dioxide (which they respire) and nutrients. This releases raw nutrients (such as nitrogen, phosphorus, and magnesium) in aa form usable to plants and algae, which incorporate the chemicals into their own cells. This process resupplies nutrients to the ecosystem, in turn allowing for greater primary production. Although decomposers are generally located on the bottom of ecosystem diagrams such as food chains, food webs, and energy pyramids, decomposers in the biosphere are crucial to the environment. By breaking down dead material, they provide the nutrients that other organisms need to survive. As decomposers feed on dead organisms, they leave behind nutrients. These nutrients become part of thesoil. Therefore, more plants can grow and thrive.

Ecological pyramids

The trophic structure and function at successive trophic levels, i.e. producers - herbivores - carnivores, may be shown graphically by means of ecological pyramids where the first or producer level constitutes the base of the pyramid and the successive levels, the tiers making the apex.

The graphic expression of the trophic structure and function at successive trophic level is referred as "Ecological Pyramids". Ecological Pyramids are of three types;

i) Pyramid of numbers refers to number of individual organisms at eachlevel.

ii) Pyramid of biomass refers to total dry weight of total amount of livingmatter

iii)Pyramid of energy shows the rate of energy flow/productivity at successive energylevel

The pyramids of numbers and biomass may be upright or inverted depending upon the nature of the food chain in the particular ecosystem, whereas pyramids of energy are alwaysupright.

It shows the relationship between producers, herbivores and carnivores at successive trophic level in terms of their numbers. In grassland ecosystem, producers are maximum in number. This number then shows a decrease towards apex as the primary consumer/herbivore are

lesser in number than producers and tertiary consumers are least in number. So pyramid becomes upright. But in forest ecosystem, producers are lesser in number, which forms the base of pyramid. Herbivores - fruit/eating birds, elephants, deers etc. are more in number than producers.

In parasitic food chain, pyramids are always inverted. Number of organisms gradually shows an increase making the pyramid inverted.

Pyramids of Biomass

In grassland and forest ecosystems, the pyramid of biomass shows an upright position. But in ponds and other aquatic systems, producers are small organisms and biomass is also least. This value shows an increase towards the apex of the pyramid and making the pyramid inverted.

Pyramids of Energy

Of the three types of ecological pyramid, this energy of pyramid gives the best picture of overall nature of the system. It is a picture of the rates of passage of food mass through food chains. So it's shape is always upright. Because there is always a gradual decrease in the energy content at successive trophic levels from the producers to various consumer.

Food Chain

A **food chain** shows how each living thing gets its food. Some animals eat plants and some animals eat other animals. For example, a simple food chain links the trees & shrubs, the giraffes (that eat trees & shrubs), and the lions (that eat the giraffes). Each link in this chain is food for the next link. Afood chain always starts with plant life and ends with an animal.

- Plants are called **producers** because they are able to use light energy from the Sun toproduce food (sugar) from carbon dioxide and water.
- Animals cannot make their own food so they must eat plants and/or other animals.They are called **consumers**. There are three groups of consumers.

a. Animals that eat ONLY PLANTS are called **herbivores** (or primary consumers).

b. Animals that eat OTHER ANIMALS are called **carnivores**.

- carnivores that eat herbivores are called secondary consumers
- carnivores that eat other carnivores are called tertiary consumers

e.g., killer whales in an ocean food web ... phytoplankton → small fishes → seals → killer whales

- Animals and people who eat BOTH animals and plants are called **omnivores**.

Then there are decomposers (bacteria and fungi) which feed on decaying matter. These decomposers speed up the decaying process that releases mineral salts back into the foodchain for absorption by plants as nutrients. The consumer organisms are heterotrophic. Unlike the autotrophic plants, which manufacture their own foodfrom simple inorganic chemicals, the herbivores must utilize the energy-rich compounds synthesized by the plants. In turn, the carnivores obtain energy for their metabolism when they consume the herbivores.

Food Web

There cannot be too many links in a single food chain because the animals at the end of the chain would not get enough food (and hence energy) to stay alive. Most animals are part of more than one food chain and eat more than one kind of food in order to meet their food and energy requirements. These interconnected food chains form a food web ie. Interlocking pattern of food chain is called food web.

Ecosystems

The first steps in the evolution of agriculture were the tending of particular plant species the taming of useful animal species. The next steps were (a) domestication of these species so as to gain control of their reproduction thereby enabling selective breeding of more productive types and (b) creation of special environmental conditions which would enable these improved types to realize their higher production potential. These environmental modifications involve soil tillage, soil water management, weeding and pest control. The resulting combination of humans, domesticated plant and animal species and their modified environments is an *agro-ecosystem*, in contrast to natural ecosystems in which humans play no special role. In agro-ecosystems, the farmer is an essential ecological variable, influencing or determining the composition, functioning and stability of the system.

Intensive and extensive agro ecosystems

Agro-ecosystems are classifiable according to whether they are extensive or intensive. Extensive systems may be defined as those where the annual output of consumable nitrogen is less than 20 kg per ha. Outputs of crop or livestock products per unit area are low, and these outputs are dependent largely on natural soil nutrient reserves and management which conserves these reserves. Forms of subsistence agriculture such as nomadic pastoralism and shifting agriculture are widespread examples.

In intensive agro-ecosystems, very high outputs are maintained by large inputs of nutrients. Both the volume and rate of nutrient cycling are much higher than in extensive systems, particularly in industrial agriculture. Since nutrient inputs are almost entirely in the form of inorganic fertilizers, nitrogen fixation and soil organic matter are both depressed to very low levels. Losses of nutrients from the system through exports of produce are great, while considerable leaching losses, of both soil nutrient reserves and nutrient inputs occur particularly in wetter environments when land is bare during part of the growing season.

Agro-ecosystems which involve a significant livestock sub-system as well as a cropping sub-system are known as *mixed farming* systems. They are usually intermediate in intensity between extensive and intensive agro-ecosystems.

Natural Resources:

A resource is anything needed by an organism or group of organisms. The sum of all physical, chemical, biological and social factors, which compose the surroundings of man, is referred as environment and each element of these surroundings constitutes a resource on which man draws in order to develop a better life. Resources which are not reproducible and are obtained from the fenite non-living reserves are called non-renewable resources (eg.) Coal and metals.

Any material which can be transformed in a way that it becomes more valuable and useful can be termed as a resource. Thus, only part of our natural environment, such as land, water, air, minerals, forest, rangeland, wildlife, fish or even human population that man can utilize to promote his welfare

may be regarded as a natural resource. In the case of humans, a resource is any form of energy of matter essential for the fulfillment of physiological, socio-economic and cultural needs, both at the individual level and that of the community.

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

Renewable

- Perpetual harvest
- Ex. Human power, fertility of soil

Non-renewable

- No-replacement
- Ex. Species of wildlife

Based on Continual Utility

- Renewable
- Nonrenewable
- Cyclic resource

Based on origin

- Biotic and
- Abiotic

Based on Utility

- some as raw materials
- some as energy resources

Renewable resources are those which are reproducible and are obtained from the biomass of living organisms. (Eg.) Forests. Potentially renewable can become nonrenewable resources, if used for a prolonged time at a faster rate than it is renewed by natural processes.

Energy Sources

Fossil fuels such as coal, gas or oil represent the principal source of energy and supply about eighty five per cent of the commercial energy requirement. Fossil fuels are types of sedimentary organic materials, often loosely called bitumens, with asphalt, a solid, and petroleum, the liquid form. More correctly bitumens are sedimentary organic materials that are soluble in carbon disulfide.

Petroleum consists largely of paraffins or simple alkanes, with smaller aromatic compounds such as benzene present in most crude oils. Natural gas is an abundant fossil fuel that consists largely of methane and ethane, although traces of higher alkanes are present. Coal, unlike petroleum, contains only a little hydrogen. Fossil evidence shows that coal is mostly derived from the burial of terrestrial vegetation with high proportion of lignin and cellulose.
Nuclear power is an attractive alternative to fossil fuels and considered as "the clear energy alternative". Damming rivers to create hydroelectric power from spinning water turbines has the attraction of providing a low-cost, renewable, air pollution-free energy source.

Conventional exhaustible energy sources

Firewood:

Man has been logging down the trees for various purposes including to get firewood as an important one. This lead to thinning of woodland that had serious consideration from both ecological and economic viewpoints. The only way out to the problem is making available to the village the cheaper non-conventional energy sources, such as biogas and solar energy in usableform.

Fossil fuel:

Are the most extensively used sources of energy today. Increase in population and per capital energy demand coupled with the industrialization at a faster rate are factors responsiblefor depletion of fossil fuel. Petroleum and natural gas to-day fulfill 60% of the world's total energy requirements. If the exploitation and consumption of these resources continues at the present incredible rate, there supply may lost only for a few more decades.

Non-conventional and in-exhaustible energy sources:

The rapid depletion of conventional energy sources has promoted governments and people to concentrate on finding and tapping some non-conventional energy sources that may last for long. The in-exhaustible energy sources like solar, hydal, tidal, wind and atomic power, can only bring hope for the sustained socio-economic development of humanity.

Solar energy:

Research and application in the field of solar energy have opened new vistas in the direction of fulfilling world's future energy requirements. It is especially drawn attention for its practically free steady supply and pollution free use. This resource can especially be tapped more effectivelyin the regions where there are long run shine hours. Department of non-conventional energy sources of Government of India has prepared a perspective plan that envisages generation of energy through non- conventional sources. Chiefly solar, to the extent of 250 million tons of coalreplacement per annum.

Wind Power:

The power of wind is being used in running mills, irrigation of fields and carrying out other farm activities. According to DNES, Government of India, 20,000 MW electricity can be generated from the wind alone.

Hydropower:

It is considered to be the cheapest source of electricity. The Brahmaputra basin has the highest hydropower potential and nearly 30% of the country's production. Next to it rank the Indus, Godavari and Ganga basins respectively. Apart from economic consideration development of such projects is beneficial for irrigation and other purposes.

Atomic Power:

Atomic power appears to be the only hope for large-scale energy requirements when fossil fuels are exhausted. Atomic energy has its application not only in generation of electricity but has successfully been used in chemical and food processing industry. The important constraints in atomic energy generation are cost of construction and maintenance of plants and also disposal of radioactive wastes.

Bio-energy:

Organic wastes provide an important renewable source of energy. It is considered to be advantageous in view of its relatively cheaper supply, and are of organic wastes in its generation reduces the impending threat of pollution due to their release in environment. As such, it serves two purposes; fuel production and waste disposal. It has more practical applicability in villages where organic waste, in the form of cattle dung, is available in plenty. Biogas so generated is thus economic and convenient to use as compared to conventional practice of burning of dry dung cakes.

Food Resources

We have thousands of edible plants and animals over the world, out of which only about three dozen types constitute the major food of humans. The main food resource include wheat, rice, maize, potato, barely, oats, cassava, sugarcane, pulses, sorghum, millet, about 20 or 50 common fruits and vegetables, milk, meat, fish and sea food. 76% of world food is produced from croplands and most it produced grains. About 17% of world food is obtained from Rangeland (Meat etc). Seven % of world food supplied by oceanic fisheries. About 30,000 plant species are eatable. 2/3 of the people used traditional grains (rice, wheat etc.,). People consume more beef, pork, chicken; egg etc., Fish and sea food are the important sources of food. Milk products are also widely used.

World Food Problems

- The world population increases and cultivable land area decreases.
- Due to the inadequate rainfall, the productivity of food is reduced by every year.
- Environmental degradation like soil erosion, water logging, water pollution, salinity, affects agricultural lands.

- Urbanization is another problem for the reduction of agricultural lands.

Indian Scenario

- India is the 3rd largest producer of crops, but 300 million Indians are still undernourished
- Land wise, India is only half as much of USA, but population wise three times higher.
- Food problem is directly related to population growth.

Under Nutrition and Malnutrition

To maintain good health and resistant disease, we need large amount of macronutrients suchas carbohydrates, proteins, fats and smaller amount of micronutrients such as vitamins A,C and Eand minerals such as iron, calcium and iodine.

