Unit – I Environment, Ecosystems and Biodiversity

Environment

INTRODUCTION

The word environment is coined form the French word "Environ" meaning" surround or surroundings" i.e., each and everything surrounding us. **E.g.** Lion in a forest surrounded by living and non-living things like air, water, trees, other animals etc.

DEFINITIONS

1. **Environment**

Environment is defined as "the sum of total of all the living and the non-living things around us influencing one another." **E.g.** Lion in a jungle surrounded by living and non-living things like air, water, trees, other animals etc.

2. **Environmental Science**

The study of the environment, its biotic (living) and abiotic (non-living) components and their interrelationship is called environmental science. It includes the basic concepts of physics, chemistry, geography, geology etc., which is used in understanding the structure, function and physical characteristics of environment.

3. **Environmental Engineering**

Environmental engineering is the application of engineering principles, science, education, ethics and law in the protection and enhancement of the quality of environment, public health and welfare.

4. **Environmental Studies**

Environmental studies are the process of educating the people for preserving quality environment. It is the multidisciplinary studies of science, engineering, technology and management which shows the impact of human activities on the environment.

TYPES OF ENVIRONMENT

Environment is divided into 2 types:

1. Natural Environment: Natural environment consists of natural components including all biotic (biological) and abiotic (physical) components created through a natural process without any human support.
E.g. Soil, water, air, trees, radiations, noise etc.

2. Man- made environment: Man is most powerful agent who modifies the environment using modern technologies, according to his needs for survival and well-being.
E.g. Houses, parks, hospitals, schools, roads etc.

SCOPE OF ENVIRONMENTAL STUDIES

Environmental Studies is the tool for educating people to preserve environment. Main scope includes:

1. To get awareness and sensitivity of environment and its related problems.

2. To motivate the active participation of individuals in the protection and improvement of environment.
3. To develop skills for identifying and solving environmental problems.
4. To know the necessity of conservation of natural resources.
5. To conduct environmental programmes in terms of social, economic, ecological and aesthetic factors.

IMPORTANCE/ SIGNIFICANCE/ NEED OF ENVIRONEMNTAL STUDIES

The air we breathe, water we drink, food we eat and the land we live are all polluted. There is no zero pollution.

To solve the above problems, knowledge of environment and its studies are very important.

1. To understand the concept of "need of development without destruction of environment".
2. To gain knowledge of different types of environment their various resources and the effects of different environmental hazards.
3. To inform people about their effective role in protecting the environment by demanding changes in laws and enforcement systems.
4. To develop a concern and respect for the environment.

NEED FOR PUBLIC AWARENESS

1. Necessity to maintain a natural balance, sensible planning of development in order to save humanity from extinction.
2. To check nominal use of natural resources as watch dogs informing government about the degradation of environment.
3.To educate and create awareness through mass media like tv, radio, short films, internet, mobile phones, etc.,
4. To motivate and active participation of individuals in protecting the environment from various types of pollution.

ECOSYSTEM

Definition:

Ecology

Ecology is the study of various ecosystems which is the relationship between organisms and their surroundings (living and non-living).

Ecosystem

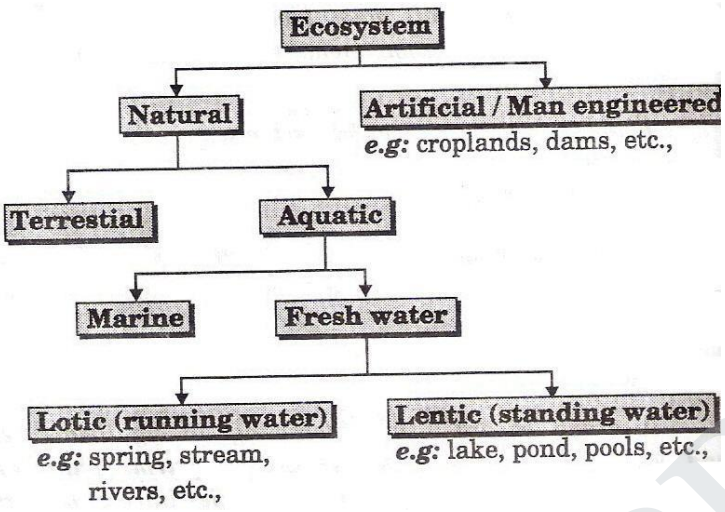
Ecosystem is the basic functional unit of ecology. It is derived from Greek word "study of home". Ecosystem is a group of organisms interacting among themselves and with the environment exchanging its energy and matter.