Under nutrition

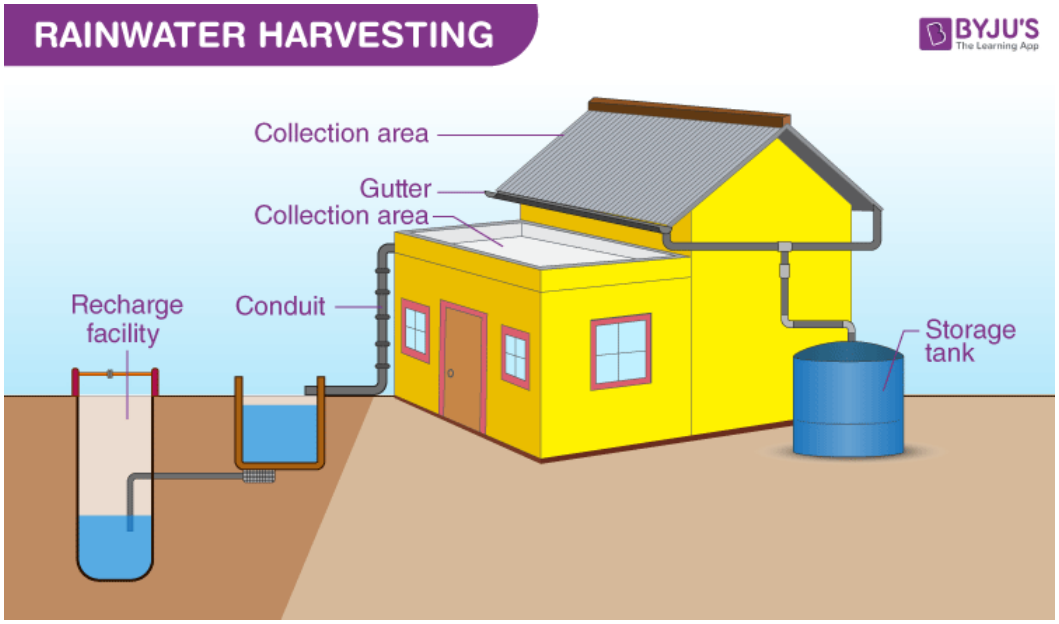
- The Food and Agriculture Organization (FAO) of United Nations estimated that on anaverage, minimum calorie intake on a global scale is 2,500 calories per day.
- Peoples receiving less than 90% of these minimum dietary calories are called undernourished.
- If it is less than 80% that are said to be seriously undernourished.
- People who cannot buy enough food to meet their basic energy needs (carbohydrates)suffer from under nutrition.

1. During the last 50 years world grain production has increased almost three times. But, at the same time, population growth increased at such a rate in LDCs (Less Developed Countries).
2. Every year 40 million people (50% of children (15 year) die on undernourishment andmalnutrition. This means that every year our food problem is killing as many people were killed by the atomic bomb dropped on Hiroshima during World WarII.
3. In countries like North America and Europe the daily average calorie intake is about 3500 cals, which is nearly one-third more than that required for healthy living.

Indian Scenario

Although India is the third largest producer of stable crops, an estimated 300 million Indians are still undernourished. Indians has only half as much land as USA, but it has nearly three times population to feed. Our food problems are directly related to population. The world Food summit, 1996 has set the target to reduce number of under nourished to just half by 2015, which still means 410 million undernourished people on the earth.

Rainwater harvesting is the simple process or technology used to conserve rainwater by collecting, storing, conveying and purifying of rainwater that runs off from rooftops, parks, roads, open grounds, etc. for later use. Here, let us have a look at the diagram of rainwater harvesting system.



Rainwater harvesting

All living things including plants, animals and human beings need water to live and to carry out different cellular activities.

Have you ever imagined a day without water?

No, we have not and it is hard to imagine. We all use water for different kinds of day to day activities, such as cleaning, washing, bathing, cooking, drinking and other domestic and industrial uses.

Water is a precious, essential and an abiotic component of the ecosystem. Today we all are heading toward the scarcity of water, and this is mainly because of the lack of water conservation and pollution of water bodies. So, let us not waste a drop of water and start conserving water for further use.

Rainwater harvesting systems consists of the following components:

- Catchment- Used to collect and store the captured rainwater.
- Conveyance system – It is used to transport the harvested water from the catchment to the recharge zone.
- Flush- It is used to flush out the first spell of rain.
- Filter – Used for filtering the collected rainwater and removing pollutants.
- Tanks and the recharge structures: Used to store the filtered water which is ready to use.

The process of rainwater harvesting involves the collection and the storage of rainwater with the help of artificially designed systems that run off naturally or man-made catchment areas like- the rooftop, compounds, rock surface, hill slopes, artificially repaired impervious or semi-pervious land surface.

Several factors play a vital role in the amount of water harvested. Some of these factors are:

- The quantum of runoff
- Features of the catchments
- Impact on the environment
- Availability of the technology
- The capacity of the storage tanks
- Types of the roof, its slope and its materials
- The frequency, quantity and the quality of the rainfall
- The speed and ease with which the rainwater penetrates through the subsoil to recharge the groundwater.

Why do we Harvest Rainwater?

The rainwater harvesting system is one of the best methods practised and followed to support the conservation of water. Today, scarcity of good quality water has become a significant cause of concern. However, rainwater, which is pure and of good quality, can be used for irrigation, washing, cleaning, bathing, cooking and also for other livestock requirements.

Advantages of Rainwater Harvesting

The benefits of the rainwater harvesting system are listed below.

- Less cost.
- Helps in reducing the water bill.
- Decreases the demand for water.
- Reduces the need for imported water.
- Promotes both water and energy conservation.
- Improves the quality and quantity of groundwater.
- Does not require a filtration system for landscape irrigation.
- This technology is relatively simple, easy to install and operate.
- It reduces soil erosion, storm water runoff, flooding, and pollution of surface water with fertilizers, pesticides, metals and other sediments.
- It is an excellent source of water for landscape irrigation with no chemicals, dissolved salts and free from all minerals.

Disadvantages of Rainwater Harvesting

In addition to the great advantages, the rainwater harvesting system has a few disadvantages like unpredictable rainfall, unavailability of the proper storage system, etc.

Listed below are a few more disadvantages of the rainwater harvesting process.

- Regular maintenance is required.
- Requires some technical skills for installation.
- Limited and no rainfall can limit the supply of rainwater.
- If not installed correctly, it may attract mosquitoes and other waterborne diseases.
- One of the significant drawbacks of the rainwater harvesting system is storage limits.

Frequently Asked Questions

Q1 What do you understand by rainwater harvesting?

Rainwater harvesting is the process of accumulation and storage of rainwater for reuse rather than allowing it to runoff.

Q2 **What are the different methods of rainwater harvesting?**

The different methods of rainwater harvesting include:

- **Rooftop rainwater harvesting –** The rooftop becomes the catchments, and the rainwater from the building and houses are collected. The components of the rooftop rainwater harvesting are:
    1. First, flush.
    2. Transportation.
    3. Catchment.
    4. Filter.
- **Surface runoff harvesting –** It is the system that collects rainwater, which flows away as surface runoff. The runoff rainwater is caught and used to recharge aquifers by adopting appropriate techniques.

Q3 **What is the importance of rainwater harvesting?**

Rainwater harvesting is a sustainable process that helps in preserving water for future needs. Water scarcity is a major concern in today's scenario. The process of rainwater harvesting is a good way to conserve water.

Q4 **What are the advantages of rainwater harvesting?**

The advantages of rainwater harvesting are:

- It is cost-effective
- Conserves water
- A source of water for landscape irrigation
- It is a simple method and easy to practice

- It reduces soil erosion and pollution of water bodies due to fertilisers and pesticides

Q5 **What are the factors affecting the amount of rainwater harvested?**

The factors affecting the amount of rainwater harvested are:

- Catchment features
- Quantum of runoff
- The capacity of storage tanks

What is Deforestation?

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

Why are Forests Important?

- Forests combat climate change by absorbing greenhouse gases (such as carbon dioxide) and acting as a carbon storehouse.
- They are a source of oxygen, food, clean water, and medicine.
- They play a vital role in the water cycle – they work to add water to the atmosphere via the process of transpiration.
- Forests help mitigate the disastrous effects of floods by acting as a floodwater sink. Therefore, deforestation also increases the vulnerability of the landmass to certain natural calamities.
- The large mass of trees in forest areas combats soil erosion by providing mechanical support to the soil.
- Forests are home to over 50% of all known species on the planet. They account for over 80% of the land-based biodiversity. Globally, forests are home to approximately 30,00,00,000 human beings.
- They are also a source of raw material for many commercially important products such as paper, wood, and fabric.
- Approximately 1.6 billion jobs are forest-dependent. Forests also account for approximately 1% of the world's GDP (gross domestic product).

The Data behind Deforestation

- Forests cover approximately 31% of the total land surface of the Earth.
- Tropical forests harbour over half of all land-based animal and plant species in the world.

- Between the years 2000 and 2012, over 568 million acres of forest have been claimed by deforestation.
- Approximately 9 million acres of virgin tropical forest were cut down in the year 2018.
- The Amazon rainforest, which is the source of 20% of the world's oxygen supply, loses approximately 1.32 acres of its area **every minute** due to deforestation.

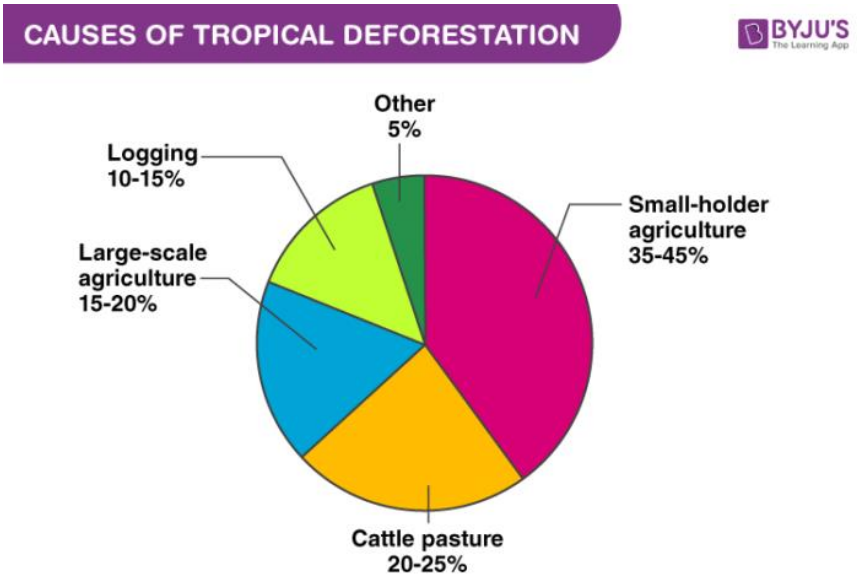
Causes of Deforestation

What are the Human Activities that Cause Deforestation?

The primary anthropogenic activities (human activities) that contribute to deforestation include:

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

According to the secretariat of the UNFCCC (United Nations Framework Convention on Climate Change), agriculture is the root cause of 80% of deforestation. Logging accounts for another 14% and the cutting of trees for use as wood fuel account for 5%. A pie-chart detailing the driving cause of the deforestation of tropical forests between the years 2000 and 2005 is provided below.



Slash-and-burn agriculture is one of the most destructive forms of agriculture that results in large-scale deforestation. It involves the burning of a large area of forest land and the subsequent plantation of crops in the same soil (which is now fertilized by the ashes of the burnt trees). Despite the practice being abandoned by several developed countries, it is still followed in some Southeast Asian countries.

What are the Secondary Factors that Contribute to Deforestation?

Illegal logging, which accounts for approximately 80% of all logging activities, involves the harvesting and sale of timber in violation of the law. Corrupt government officials may accept bribes from illegal loggers and offer access to protected forest areas in return. Therefore, corruption can be viewed as an indirect cause of deforestation.

Overpopulation and population growth increase the requirement for several resources such as food and infrastructure. These requirements can, directly or indirectly, result in deforestation. For example, a huge explosion in the population of a city can result in the deforestation of the surrounding area for:

- The construction of homes and other buildings.
- Agriculture (to meet the increased demand for food).
- The construction of roads, dams, and other infrastructure.

Military conflicts among humans can also result in deforestation. For example, the U.S. military made extensive use of Agent Orange (a defoliant that causes the leaves of trees to wither and fall off) during the Vietnam War (1955 – 1975).

Can Deforestation Occur due to Natural Causes?

In some relatively rare cases, the deforestation of forest areas can be traced to natural causes. For example, volcanic eruptions can burn away the forest lands surrounding the volcano. Other examples of natural deforestation include:

- Destruction of forests due to hurricanes, floods, and other natural calamities.
- Invasion of the forest ecosystem by parasites that destroy trees.
- Forest fires are sparked by lightning and other natural phenomena.

It is important to note that natural factors have a very small stake in the overall deforestation of the Earth's land surface (anthropogenic factors account for almost all of it).

How Does Deforestation Affect the Environment?

Increased Carbon Dioxide Levels in the Atmosphere

Forests serve as a carbon sink by absorbing atmospheric carbon dioxide during photosynthesis. Since carbon dioxide is a greenhouse gas, deforestation is a direct contributor to the greenhouse effect and (consequently) global warming.

Apart from being responsible for allowing gaseous carbon dioxide to linger in the atmosphere, deforestation also contributes to increased carbon dioxide emissions. The CO_2 emissions caused by deforestation account for approximately 12% of all anthropogenic carbon dioxide emissions.

Deforestation and the Water Cycle

- Since trees play a vital role in the water cycle, deforestation can contribute to significant disturbances in it.
- Trees and plants regulate the moisture content in the atmosphere via the process of transpiration (they absorb groundwater through their roots and release it into the atmosphere from their leaves and flowers).
- Also, their roots burrow into the soil and create macropores in it. These macropores allow water to penetrate deeper into the soil, thereby increasing the water-holding capacity of the soil.
- Dead plant material (such as leaves and twigs) that fall to the surface of the ground impart several properties to the soil, such as increased water-holding capacity.
- Approximately 30% of the world's freshwater supply can be sourced from tropical rainforests.
- Deforestation is accompanied by reduced humidity, owing to the absence of transpiring trees. The water content in the soil and the groundwater levels also decline in the cleared land.
- It is not uncommon for deforested land to experience extremely arid climates. In fact, deforestation has been linked to desertification and droughts.

Soil Erosion as a Consequence of Deforestation

Trees tend to bind their roots to the soil bedrock, thereby reinforcing the soil. Additionally, the plant litter generated by trees offers protection to the surface of the soil. In the absence of trees (as a consequence of deforestation), the soil becomes vulnerable to erosion.

Deforestation of sloped lands is often accompanied by landslides, which can be explained by the loss of soil adhesion due to the absence of trees. The extent of erosion is amplified by certain natural calamities such as floods (note that the plant litter found on forest surfaces helps reduce the amount of soil washed away).

Since soil erosion is a direct contributor to eutrophication, deforestation can be viewed as a contributor to other environmental concerns.

Effects of Deforestation on Biodiversity

Forests play host to a wide spectrum of wildlife. In fact, tropical rainforests are believed to be the most diverse ecosystems on the planet. Deforestation poses a grave threat to this biodiversity. On a local scale, the clearing of forest land can cause a decline in the population of certain species. On a global scale, however, deforestation can result in the extinction of several desirable species.

Approximately 50,000 species (consisting of plants, animals, and insects) are lost every year as a consequence of deforestation. Studies suggest that over 40% of all plant and animal species in the Southeast Asian region will undergo extinction over the course of the 21st century.

The implications of large-scale biodiversity loss are difficult to predict, but it is highly probable that it would have an adverse effect on the food web. Also, the extinction of one species may play a leading role in the extinction of another via the phenomenon of co-extinction.

Other Effects of Deforestation

How Does Deforestation Affect the Economy?

- Deforestation facilitates the generation of raw materials for a wide range of industries. Examples include the agriculture industry, the wood industry, and the construction industry.
- However, the overexploitation of wood and timber can have a negative impact on the economy. The short-term economic gains made from deforestation are accompanied by reduced long-term productivity.
- For example, overenthusiastic timber harvesting from a forest area may increase the overall output temporarily, but the declining forest area will eventually cause the harvest to decline. The overall forest output is greatly reduced by such practices.
- According to some reports, the global GDP may see a 7% decline by the year 2050 due to deforestation and other factors.
- Therefore, a sustainable approach to the usage of forest resources is ideal for the economy.

Deforestation and Human Health

Deforestation can, directly or indirectly, provide a channel for the propagation of many infectious diseases. Since deforestation is often accompanied by the loss of indigenous species, it is not uncommon for new species to flourish in deforested lands.

In Malaysia, the geographic shift of the fruit bat population (as a consequence of deforestation) facilitated the transmission of the Nipah virus. Fruit bats, which are known to be vectors of the disease, lost their natural habitat due to deforestation and started feeding in the orchards surrounding habited areas. Through proximity, the Nipah virus spread from fruit bats to pigs, and then to humans.

Increased soil erosion (due to deforestation) can result in the formation of pools of stagnant water. These pools serve as breeding grounds for mosquitoes, which are vectors of several deadly diseases such as malaria and yellow fever. Some theories also suggest that deforestation has contributed to the propagation of the human immunodeficiency virus (HIV).

How can Deforestation be Controlled?

Role of Governments and other Administrative Authorities

The following strategies can be implemented by governments to combat deforestation:

- Implementation of security measures and strict laws to prevent illegal logging.
- Increasing the count and range of forests under government protection.
- Carefully planning the construction of infrastructure (roads, dams, etc.) in order to minimize the loss of forest area.
- Investing in new technologies in the agricultural industry (such as hydroponics) and helping farmers implement eco-friendly agricultural practices (such as cyclic agriculture).
- Optimizing the management of forests by banning inefficient agricultural practices (such as slash-and-burn agriculture).
- Facilitating the production and use of wood alternatives to reduce the demand for timber. For example, bamboo can serve as an alternative to wood fuel.
- Launching new reforestation campaigns to restore deforested lands.
- Investing in forest plantations – forests planted with high yielding trees can offer 5 – 10 times the output (per hectare) of a natural forest.

Role of Individuals

Every human on the planet shares the responsibility of preserving its resources (for other humans, other species, and for future generations). An individual can contribute to the prevention of deforestation by implementing the 3R (Reduce, Reuse, and Recycle) principle in their daily lives.

- Reduce – Reducing the amount of paper consumed by using alternatives wherever possible.
- Reuse – Avoid use-and-throw products to prevent wastage.
- Recycle – Diligently recycle all used wood and paper products.

Individuals can also combat deforestation by spreading awareness about its negative consequences and participating in tree-planting campaigns.

To learn more about deforestation and other important environmental concerns (such as soil pollution), register with BYJU'S and download the mobile application on your smartphone.

Frequently Asked Questions – FAQs

Q1 What are the key causes of deforestation?

One of the leading causes of deforestation is agriculture and cattle grazing. Forest land is frequently cleared and transformed into agricultural land in order to keep up with the ever-increasing demand for food (which can, in turn, be linked to overpopulation). The four commodities that are majorly responsible for tropical deforestation include palm oil, timber, soy, and beef. Generation of grazing land for cattle is another leading cause of deforestation.

Q2 What are the environmental effects of deforestation?

One of the most important negative consequences of deforestation is global warming and climate change. Over 20% of the world's greenhouse gas emissions can be sourced from the deforestation of tropical rainforests. Since the roots of trees provide support to the surrounding soil, deforestation also contributes to soil erosion (the removal of trees makes the soil vulnerable to erosion).

Q3 How can deforestation affect the water cycle?

Trees are known to absorb groundwater through their roots and subsequently release it into the atmosphere via the process of transpiration. Thus, trees play a vital role in the water cycle by regulating the atmospheric water vapour levels and also by providing a platform for water to enter the atmosphere from below-ground levels.

Q4 How can I as an individual help reduce deforestation?

The following practices can be incorporated to reduce the demand for forest products:

- Going paperless and using digital media wherever possible (using digital receipts, preferring the use of E-mails instead of letters).
- Purchasing only recyclable products and recycling them once used.
- Purchasing only certified wood products and supporting the organizations that are fighting deforestation.
- Educating other individuals about deforestation and its negative impact on the environment.

Q5 How does deforestation affect biodiversity?

Tropical rainforests are known to be the most diverse ecosystems on the planet. Since deforestation involves the quelling of these ecosystems, the habitats of many species become endangered. In fact, deforestation also endangers the population of some microbes that work on the recycling of nutrients and the purification of water.

Unit-2

Air and Noise Pollution

It is defined as the excessive concentration of foreign material in the atmosphere, which affectsthe health of individuals and also causes damage to the property.

Air pollution episodes

London smog **:** SO_2 H_2SO_3vapours in the atmosphere. When automobile exhausts are trapped by this smog and exposed to sunlight, it produces photochemicalsmog.

Bhopal gas tragedy **:**The poisonous gas, methyl isocyanate (MTC) leakage in the pesticide manufacturing plant of Union Carbide of India Ltd., (UCIL), Bhopal, Madhya Pradesh on December 3, 1984. 46 tons of MIC was released spreading to 40 km. *Effects* : About 65,000 people suffered from various disorders in eyes, lungs, stomach, heart, etc. The immediate symptom is bronchospasm which causes coughing, chest pain and abdominal pain. Nearly 3000 people died within a short span of time, 1600 domestic animals died and crop yields were reduced.

Darkening effect of TajMahal

TajMahal is a white marble stone mausoleum. Recently it was observed that the walls of TajMahal has become darkened and disfigured due to air pollution from nearby Mathura Oil refinery.

$H_2O + SO_2$ $\rightarrow$ H_2SO_3, $SO_2 + O_2 \rightarrow SO_3$; $SO_3 + H_2O \rightarrow H_2SO_4$.

The acid rain reacts with marble stone ($CaCO_3$) to produce calcium sulphate, causing darkening anddisfigurement.

Types, sources and effects of air pollution

Air pollution may be simply defined as the presence of certain substances in the air in high enough concentrations and for long enough duration to cause undesirable effects. “Certain substances” maybe any gas, liquid or solid, although certain specific substances are considered significant pollutants because of very large emission rates are harmful and unwanted effects. “Long enough durations” canbe anywhere from a few hours to several days or weeks; on a global scale, durations of monthsand years are of concern.

Sources

Air pollution results from gaseous emission from mainly industry, thermal power stations, automobiles, domestic combustion etc.

1. **Industrial chimney wastes**: There are a number of industries which are source of air pollution. Petroleum refineries are the major source of gaseous pollutants. The chief gases are $SO_2$and NO_x. Cement factories emit plenty of dust, which is potential health hazard. Stone crushers and hot mix plants also create a menace. Food and fertilizers industries which emit gaseous pollutants. Chemical manufacturing industries which emit acid vapors in air.
2. **Thermal power stations:** There are a number of thermal power stations and super thermal power stations in the country. The National thermal power corporation (NTPC) issetting up four mammoth coal-powered power stations to augment the energy generation.These are at Singrauli in U.P., Korba in M.P., Ramagundam in Andhra Pradesh and Farakka in W. Bengal. The coal consumption of thermal plants is several million tones. The chief pollutants are fly ash, SO_2 and other gases and hydrocarbons.
3. **Automobiles**: The toxic vehicular exhausts are a source of considerable air pollution, next only to thermal power plants. The ever increasing vehicular traffic density posed continued threat to the ambient air quality. Chief sources of emission in automobiles are

   (i) exhaust system, (ii) fuel tank and carburettor and (iii) crankcase. The exhaust produces many air pollutants including unburnt hydrocarbons, CO, $NO_x$and lead oxides. There are also traces of aldehydes, esters, ethers, peroxides and ketones which are chemically active and combine to form smog in presence of light. Evaporation from fuel tank goes on constantly due to volatile nature of petrol, causing emission of hydrocarbons. The evaporation through carburettor occurs when engine is stopped and heat builds up, and as much as 12 to 40 ml of fuel is lost during each long stop causing emission of hydrocarbons.