E.g, forest, desert etc.

Biome

Biome is a small ecosystem within another ecosystem having dominant species with similar lifestyle, climatic conditions and physical structure etc.,

TYPES OF ECOSYSTEM



STRUCTURE OR COMPONENTS OF AN ECOSYSTEM

The ecosystem has two major components (a) abiotic and (b) biotic.

(a) Abiotic Components

Non-living components of ecosystem (physical and chemical) form the abiotic community.

(i) Physical components: It includes energy, climate, raw materials and living space.

E.g. Air, water, soil, sunlight

(ii) Chemical components: They are the sources of nutrients.

(a) Organic substances E.g. proteins, lipids, carbohydrates

(b) Inorganic substances E.g. (C, N, O, P, K, H) and (Al, Co, Cu, Zn).

(b) Biotic Components

Living members in a community form the biotic community.

(i) **Autotrophic/Producers/Self-feeders**: They prepare their own food with the help of chlorophyll, sunlight, water and carbondioxide. E.g. plants, trees.

(ii)**Heterotrophic / Consumers/ other-feeders:** They lack chlorophyll and do not prepare their own food but depends on the producers for their food.

(a) Macro consumers: Herbivores, carnivores and omnivores.

(b) Micro consumers/ Saprotrophs: Decomposers (bacteria, fungi)

Classification/members of biotic components

Based on their source of food

1. **Autotrophs/ Producers**: Prepare their food through photosynthesis using chlorophyll, CO_2 and sunlight.

$$6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$$

2. **Heterotrophs/Consumers**: They do not make their food but depend on producers for their food.

(A) Primary consumers/Herbivores. Depend on plants for their food. E.g. Insects, rats.

(B) Secondary consumers/Primary carnivores: They feed on primary consumers. E.g. Frogs, cat, snakes.

(C) Tertiary consumers/Secondary carnivores: They feed on secondary consumers e.g. lions, tigers

Grass → Rat → Cat → Tiger

3. **Decomposers**: They feed on dead plants and animals and decompose them into simpler compounds releasing inorganic nutrients. These are again utilized by plants with other organic substances for the synthesis of food.
e.g. Bacteria, fungi.

FUNCTION OF AN ECOSYSTEM

Its main function is to allow the flow of energy and nutrients.

Types of function

1. Primary function/ production: It is manufacturing of starch by photosynthesis.
2. Secondary function/ production: It is the distribution of energy to all consumers in the form of food which is stored by them.
3. Tertiary function: The dead systems (plants and animals) are decomposed by decomposers thereby initiating the third function called "cycling".

ENERGY FLOW IN THE ECOSYSTEM

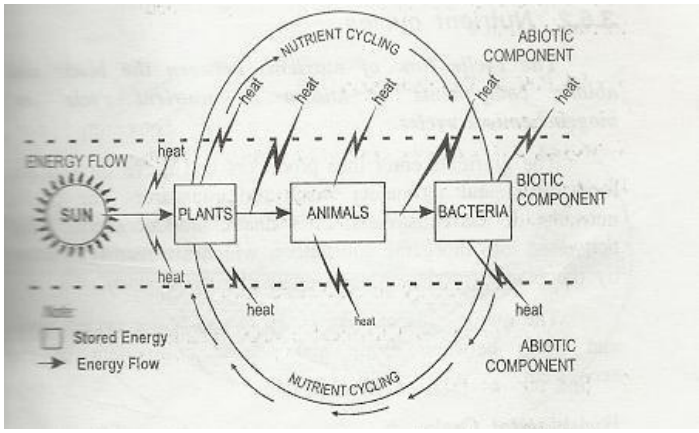
Solar energy is the main energy on earth's surface. About 1% of this is used by plants for photosynthesis. They convert this into chemical energy part of which is used for their growth and remaining is passed onto consumers.

Thus, energy enters ecosystem through photosynthesis and travels through different feeding or trophic levels at the rate of 10% and the rest 90% is lost in the form of heat. This indicates that the energy flow is greatly reduced at each trophic levels from producers to carnivores. The energy flow is unidirectional i.e energy from sun never return back to sun.