Sources of indoor air pollution

- Combustion (to heat water, cook and spaceh eating) can produce elevated levels of CO and NO_X.Certain photocopying machines emit ozone.
- Formaldehyde emissions from particle board, plywood, urea – formaldehyde foam insulation.Asbestos used for fireproofing and insulation.
- Various volatile organics emitted from household cleaning products.

- Many pollutants, such as cigarette smoke and radon when emitted indoors can be concentrated, leading to harmful exposure levels.
- Tobacco smoke contains numerous known or suspected carcinogens, including benzene,hydrazine, benzo - -pyrene (BaP) and Nickel.
- Smoke particles are small, averaging about 0.2 μm, so they are easily carried into the deepestregions of thelungs.
- A single cigarette smoke gives off on the order of 1012 smoke particles, most of which are released while the cigarette is simply smoldering in the air (*side stream smoke*) rather than when a smoker takes a puff (*main stream smoke*).
- Hence non smokers are also exposed to significant amount of smoke particles.
- Other indoor air pollutants arising from tobacco smoke include carbon monoxide, nicotine,nitrosamines, caroling and other aldehydes.
- Another potentially important source of indoor air pollution is caused by wood-burningstoves and fireplaces.
- Wood combustion produces CO, NO_X, hydrocarbons and reparable particles and some emissions that are suspected carcinogens like benzo - -pyrene.

Effects of air pollution

Air pollution is known to have many adverse effects, including those on human health, building facades and other exposed materials, vegetation, agricultural crops, animals, aquatic andterrestrial ecosystems, and the climate of earth as a whole.

a) Health Effects

Perhaps the most important effect of air pollution is the harm it causes to human health. Generally, air pollution is most harmful to the very old and the very young. Many elderly people may already suffer from some form of heart or lung disease, and their weakened condition can make them very susceptible to additional harm from air pollution. The sensitive lungs of new born infants are also susceptible to harm from dirty air. But it is not just the elderly or the very young who suffer; healthy people of all ages can be adversely affected by high levels of air pollutants. Major health effects are categorized as being acute, chronic, or temporary.

b) Effect on Materials

Every year, air pollutants cause damage worth billions of rupees. Air pollutants breakdown the exterior paint in cars and houses. Air pollutants have discolored irreplaceable monuments, historic buildings, marble statues and other heritage and natural beauty sites.

c) Effect on Plants.

Some gaseous pollutants enter leaf pores and damage the crop plants. Chronic exposure of leaves to air pollutants damages waxy coating, leads to damage from diseases, pests, drought and frost. Such exposure interferes with photosynthesis and plant growth, reduces nutrient uptake and causes leaves to turn yellow, brown or drop off. At higher concentrations of SO_2 most of the flower buds become stiff and hard and fall off. Prolonged exposure to higher levels of air pollutants from Iron smelters, coal burning power plants and industries, vehicles can damage trees and plants.

d) Effect on Stratosphere

Ozone is continuously being created in the stratosphere by the absorption of short-wavelengthUV radiation, while at the same time it is continuously being removed by various chemical reactions that convert it back to molecular oxygen. The rates of creation and removal at any given time and location dictate the concentration of ozone present. The balance between creation and removal is being affected by increasing stratospheric concentrations of chlorine, nitrogen and bromine, which acts as catalysts, speeding up the removal process. CFCs are predominant.

Management of Air Pollution

For ages man has been dumping wastes into the atmosphere, and these pollutants havedisappeared with the wind. We have seen that the main sources of air pollution are (i) motor vehicles,

(ii) Industries-particularly their chimney wastes, (iii) fossil-fuel (coal) based plants, as thermalpower plants. Steps are to be taken to control pollution at source (prevention) as well as after the release so pollutants in the atmosphere. There is an urgent need to prevent the emissions from the above said major sources of air pollution. The control of emissions can be realized innumber of ways

Causes, effects and control of noise and thermal pollution.

Noise pollution

Noise is perhaps one of the most undesirable by products of modern mechanized lifestyle. It may not seem as insidious or harmful as the contamination of drinking water supplies from hazardous chemicals, but it is a problem that affects human health and well-being and that can also contribute to the general deterioration of environmental quality. It can affect people at home, in their community, or at their place of work.

Sound waves cause eardrums to vibrate, activating middle and inner organs and sending bioelectrical signals to the brain. The human ear can detect sounds in the frequency range of about 20 to 20,000 Hz, but for most people hearing is best in the range of 200 to 10,000 Hz. A sound of 50 Hz frequency, for example, is perceived to be very low-pitched, and a 15,000 - Hz sound is very high pitched.

Simply defined, noise is undesirable and unwanted sound. It takes energy to produce sound, so, in a manner of speaking, noise is a form of waste energy. It is not a substance that can accumulate in the environment, like most other pollutants, but it can be diluted with distance from a source. All sounds come from a sound source, whether it be a radio, a machine, a human voice, an airplane, or a musical instrument. Not all sound is noise. What may be considered music to one person may be nothing but noise to another. To a extent, noise pollution is a matter of opinion. Noise is measured in terms of Decibel units.

Sources of noise

Based on the type of noise include

a) Industrial Noise

b) Transport Noise

c) Neighborhood Noise

Industrial Noise

It is caused by machines used for the technological advancement. There exist a long list of sources of noise pollution including different machines of numerous factories, industries and mills.

Transport Noise:

Main source is transport. In addition to adversely impacting urban air quality, heavy automobile traffic creates seemingly unbearable noise pollution. Ever since industrial revolution doubling of noise for every 10 years

Pointed nose that angles downward during takeoff, the Anglo-French Concorde flies at more than twice the speed of sound. Supersonic plane is very noisy, and some believe its sonic booms harm theenvironment.

Animals such as whales use water to communicate with one another over great distances. Human-generated noises in the ocean, such as engine noises by boats, may interfere with animal communication.

Intensity of Noise sources

Sources	**Intensity(dB)**
Breathing	10
Trickling clock	20-30
Normal conversation	35-60
Office noise	60 - 80
Traffic	50-90
Motor cycle	105
Jet fly	100- 110

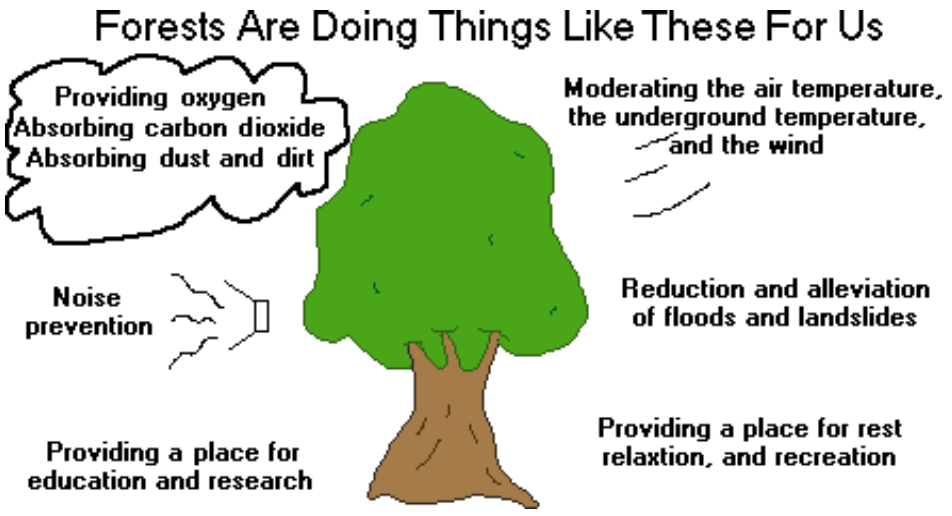
Control of Noise Pollution

Noise definitely affects the quality of life. It is therefore important to ensure themitigation or control of noise pollution**.** Noise pollution can be controlled

- At source level – Can be done by i) Designing and fabricating silencing devices in air craft engines, automobiles industrial machines and home appliances, ii) By segregating the noisy machines

- During Transmission – can be achieved by adding insulation and sound-proofing to doors, around industrial machinery. Zoning urban areas to maintain a separation between residential areas and zones of excessive noise. Sound
    a) Acoustillite : made up of Compressed wood pulp, wood fibers and is available in the form of tiles
    b) Acoustical blanket : Prepared from mineral wool or glass fibers
    c) Hair Felt: Consists of wool fibers, Coarse Cotton Fibers.
    d) Fiber Glass
    e) Cork Carpet: Prepared out of pieces of corks treated with linseed oil and is used for covering floors.
    f) Acoustic Plaster: Mainly consists of gypsum in the form of plaster.
- Protecting the exposed person
- By creating vegetation cover – Plants absorb and dissipate sound energy and thus act as Buffer Zone. Trees should be planted along highways, schools and other places.

Planting vegetation to absorb and screen out noise pollution – Trees can act as a noise barrier



- Through law

a) Silence Zones must be created near Schools, hospitals
b) Indiscriminate use of loudspeakers at public places should be banned/restricted bylaws
c) Restriction on unnecessary us e of horns and vehicles plying without silencers

Thermal Pollution

The term thermal pollution has traditionally been used more often to refer to the heating of lakes, river, streams, and other water bodies usually by electric power generating plants or byfactories

- The combustion of fossil fuels always produces heat, sometimes as a primary desired product, and sometimes as a secondary, less desired by-product i.e. Noise
- Heat is also produced when fossil fuels are burned to generate electricity. In this case, heat is a by-product, not the main reason that fuels are burned.
- Electricity is also generated in nuclear power plants, when no combustion occurs.
- The decay of organic matter in landfills also releases heat to the atmosphere.

It is clear, therefore, that a vast array of human activities result in the release of heat to the environment. As those activities increase in number and extent, so does the amount of heat released. In many cases, heat added to the environment begins to cause problems for plants, humans, or other animals. This effect is then known as *thermal pollution.*

Sources of Thermal pollution

- Coal fired power plant effluents
- Domestic sewage
- Hydroelectric power effluent
- Industrial effluents
- Nuclear power plants

Effects of thermal Pollution

A one megawatt nuclear power plant may require 1.3 billion gallons (five million m^3) of cooling water each day. The water used in such a plant has its temperature increased byabout 63^oF (17^oC) during the cooling process. For this reason, such plants are usually built veryclose to an abundant water supply such as a lake,a large river, or the ocean.

When thermal pollution drives water temperatures up, most aquatic and marine wildlife cannot survive. Immobile organisms, such as plants and shellfish, simply die. One inevitable

result of thermal pollution is a reduction in the amount dissolved oxygen in water. The amount of any gas that can be dissolved in water varies inversely with the temperature. As water is warmed, therefore, it is capable of dissolving less and less oxygen. Organisms that need oxygen to survive will, in such cases, can't be able to survive.

When heated water is released from a plant or factory, it does not readily mix with the cooler water around it. Instead, it forms a stream- like mass known as a thermal plume that spreads out from the outflow pipes. It is in this thermal plume that the most severe effects of thermal pollution are likely to occur. Only over an extended period of time does the plume gradually mix with surrounding water, producing a mass of homogenous temperature

Control of Thermal pollution

The water heated by thermal pollution also has a number of potential useful applications. For example, it may be possible to establish aquatic farms where commercially desirable fish and shellfish can be raised. The Japanese have been especially successful in pursuing this option. Some experts have also suggested using this water to heat buildings, to remove snow, to fill swimming pools, to use for irrigation, to de-ice canals, and to operate industrial processes that have modest heat requirements. Hot water is pumped into one end of the pond and cooler water is removed from the other end. The heat gets dissipated from the pond into the atmosphere. The main disadvantage is large amounts of water are lost due to evaporation

Here at Westport, Kentucky the Ohio River provides the large amount of water required by this coal-fired power plant. Thermal pollution is abated by the use of the large cooling tower which emits onlysteam into the atmosphere.

Unit-3

Water and Soil Pollution

Causes, Effects and Control of Water Pollution.

Water is one of the most important commodities which Man has exploited than any other resource for sustenance of his life. Most of the water in this planet is stored in oceans and ice caps which is difficultto be recovered for our diverse needs. It can be said that no water is pure or clean owing to the presence of some quantities of gases, minerals and life. Pure water is considered to be that which has low dissolved and suspended solids and obnoxious gases as well as low biological life. Water can be regarded polluted when it changes its quality or composition either naturally or as a result of human activities, thus becoming less suitable for drinking, domestic, agricultural, industrial, recreational, wildlife and other uses.

Some pollutants can be formed by way of concentrations and transformations of naturally occurring compounds during their domestic, agricultural or industrial use. The generation of sewage and the waste waters containing agrochemicals, certain pesticides and surfactants, petrochemicals, hydrocarbons, heavy metals and radionuclides are some important examples of pollutants originated in this way.

Sources of Water Pollutants

To understand the effects of water pollution and the technology applied in its control, it is useful to classify pollutants into various groups or categories. Water pollutant can be classified according to the nature of its origin as either a **point source** or a **dispersed source pollutant**.

A **point source** pollutant is one that reaches the water from a pipe, channel or any other confined and localized source. The most common example of a point source of pollutants is a pipe thatdischarges sewage into a stream or river. Most of these discharges are treatment plant effluents.

A **dispersed or non point source** is a broad, unconfined area from which pollutants enter a body of water. Surface runoff from agricultural areas carries silt, fertilizers, pesticides, and animal wastes into streams, but not at only one particular point. These materials can enter the water all along astream as it flows through the area. Acidic runoff from mining areas is a dispersed pollutant. Storm water drainage systems in towns and cities are also considered to be dispersed sources of many pollutants, because, even though the pollutants are often conveyed into streams or lakes in drainage pipes or storm sewers, there are usually many of these discharges scattered over a large area.

Point source pollutants are easier to deal with, while pollutants from dispersed sources are much more difficult to control. Many people think that sewage is the primary culprit in water pollution problems, but dispersed sources cause a significant fraction of the water pollution. The most effective way to control the dispersed sources is to set appropriate restrictions on land use.

Effects of Water Pollution

1.Physicochemical effects

A large number of pollutants can impart color, tastes and odors to the receiving waters, thus making them unaesthetic and even unfit for domestic consumption. The changes in oxygen, temperature and pH affect the chemistry of waters often triggers chemical reactions resulting in the formation of unwanted products. The addition of organic matter results in depletion of oxygen with concomitant increase in carbon dioxide owing to bacterial degradation.

2.Biological effects

The addition of pollutants leads to the shift in flora and fauna due to homeostatic factors operating in the aquatic systems. Most of the freshwater algae are highly sensitive to pollutants and their elimination modifies the prey-predatory relationships by breaking down the food chains. This results in the change of the whole plant and animal communities. The diversity of organism decrease due to the presence of only a few tolerant forms in the polluted conditions.

The first response to the added nutrients is increased algal growth which is often composed of obnoxious bloom forming blue-green or green chlorophycean algal forms. Many of the blue- greens are not consumed by predators and some even produce toxic secretions causing allopathic effects (e.g., *Microcystis*spp.)

3.Toxic effects

These are caused by pollutants such as heavy metals, biocides, cyanide and other organic and inorganic compounds which are detrimental to the other organisms. These substances usually have very low permissible limits in water and their presence beyond limits can render the water unfit for aquatic biota and even for human use

These chemicals are toxic to aquatic organisms, and many of them especially those non-biodegradable, accumulate in the body of the organisms and biomagnified along the tropic levels causing long term effects.

4.Pathogenic effects

Besides the chemical substances, a few wastes like sewage, also contain several pathogenic and nonpathogenic microorganism and viruses. The *Clostridium perfringens* and *Streptococcus faecalis* cause various types of food poisoning. Apart from this, many water borne diseases like cholera, typhoid, paratyphoid, colitis, and infective hepatitis (jaundice) are spread by consumption of sewage contaminated waters.

5.Eutrophication

One of the most severe and commonest water pollution problems is due to enrichment of waters by plant nutrients that increases the biological growth and renders the water bodies unfit for diverse uses. The process of increase in the nutrients of waters and resultant spurt in algal productivity is called ***eutrophication*.**

Control of Water pollution

Raw or untreated sewage comprises about 99.9 per cent water and only about 0.1 per cent impurities. In contrast to this, sea water is only about 96.5 per cent pure water; it contains about 35,000 mg/L, or 3.5 per cent dissolved impurities. Although sea water contains more impurities than does sanitary sewage, we do not ordinarily consider seawater to be polluted. The important distinction is not the total concentration, but the type of impurities. The impurities in seawater are mostly inorganic salts, but sewage contains biodegradable organic material, and it is very likely to contain pathogenic microorganisms as well. Actually, sewage contain so many different substances, both suspended and dissolved, that it is impractical to attempt to identify each specific substance or microorganisms. The total amount of organic materials is related to the strength of the sewage. This is measured by the biochemical oxygen demand, or BOD. Another important measure or parameter related to the strength of the sewage is the total amount of suspended solids, or TSS. On the average, untreated domestic sanitary sewage has a BOD of about 200 mg/L and a TSS of about 240 mg/L. Industrial wastewater may have BOD and TSS values much higher than those for sanitary sewage; its composition is source dependent.

Another group of impurities that is typically of major significance in waste water is the plant nutrients. Specifically, these are compounds of nitrogen and phosphorous. On the average, raw

Waste water treatment

These treatment methods are grouped into three general categories: **primary** treatment, **secondary or biological** treatment and **tertiary or advanced** treatment.

Primary Treatment

Untreated or raw wastewater usually flows by gravity from an interceptor or trunk sewer into the head works of a treatment facility; sometimes wastewater may be pumped to the treatment plant in a force. The head works of a treatment plant include a flow measurement device and mechanical systems that provide preliminary treatment. Preliminary treatment systems typically include screens, comminutors, and grit chambers.

Grit removal

A portion of the suspended solids in raw sewage consists of gritty material, such as sand, coffee grounds, eggshells, and other relatively inert material. In cities with combined sewer systems, sand and silt may be carried in the sewage. Suspended grit can cause excessive wear and tear on pumps and other equipment in the plant. Most of it is non-biodegradable and will accumulate in treatment tanks. For these reasons, a grit removal process is usually used after screening and / or comminuting.

Primary sedimentation (Settling)

After preliminary treatment by screening, comminuting, and grit removal, the wastewater still contains suspended organic solids that can be removed by plain sedimentation. Settling tanks that receive sewage after grit removal are called primary clarifiers. The combination of preliminary screening and gravity settling is called primary treatment. Chemicals may sometimes be added to the primary clarifiers to promote the removal of very small (or colloidal) particles. Primary treatment usually can remove up to 60per cent of the suspended solids and about 35 per cent of the BOD from wastewater, but this relatively low level of treatment is no longer adequate. In almost all cases, primary treatment must be followed by secondary treatment processes; tertiary treatment may also be required to protect sensitive bodies of water that receive the treated effluent.

Causes, effects and control of soil pollution

Soil Pollution

Soil is the loose and unconsolidated outer layer of earth's crust that is powdery in nature and made up of small particles of different sizes. Soil ecosystem includes inorganic and organic constituents, and the microbial groups. Soil microorganisms are the active agents in the decomposition of plant and animal solid wastes and said to be nature's garbage disposal system. The soil microbes keep our planet earth freeof unwanted waste materials and recycle the elements (C, N, and P) through mineralization. Soil microbes decompose a variety of compounds, cellulose, lignin, hemi cellulose, proteins, lipids, hydrocarbons etc. The soil microbial community has little or no action on many man made synthetic polymers. The persistent molecules that fail to be metabolized or mineralized have been termed as recalcitrant

Fertilizer pollution

The agricultural production depends on chemical fertilizer application, as most of our high yielding varieties are fertilizer responsive. Continuous application of chemical fertilizers alone lead to deterioration of soil properties and cultivated soils loose their natural characteristics. Fertilizers like ammonium sulphate, ammonium chloride and urea reduce the soil pH. Many crops, like potato, grapes, citrus, beans are sensitive to chloride toxicity. In integrated nutrient management, to sustain the productivity of our soils, organic manures and bio fertilizers are recommended as supplements to chemical fertilizers.

Nitrate pollution

Nitrogen occurs in many forms in the environment and takes part in many biochemical reactions. The four forms of nitrogen that are of particular significance in environmental technology are organic nitrogen, ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen. In water contaminated with sewage, most of the nitrogen is originally present in the form of complex organic molecules (protein) and ammonia (NH_3). These substances are eventually broken down by microbes to form nitrites and nitrates.

Excess Salts and Water

Irrigation water helps to produce more yield than rain fed land. Irrigation water contains dissolved salts and in dry season, water is in the form of saline solution evaporates leaving its salts such as NaCl in the top soil. This saline soil causes stunted plant growth, lower yield. Flushing out salts reduces the salinity but makes downstream irrigation water, saltier. Another problem is waterlogging.

Heavy metal pollution

Heavy metals include all metals with atomic numbers greater than 23 (with few exceptions) or more than5 gm per ml. (eg. Hg, 70 gm ml^{-1}). Heavy metals are hazardous, not acceptable to biological system. Theyare toxic to man and other life forms. Most of them are slow poisons as they accumulate in the body andcause serious disorders. Mercury, lead, arsenic, chromium and cadmium are the five most common toxic heavy metals and they have serious effects on human health

Industrial Wastes: Indiscriminate dumping of untreated or inadequately treated domestic, mining and industrial wastes on and is an important source of soil pollution. Fall out of gaseous and particulate air pollutants from mining and smelting operations, smoke stacks etc. are the major source of soil pollutants in nearby areas.

Urban Wastes: Millions of tons of urban waste are produced every year from polluted cities. The inadequately treated or untreated sewage sludge not only poses serious health hazards but also pollutes soil and decreases its fertility and productivity. Other waste materials such as rubbish, used plastic bag, garbage sludge, dead animals, hospital wastes, skins, tyres shoes etc. cause land and soil pollution. Suspended matter present in sewage can act as a blanket on the soil and interfere with its productivity.

Plastics

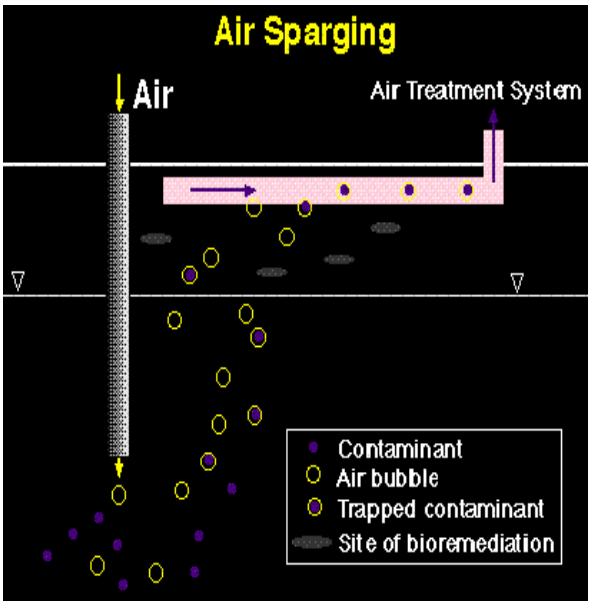
Plastics form a major part of global domestic and industrial waste. Not being biodegradable, waste plastic accumulates, adding to pollution. Using photodegradable plastic or biodegradable plastic can solve plastic pollution problem. Photodegradable plastic contains an element sensitive to UV rays. Under the effect of solar rays the element is activated and breaks the polymeric chain of the photodegradable plastic. It results in small fragments that are easily digested by microbes.

Control of Soil Pollution

Soil may be polluted and converted into acidic soil or alkaline soil. It should be corrected by suitable technology, before cultivation

Methods of Soil treatment

Air sparing is an *in situ* remedial technology that reduces concentrations of volatile constituents in petroleum products that are adsorbed to soils and dissolved in groundwater. This technology, which is also known as "*in situ* air stripping" and "*in situ* volatilization," involves the injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to a vapor phase. The air is then vented through the unsaturated zone. Air sparing is most often used together with soil vapor extraction (SVE), but it can also be used with other remedial technologies.



Soil washing is a water-based process for scrubbing soils ex situ to remove contaminants. The process removes contaminants from soils in one of the following two ways:

- By dissolving or suspending them in the wash solution (which can be sustained bychemical manipulation of pH for a period of time);or
- Byconcentratingthemintoasmallervolumeofsoilthroughparticlesizeseparation,gravity

Soil conservation

Soil conservation is the protection of soil against excessive loss of fertility by natural, chemical, or artificial means. It encompasses all management and land-use methods protecting soil against degradation, focusing on damage by erosion and chemicals. Soil conservation techniques can be achieved through crop selection and rotation, fertilizer and lime application, tilth, residue management, contouring and strip cropping, and mechanical methods (e.g.,terracing).

1. Agronomic practices
2. Dry farming
3. Agrostological methods

Soil Amelioration

Soil Amelioration

Amelioration of Acidic Soil: Soil acidity is due to the accumulation of H^+ ions over OH^- ions. Limiting material – are neutralization of H^+ ions such as

- *Quicklime*- oxide of lime is usually known as burned lime or quicklime.
- *Slaked lime*-can be obtained by adding water to quicklime.
- *Blast furnace slag*- a byproduct during the manufacturer of pig iron viz, calcium silicate.
- *Basic Slag*- is a byproduct of the basic open heart method of producing steel from pig iron,
- *Electric furnace slag*- is produced from the electric furnace reduction of phosphate rock during preparation of phosphorous. The product is manly the calcium silicate.

Amelioration of Saline and Alkali Soil

Saline soil- they contain an excess of soluble salts. *Saline soil reclamation can be achieved by:*

- Providing proper drainage
- Using salt free irrigation water
- Use of acidic fertilizers-such as ammonium sulphate
- Use of organic fertilizers
- Use of organic manures.

Alkaline soil-they contain appreciable amounts of soluble salts. *Alkali soil reclamation* may be achieved by the following practices:

- Application of gypsum
- Use of sulphur
- Addition of organic matter
- Addition of molasses.

Prevention of solid waste dumping

Open dumping of solid waste should be segregated and recyclable materials could be recycled. Other garbage can be converted into organic manure by suitable technology.

4. Usage of bio-fertilizers and bio-pesticides.

5. Following the concept of Integrated Plant Nutrient System (IPNS).

UNIT IV

Impact of Energy Usage on Environment

Global warming and climate change: GHG emission, GH effect, impact on environment and agriculture – mitigation strategies, Ozone depletion and Acid Deposition

Air pollution problems are not necessarily confined to a local or regional scale. Atmospheric circulation can transport certain pollutants far away from their point of origin, expanding air pollution to continental or global scales; it can truly be said that air quality problems know no international boundaries. Some air pollutants are known to be associated with changes in Earth's climate, requiring consideration of governmental actions to limit their impacts. Two important air pollution problems that are generally considered worldwide in scope are **global warming** and **depletion of stratospheric ozone.**

Greenhouse Gases

Since $CO_2$is confined exclusively to the troposphere, its higher concentration may act a serious pollutant. Under normal conditions (with normal CO_2Concentration) the temperature at the surface of the earth is maintained by the energy balance of the sun rays thatstrike the planet the planet and heat that is radiated back into space. However, when there isan increase in CO_2concentration, the thick layer of this gas prevents the heat from being re- radiated out. This thick CO_2layer thus functions like the glass panels of a greenhouse (or the glass windows of a motor car), allowing the sunlight to filter through but preventing the heat from being re-radiated in outer space. This is the so-called greenhouse effect. Nitrogen and oxygen, the main constituents of the atmosphere, play no part in the greenhouse effect. But there are approximately 35 trace gases that scientists believe contribute to global warming. **Carbon dioxide (CO_2)** is considered to be one of the most important of these greenhouse gases, absorbing most of the heat trapped by the atmosphere.

Other gases of special importance in global warming are **chlorofluorocarbons** (CFCs), **methane, nitrous oxide** and **ozone.** Although the average concentrations of these gases are much lower than that of carbon dioxide, they are much more efficient than carbon dioxide at soaking up long – wave radiation. Overall, carbon dioxide is estimated to cause almost 60 per cent of the warming effect and CFCs about 25 per cent, and the remainder is caused by methane, nitrous oxide, ozone, and other trace gases.

More than 80% of the mass of the atmosphere and virtually all of water vapour, clouds and precipitation occur in the troposphere. Earth's surface, it consists of *troposphere, stratosphere, mesosphere* and the *thermosphere.* Troposphere extends upto 10-12 km at mid-latitudes (at equator – 18 km, at poles 5-6 km). In troposphere, temperatures typically decrease at5-7°C per km (wet adiabatic lapse rate).

Equilibrium temperature increase caused by CO_2

- Considerable effort has gone into attempting to quantify the relationship between expected global temperature change and CO_2concentration.
- Typical of current understanding is that a doubling of CO_2will likely result in an eventual global warming of approximately 1.5–4.5°C.
- An increase of only 1.5° C, over the pre-industrial temperature would make the earth warmer than it has been in the last 10,000years.
- In the past 100 years or so, an increase of 0.5°C has actually occurred in the global average surface temperature.
- Elevated temperatures increase evaporation, increasing the amount of water vapour in the air. Since water vapour is a greenhouse gas, it might cause even more warming. On the other hand, increased cloudiness may increase the albedo. Increasing albedo would lead toglobal cooling.

CHLOROFLUOROCARBONS

- CFCs are mainly used as refrigerants, solvents, foaming agents in the production of rigid and flexible foams and as aerosol propellants for such products as deodorants, hairspray and spray-paint.
- Chlorofluorocarbons (CFCs) are molecules that contain chlorine, fluorine and carbon.
- As opposed to other greenhouse gases, CFCs do not occur naturally and their presence in the atmosphere is due entirely to human activities.
- CFCs absorb strongly in the atmospheric window (7-12 μm) and tend to have long atmospheric residence times. Hence they are potent greenhouse gases.
- The two CFCs that have received the most attention, in both ozone and climate change contexts are trichlorofluoromethane, $CFCl_3$(CFC-11), and dichlorofluoromethane, CF_2Cl_2(CFC-12).
- CFC molecules are inert and non–water soluble, so they are not destroyed through chemical reactions or removed with precipitation.
- The only known removal mechanism is photolysis by short wavelength solar radiation, which occurs after the molecules drift into the stratosphere. The chlorine freed during thisprocess can go on to destroy stratospheric ozone.
- CFCs are mainly used as refrigerants, solvents, foaming agents in the production of rigid and flexible foams and as aerosol propellants for such products as deodorants, hairspray and spray-paint.
- Some of the CFCs are based on a one-carbon methane structure, such as trichlorofluromethane ($CFCl_3$) and dichlorofluromethane (CF_2Cl_2),they were often referred as *chlorofluromethanes or CFMs*. The Duiont trade name Freon has also been used.
- When molecules contain only fluorine, chlorine and carbon, they care called *fully halogenatedCFCs*.

- Some CFCs contain hydrogen as well as chlorine, fluorine and carbon and they are called *hydrochlorofulorocarbons or HCFCs*.
- HCFCs have the environmental advantage that, due to the hydrogen bond, they are less stable in the atmosphere and hence, are less likely to reach the stratosphere to affect the ozone layer. The ozone depleting potential of HCFCs is only 2-5% compared most commonly used CFCs. The most widely used CFCs are CFC –11, CFC –12 and CFC– 113.
- When no chlorine is present in the molecule, they are called *hydroflurocarbons or HFCs*. HFCs are important replacements for CFCs, since their lack of chlorine means they do notthreaten the ozone layer.

OTHER GREENHOUSE GASES

- ***Methane*** is a naturally occurring gas that is increasing in concentration, as a result ofhuman activities.
- It is produced by bacterial fermentation under anaerobic conditions, such as in swamps, marshes, rice paddies, as well as in the digestive systems of ruminants and termites.
- It is also released during the production, transportation and consumption of fossil fuels, aswell as when biomass fuels are burned.
- After its release, methane is thought to have an atmospheric residence time of around 8-11years. It is eventually removed through oxidation with various OH radicals.
- Methane concentrations have increased rapidly in the past 20 years and correlate quitewell with human population size.
- ***Nitrous oxide*** is another naturally occurring greenhouse gas that has been increasing in concentration due to human activities.
- It is released into the atmosphere mostly during the nitrification portion of thenitrogen cycle NH_4^+ N_2 N_2O NO_2^- NO_3^-
- Combustion of fossil fuels and nitrogen fertilizer consumption are thought to be the two most important human activities leading to increases in nitrous oxide levels.
- It apparently has no significant tropospheric sinks and is only slowly degraded in the stratosphere by photolysis.
- The destruction process in the stratosphere involves a reaction with atomic oxygen leading to formation of nitric oxide, which in turn reacts catalytically with ozone.
- The desired removal of nitrous oxide, then, has the undesired effect of reducing stratospheric ozone.
- Nitrous oxide has an extremely long residence time of 150 years in the atmosphere. It has strong absorption bands at 4.5, 7.8 and 17 μm and it is thought to be about 230 times as potent as CO_2 in causing global warming.
- ***Ozone*** plays an important role in both troposphere and stratosphere.
  About 90% of atmospheric ozone resides in the stratosphere and it protects life by

absorbing short- wavelength ultraviolet radiation.

- Stratospheric ozone also affects climate, but in a very complex way. Incoming solar energy is absorbed, which heats the stratosphere. This, however, reduces the radiation arriving at the earth's surface, thereby cooling the surface.
- On the other hand, the warmed stratosphere radiates energy back to the earth's surface, thereby heating it. The net effect is uncertain.
- In the troposphere, ozone is a component of photochemical smog and it poses a serious health problem.
- Tropospheric ozone absorbs strongly at around 9.6 μm, right in the middle of the atmospheric window. Increasing concentrations could contribute to raising global temperatures.
- Ozone, however, has a rather short residence time in the troposphere, measured in days. Itis irregularly distributed by time of day, geographic location, and altitude. So it has been difficult to assess its overall change with time, leaving us uncertain as to its impact on climate.

The Greenhouse effect

- Nearly all the incoming solar energy arrives extra terrestrially, with wavelength less than 4 μm(short wavelength radiation), while the outgoing energy radiated by the earth has essentially allof its energy in wavelength greater than 4 μm (long wavelength or thermal radiation) Essentially all the
- incoming solar radiation with wavelengths less than 0.3 μm(ultraviolet) is absorbed by oxygen and ozone in the stratosphere.
- Most of the long wave-length energy radiated by the earth is affected by a combination of radioactively active gases, most importantly water vapour (H_2O), CO_2, N_2O and CH_4.
- Radioactively active gases that absorb wavelengths longer than 4 μm are called *greenhouse*
- *gases*.These gases trap most of the outgoing thermal radiation attempting to leave the earth's surface. This absorption heats the atmosphere, which, in turn, radiates energy back to the earth as well as out to space.
- The greenhouse effect adds 33°C of warming to the surface of the earth, i.e., if there was no greenhouse effect, the earth would have an average temperature of –18°C or about0°C.
- Distributed over the entire surface of the earth, theincomingsolarradiationisequalto343W/m^2.
- Since the albedo is 30% (103 W/m^2), the amount of incoming radiation absorbed by the atmosphere and earth is 240W/m^2.
- Of that 240 W/m^2, 86 W/m^2 are absorbed by the atmosphere and the remaining 154 W/$m^2$are absorbed by the surface of the earth.

Global Warming and Climate Change

Carbon dioxide is a green house gas that is confined to the troposphere and its higher concentration may act as a serious pollutant. Under normal conditions the temperature at the surface of the earth is maintained by energy balance of the sun rays that strike the planet and heat that is reradiated back into space. However when there is an increase in

CO_2concentration, the thick layer of the gas prevents the heat from being reradiated out. This thick CO_2layer functions like the glass panel of a green house, allowing the sun light to filter through but preventing the heat from being reradiated into outer space. Therefore, it is warmer inside the green house than outside. Similar condition is resulted in the troposphere ofthe earth and termed as **'Green house effect'**.

Carbon dioxide concentration of the troposphere has been increasing steadily due to industrial growth. Nearly hundred years ago the CO_2 concentration was 275 ppm, today it is 350 ppm and by the year 2040 it is expected to reach 450 ppm. Certain gases in the atmosphere, known as 'green house' gases like CO, CO_2, CH_4 are able to absorb and emit heat. When sunlight strikes the earth's surface it warms up, emits heat, which radiates upwards into space. This heat warms up the green house gases so that they also emit heat, some into space and some back down to earth, which results in heating up of the earth atmosphere, also known as **Global warming.**

Acid deposition/Acid rain

The presence of excessive acid in rain water is called Acid rain. It is a mixture of nitric acid ,sulphuric acid and carbonic acid. Since the early 1970s, problems associated with acidic precipitation have gained worldwide attention. Acid rain have damaged or destroyed fish and plant life inthousands of lakes throughout central and northern Europe (especially in Scandinavia), the north east United States, south east Canada, and parts of China. Many species of trees in forests throughout these regions have been in decline, largely due to soil acidification. Acid rain also causes pitting and corrosion of metals and the deterioration of painted surfaces, concrete, limestone, and marble in buildings, monuments, works of art, and other exposed objects.

Acid rain is caused by the emission of sulfur and nitrogen oxides into the atmosphere, mostly from the burning of fossil fuels for electric power. Other sources from human activities include certain industrial processes and the gasoline powered automobile. Sulfur dioxide reacts with water vapor in the air to form sulfuric acid; nitrogen dioxide reacts with water vapor to form nitric acid. It has been found that the contribution of sulfur dioxide to acid rainfall is more than twice that from nitrogen oxides. Contributionof these gases from natural sources, such as from swamps and volcanoes, are small in comparison to human sources.A major environmental impact of acid deposition is the lowering of pH in lakes an drivers.Most aquatic life is disrupted as the pH drops. Phytoplankton populations are reduced, and many common water – dwelling invertebrates, such as may flies and stone flies, cannot survive when the pH falls below about 6.0. Some sensitive species of fish, including trout and salmon, are harmed when pH levels fall below 5.5. Acidity has a deleterious effect on the reproductive cycle of fish; when the pH is less than 4.9, reproduction of most fish species is unlikely. Acid dead lakes have pH below about3.5.

UNIT-V

Disaster Management

Disaster management, Floods, earthquakes, cyclones and landslides.

Disaster is a sudden, calamitous event bringing great damage, loss, destruction and devastation tolife and property. The damage caused by disaster is immeasurable and varies with the geographical location, climate and the type of the earth surface. This influences the mental, socio-economic, political and cultural state of the affected area. Generally, disaster has the following effects in the concerned areas**,**

1. It completely disrupts the normal day to day life
2. It negatively influences the emergency systems
3. Normal needs and processes like food, shelter, health, etc. are affected and deteriorate depending on the intensity and severity of the disaster.

It may also be termed as "a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of the affected society to cope using its own resources."

Types of Disaster

Generally, disasters are of two types – **Natural** and **Manmade**. Based on the devastation,these are further classified into major/minor natural disaster and major/minor manmade disasters.Some of the disasters are listed below,

Major natural disasters:

- Flood
- Cyclone
- Drought
- Earthquake

Minor natural disasters:

- Cold wave
- Thunderstorms
- Heat waves
- Mudslides
- Storm

Major manmade disaster:

- Setting of fires Epidemic
- Deforestation
- Pollution due to prawn cultivation
- Chemical pollution.
- Wars

Minor manmade disaster:

- Road / train accidents, riots
- Food poisoning
- Industrial disaster/crisis
- Environmental pollution

Disaster Management

There are no standardized rules defining the different phases of the disaster management cycle. Different agencies use different cycles depending upon their objectives. However, while approaches vary, it is agreed that disaster management activities should be carried out in a cycle. The following figures illustrates the phases of the disaster management cycle, which are described as follows:

The Disaster Management Cycle

Disaster prevention, mitigation and preparedness

The first important steps towards reducing disaster impact are to correctly analyses the potential risk and identify measures that can prevent, mitigate or prepare for emergencies. Information and Communication Technology can play a significant role in highlighting risk areas, vulnerabilities and potentially affected populations by producing geographically referenced analysis through, for example, a geographic information system (GIS). The importance of timely disaster warning in mitigating negative impacts can never be underestimated. For example, although damage to property cannot be avoided, developed countries have been able to reduce loss of life due to disasters much more effectively than their counterparts in the developing world. A key reason for this is the implementation of effective disaster warning systems and evacuation procedures used by the developed countries, and the absence of such measures in the developing world.

Disaster Warning

Disaster Reduction identifies several key parties that play major roles in the disaster management process, especially in disaster warning **Communities,** particularly those most vulnerable, are vital to people-centered early warning systems. Their input into system design and their ability to respond ultimately determine the extent of risk associated with natural hazards. Communities should be aware of hazards and potential negative impacts to which they are exposed and be able to take specific actions to minimize the threat of loss or damage. As such, the geographic location of a community is an essential determinant in the selection of disasters on which the system should focus their community education. For example, coastal communities need to be educated and prepared for the possibility of a tsunami, while a mountain community can be educated to respond to an early warning system for landslides.

Local governments should have considerable knowledge of the hazards to which their communities are exposed. They must be actively involved in the design and maintenance of early

warning systems, and understand information received to be able to advise, instruct or engage the local population in a manner that increases their safety and reduces the potential loss of resources on which the community depends.

National governments are responsible for policies and frameworks that facilitate early warning, in addition to the technical systems necessary for the preparation and issuance of timely and effective hazard warnings for their respective countries. They should ensure that warnings and related responses are directed towards the most vulnerable populations through the design of holistic disaster response and early warning frameworks that address the specific needs of the related micro- and macro-level actors. The provision of support to local communities and local governments to develop operational capabilities is an essential function to translate early warning knowledge into risk reduction practices.

Regional institutions and organizations should provide specialized knowledge and advice in support of national efforts to develop or sustain the operational capabilities of countries that share a common geographical environment. Regional organizations are crucial to linking international capabilities to the particular needs of individual countries and in facilitating effective early warning practices among adjacent countries.

International bodies should provide support for national early warning activities and foster the exchange of data and knowledge between individual countries. Support may include the provision of advisory information, technical assistance, and policy and organizational support necessary to ensure the development and operational capabilities of national authorities or agencies responsible for early warning practice.

Non-governmental organizations (NGOs) play a critical role in raising awareness among individuals and organizations involved in early warning and in the implementation of early warning systems, particularly at the community level. In addition, they play an important advocacy role to help ensure that early warning stays on the agenda of government policy makers.

The private sector has a diverse role to play in early warning, including developing early warning capabilities in their own organizations. The private sector is also essential as they are usually better equipped to implement Information and Communication Technology-based solutions. The private sector has a large untapped potential to help provide skilled services in the form of technical manpower, know- how, or donations of goods or services (in-kind and cash), especially for the communication, dissemination and response elements of early warning.

The media plays an important role in improving the disaster consciousness of the general population and in disseminating early warnings. The media can be the critical link between the agency providing the warning and the general public.

The scientific community has a critical role in providing specialized scientific and technical input toassist governments and communities in developing early warning systems. Their expertise is critical to analyzing the risks communities face from natural hazards, supporting the design of scientific and systematic monitoring and warning services, fostering data exchange, translating scientific or technical information into comprehensible messages, and disseminating understandable warnings to those at risk.

Channels Used forDisaster Warning Radio and Television

Considered the most traditional electronic media used for disaster warning, radio and television have a valid use. The effectiveness of these two media is high because even in developing countries and rural environments where the tele-density is relatively low, they can be used to spread a warning quickly to a broad population. The only possible drawback of these two media is that their effectiveness is significantly reduced at night, when they are normally switched off.

Telephone (Fixed and Mobile)

Telephones can play an important role in warning communities about the impending danger of a disaster.

Short Message Service

Short message service (SMS) is a service available on most digital mobile phones that permits the sending of short messages (also known as ‘text messages’, ‘SMSes’, ‘texts’ or ‘txts’) between mobile phones, other handheld devices and even landline telephones.

Satellite Radio

A satellite radio or subscription radio is a digital radio that receives signals broadcast by communications satellite, which covers a much wider geographical range than terrestrial radio signals. Satellite radio functions anywhere there is line of sight between the antenna and the satellite, given there are no major obstructions such as tunnels or buildings. Satellite radio audiences can follow a single channel regardless of location within a given range. Satellite radio can play a key role during both disaster warning and disaster recovery phases. Its key advantage

is the ability to work even outside of areas not covered by normal radio channels. Satellite radios can also be of help when the transmission towers of the normal radio station are damaged in disaster.

Internet/Email

The role Internet, email and instant messages can play in disaster warning entirely depends on their penetration within a community and usage by professionals such as first responders, coordinating bodies, etc. While these media can play a prominent role in a developedcountry, where nearly half of all homes and almost all offices have Internet connections, this is not the case in the developing world. In many developing countries, less than 5 percent of the population uses the Internet and even those who are users do not use it on a regular basis. In sucha situation, it is difficult to expect Internet and email to play any critical role.

The use of GIS in different phases Planning

Locating and identifying potential problems is a core requirement in disaster management. GIS can be used effectively to achieve this objective. Using a GIS, it is possible to pinpoint hazard trends andstart to evaluate the consequences of potential emergencies or disasters. When hazards are viewed with other map data, such as buildings, residential areas, rivers and waterways, streets, pipelines, power lines, storage facilities, forests, etc., disaster management officials can formulate mitigation, preparedness, response and possible recovery needs.

Mitigation

After potential emergency situations are identified, mitigation needs can be addressed. This process involves analysing the developments in the immediate aftermath of a disaster, evaluating the damage anddetermining what facilities are required to be reinforced for construction or relocation purposes. Mitigation may also include implementing legislation that prevents building structures in areas prone to earthquake, flood or tsunami. Other mitigation approaches may target fire-safe roofing materials in wildfire hazard areas. Utilizing existing databases linked to geographic features in GIS makes the task of monitoring these possible.

Preparedness

During the preparedness and response phases, GIS can accurately support better response planning inareas such as determining evacuation routes or locating vulnerable infrastructure and vital lifelines, etc. It also supports logistical planning to be able to provide relief supplies by displaying

previously available information on roads, bridges, airports, railway and port conditions and limitations. Apart from this, activities such as evacuee camp planning can also be done using GIS.

Disaster response

The most difficult period of a disaster is the immediate aftermath. This period calls for prompt actionwithin an exceptionally short period of time. In the aftermath of any disaster, a significant number of individuals will be injured and/or displaced. Many of them may still be living with the trauma they have encountered, including loss of loved ones. Affected individuals may also be without food or other essential items. They might be waiting in temporary shelters, with no idea what to do next. Some might need immediate medical attention, while the disaster aftermath environment also createsideal breeding grounds for possible epidemics.

- Tracing Missing Persons
- Coordinating Donor Groups
- Recording the Locations of Temporary Camps and Shelters

Disaster recovery

Disaster reconstruction has to start as soon as the initial disaster cleanup has taken place. This is a very complex endeavor, requiring a huge array of skill sets and a thorough knowledge of an ever- increasing variety of techniques and equipment. A range of software tools are being used for these purposes. Thus, while the role of Information and Communication Technology in the long-term disaster recovery process is not as apparent as it is in disaster warning, there is no doubt that Information and Communication Technology is being used widely to expedite these activities.

Disaster management in India

The **National Disaster Management Authority** (NDMA), headed by the Prime Minister of India, isthe Apex Body for Disaster Management in India. The setting up of the NDMA and the creation of an enabling environment for institutional mechanisms at the State and District levels is mandated by the Disaster Management Act,2005.

Evolution of NDMA

Emergence of an organization is always an evolutionary process. Establishment of NDMA has

also gone through the same processes. Towards this aim, the Government of India (GOI), in recognition of the importance of Disaster Management as a national priority, has set up a High-Powered Committee (HPC) in August 1999 and also a nation committee after the 2001 Gujarat earthquake, formaking recommendations on the preparation of Disaster Management plans and suggestion effective mitigation mechanisms. The Tenth Five-Year Plan Document also had, for the first time, a detailed chapter on Disaster Management. Similarly, the Twelfth Finance Commission of India was also mandated to review the financial arrangements for Disaster Management. On 23 December 2005, the Government of India enacted the Disaster Management Act, which envisaged the creation of the National Disaster Management Authority (NDMA), headed by the Prime Minister of India, and StateDisaster Management Authorities (SDMAs) headed by respective Chief Ministers of the States, to spearhead and implement a holistic and integrated approach to Disaster Management in India.

Floods

A flood is an expanse of water submerging land. A flood is caused by excess water in a location, usually due to rain from a storm or thunderstorm or the rapid melting of snow. A flood happens when an area of land, usually low-lying, is covered with water. The worst floods usually occur when a river overflows its banks. The flood is constituted not only of the overflowing water but also of all other waters that are unable to drain off into water channels.

Causes of floods

1) When snow on a mountain melts or when a river or a lake of some sort overflows
2) Flooding from water displacement, such as in a landslide,
3) The failure of a dam,
4) An earthquake induced tsunami,
5) A hurricane's storm surge or melt water from volcanic activity.
6) Flooding of Coastal areas by high tides or by tsunami waves caused by undersea earthquakes.
7) A flood that rises and falls rapidly with little or no advance warning is called a flash flood. Flashfloods usually result from intense rainfall over a relatively small area.

Elements at risk

1) Buildings built of earth (mud),weak foundation and water soluble material.
2) Basement of buildings.

3) Utilities such as sewerage, water supply.
4) Agricultural equipment and crops, vehicles, fishing boasted.

Effects of flood

- Physical damage- structures such as buildings get damaged due to flood water. Landslides can also take place. Top soil gets washed away
- Causalities - people and livestock die due to drowning. It can also lead to epidemics and diseases.
- Water supplies- Contamination of water. Clean drinking water becomes scarce.
- Crops and food supplies- shortage of food crops can be caused due to loss of entire harvest.

Flood management

Flood management involves the following activities:

5) **Mapping**- of the flood prone area.
6) **Land use control**- no major development should be permitted in the areas subjected to flooding.
7) **Construction of engineered structures**- strong structures to withstand flood forces. Moreover the buildings should be constructed on an elevated area and if necessary should be build onsite.
8) **Flood control**- it aims to reduce flood damage. It includes:
    a) Flood reduction
    b) Flood diversion
    c) Flood proofing

For example,

- London is protected from flooding by a huge mechanical barrier across the river Thames, which is raised when the water level reaches a certain point.

Notable floods

- Jakarta on January 2007 till now is having a 1.5 M flood. Whole city is affected. 80 people killed.
- The floods in peninsular Malaysia, Sabha and Sumithra in December 2006 andJanuary

2007 is considered to be the worst in 100 years, resulting in evaluation of over 100,000 people in the worst-hit state of Johor at its peak.

- Ethiopia saw one of its worst floods in August2006.

Cyclone

The name cyclone was first coined by Captain Henry Paddington, Chairman of Marine Court, Calcutta in 1848. It is derived from Greek word means coil of a snake. Cyclone is an meteorological phenomena in which an area of low pressure characterized by inward spiraling winds that rotate counter clockwise in the northern hemisphere and clockwise in the southern hemisphere of the earth. Near the places of their origin they are only 80 Km in diameter, but well developed cyclones have their diameter ranging from 300 to 1500 km. They move at faster rate over the oceans than over the land because the irregularities of the land surface retard their speed. The six main types of cyclones are polar cyclone, polar low, extra tropical, subtropical, tropical and musicale.

While moving over the ocean, they pick up energy from the warm water of the ocean and some of them grow into a devastating intensity. On an average, about 5-6 tropical cyclones form in the Bay of Bengal and the Arabian sea every year, out of which 2-3 may be severe.

Depending on their location and strength, there are various terms by which tropical cyclones are known, such as hurricane, typhoon, tropical storm, cyclonic storm and tropical depression. They are all cyclonic storm systems that form over the oceans. Tropical cyclones canproduce extremely strong winds, tornadoes, torrential rain, high waves, and storm surges. The heavy rains and storm surges can produce extensive flooding. Although one cannot control cyclones, the effects of cyclones can be mitigated through effective mitigation policies and strategies.

- Installation Of Earth Warning Systems **:**Such systems fitted along the coastlines can greatly assist forecasting techniques, thus helping in early evacuation of people in the storm surge areas.
- Developing communication infrastructure Amateur Radio has today emerged as second line unconventional communications systems and is an important tool for disaster mitigation.
- Developing shelter belts: Shelter belts with plantations of trees can act as effective wind- and tide-breakers. Apart from acting as effective windbreakers and protecting soil crops from being damaged, they also prevent soil erosion.

- Developing community cyclone shelters: Cyclone shelters at strategic locations can help in minimizing the loss of human life. In the normal course of life, these shelters can be used as public utility buildings.
- Construction of permanent houses: There is a need to build appropriately-designed concrete houses that can withstand high winds and tidal waves.
- Training and education: Public awareness programs that inform the population about their response to cyclone warnings and preparedness can go a long way in reducing causalities.
- Land use control and settlement planning: Ideally, no residential and industrial units should be permitted in the coastal belt of 5 km from the sea, as it is the most vulnerable belt. No further growth of settlements in this region should be permitted. Major settlements and other important establishments should be located beyond 10 km from these.

Earthquakes and Mitigation Measures

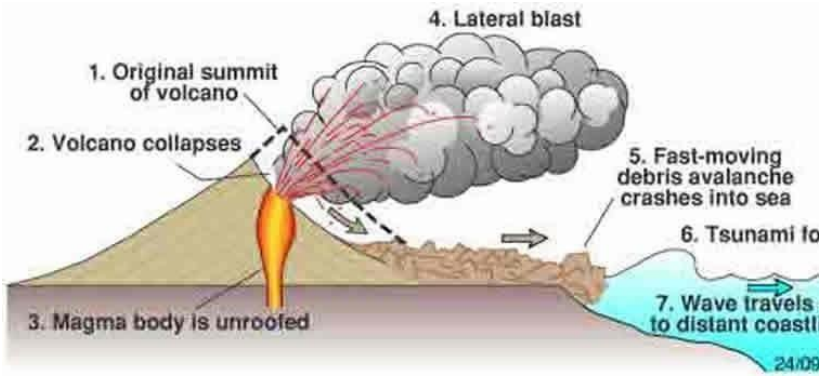
Earthquake is those movements of the earth crust which make the ground vibrate and shake backward and forward. The shaking of earth crust proceeds in the form of waves from the centre of disturbance. Longitudinal waves, transverse waves and surface waves are the 3 types of waves. Earthquake may be caused by two types of forces.

1) Techtronic occurrence: tectonic occurrence like faulting, breaking of rocks, raising or sinking of layers of the earth, folding of the strata or vapour seeking to escape from the earth.

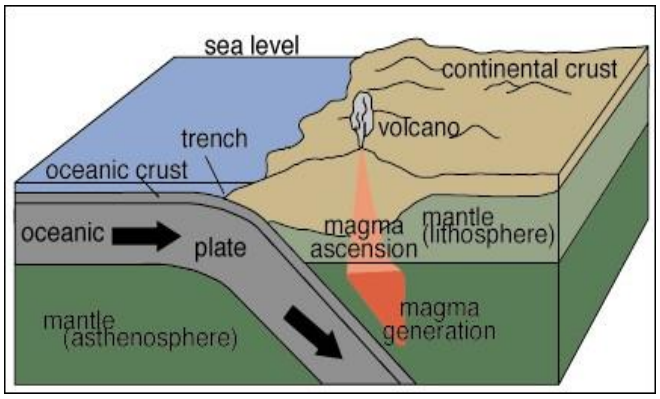
2) Volcanic activity: violent eruptions and intrusion of igneous magma from below the earth.

Types of earthquake:

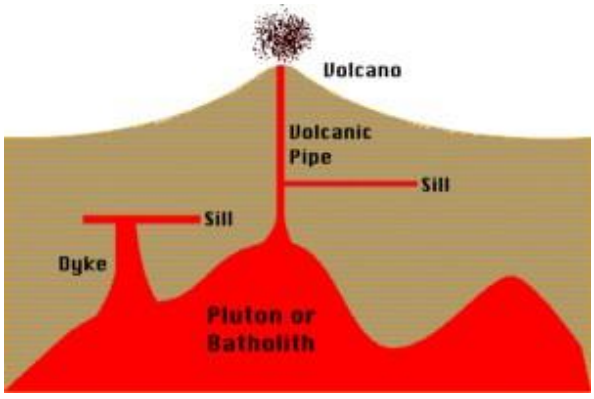
Volcanic earthquake: are associated with the flow of hot magma interrupting volcanoes. These happen to be localized and seldom cause any extensive damage.



Techtonic earthquake: are those which result from structural and justments inside the earth.



Plutonic earthquake: are those which have their origin at greater depths. They may also be generated inthe same manner as the tectonic earthquake far below the surface of the earth.



Effects of earthquake:

- Collapse of manmade structure like building, bridges, towers etc.
- Roads get affected due to subsidence of the ground and enormous fissures appear on land.
- Extensive landslides in hilly regions and rocky depris come down to block the path of streams.
- When earthquake are accompanied by volcanic activity, the destruction is very enormous**.**

Mitigation measures:

- Damage to structure can be avoided by prohibiting restriction on such earthquake pronezones.
- Power lines and pipelines can be built with extra slack where they cross such earthquake prone zones.
- New buildings should be constructed with proper earthquake resistant measures. They require secure anchoring and tight bonding of foundations, frame, outer and inner walls,floors and roofs.
- Vulnerable older building located in high risk areas might be rebuilt to withstand anticipated earthquake.

Indian Scenario

It has been several years since the earthquakes struck Gujarat on January 26, 2001, re-habitation has been done on a massive scale. Gujarat's experience has taught that building shelters with less vulnerability to earthquakes should also take into consideration of the specific needs of the victims instead of being a top-down approach. The role of NGO's in this is very important. Their strength lies in their manpower, informality in operations and valuable human resources. Their ability to reach out to the community and sensitivity to local traditions is an asset in such situations.

The initiatives of the International Fund for Agricultural Development in supporting the self- employed Woman association(SEWA) and the Government's initiative in community-basedlivelihood security for earthquakes and drought victims have the potential to shape future disaster response and development projects in Gujarat, the Gujarat Woman's Economic Development Corporation (GWEDC) initiative in reviving woman's businesses after the

calamity also providesmany practical lessons in regenerating local economies and artisan markets.

The coordination between Government, local NGO's and local community initiatives, both for rescue as well as rehabilitation, needs to be strengthened as this can cause delays, overlaps and waste of relief material and efforts.

Land Slides and Mitigation Measures

In the recent years, intensive construction activity and the destabilizing forces of nature haveaggravated the land Slide problem. Landslides refer to the downward sliding of huge quantities of land masses. Sliding occurs along steep slopes of hills of mountains. The rate of movement of such a mass is never constant. Landslides occur as a result of changes on a slope, sudden or gradual, either in its composition, structure, hydrology or vegetation. The changes can be due to geology, climate, weathering, changing land use and earthquakes.

The causes of landslides may be grouped into two types:

- Inherent or internal causes.
- Immediate causes.

Effect of landslides:

Landslides are not only destructive to the man but also to the structures. One of the most disastrous landslides occurred in Switzerland in 1806, when great masses of loose rock and soil suddenly slide down into the valley form the mountain side. It resulted in killing of 800 persons. Initially the Vajont Dam, was the highest arch failed due to landslide on October 9, 1963, when a rock mass of about 600 million tons slide down into the lake.

- A significant reduction in hazards caused by landslides can be achieved by prevention of the exposure of population and facilitates by physically controlling the landslides.
- Development programs that involve modification of the topography, exploitation of natural resources and change in the balance load on the

ground should not be permitted.

- Some critical measures that could be undertaken to prevent further landslides are drainage measures, erosion control measures such bamboo check-dams, terracing,jute and coir netting and rock control measures such as grass plantation, vegetated dry masonry walls, retaining walls and, most importantly, preventing deforestation and improving afforestation.
- Disasters cannot be totally prevented. However, early warning systems, careful planning and preparedness on part of the vulnerable community would help in minimizing the loss of life and property due to these disasters.