Energy flow through an atmosphere in an ecosystem is governed by laws of thermodynamics

I law of thermodynamics - Energy can neither be created nor destroyed, but it can only be converted from one form to another.

II law of thermodynamics - Whenever there is transformation of energy, there is loss of energy in the form of heat. The loss of energy takes place through respiration, running, hunting etc. Relationship between structure and function (flow model)



ECOLOGICAL SUCCESSION

The progressive replacement of one community by another till the development of a stable community in a particular area is called ecological succession.

Stages of Ecological succession

1. **Pioneer Community**:

The first group of organisms which establish their community in an area is called pioneer Community.

2. **Seres or Seral Stage:**

The various developmental stages of a community is called **'seres'**.

Community: Group of plants or animals living in an area.

Types of ecological succession

1. Primary succession: Involves gradual establishment of biotic communities on a lifeless ground.
2. (a) **Hydrarch**: Establishment starts in watery area (lake, pond)
3. (b) **Xerarch**: Establishment starts in dry land (desert, rocks)
4. Secondary succession: Involves the establishment of biotic communities in an area, where some type of biotic community is already present.

Process of ecological succession

Ecological succession takes place in the following steps:

1. **NUDATION**: It is the development of bare land without any life form.
2. **INVASION**: It is the establishment of one/more species on a bare land through migration followed by establishment.

(a) MIGRATION: Migration of seeds by wind, water and birds.

Types of food chain

1. **Grazing food chain**:

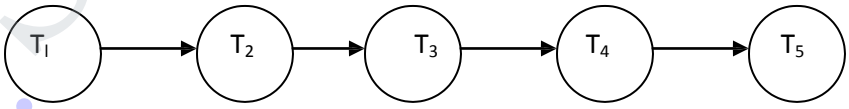
Found in grass land and pond ecosystems. It starts with green plants and goes to the decomposer/detritus food chain through herbivores and carnivores.

2. **Detritus food chain**:

Found in grassland and forest ecosystems. It starts with dead organic matter and goes to decomposer food chain through herbivores and carnivores.

Trophic levels

The various steps through which food energy passes in an ecosystem is called trophic levels.



T_1 – Green plants/producer
T_2 – Herbivores/primary consumers
T_3 – Carnivores/secondary consumers
T_4 – Tertiary consumers
T_5 — Decomposers

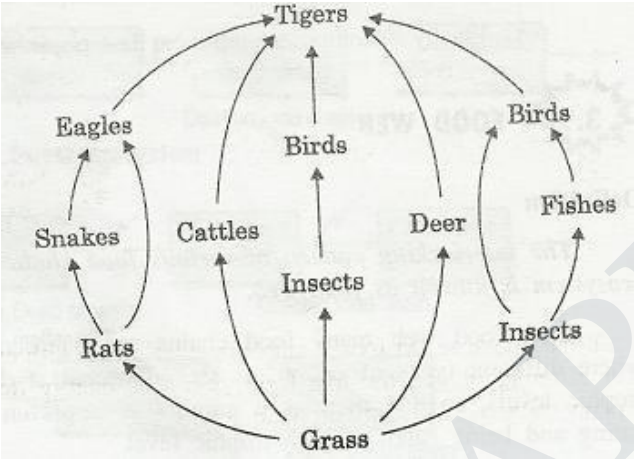
FOOD WEB

Definition: The interlocking pattern of various food chains which are linked together in an ecosystem is called food web. Different types of organisms are connected at different trophic levels so that there are number of opportunities of eating and being eaten at any trophic level.

Functions:

- Maintains the stability of ecosystems.
- Maintains the nutritional balance in an ecosystem.
- Control the population size of species in an ecosystem.
- Provide alternate food source.

Energy flow in a food web



Significance of food chains and food webs

1. Food webs and food chains play an important role in ecosystem as energy and nutrient flow takes place through them.
2. They maintain and regulate the population size of different trophic levels thereby maintaining ecological balance.
3. They have property of biomagnification. The passing of non-biodegradable material from one trophic level to another causing its concentration to increase and this is called biomagnification.

E.g., **Biomagnification of DDT**

The concentration of DDT sprayed on plants increases along the food chain through phytoplankton to zooplanktons and then goes to fish, animals and human beings. Thus concentration of DDT is magnified in birds, animals and humans damaging the egg shells in birds and cell tissues in humans. As DDT is fat soluble its accumulation in human body is easier and cannot be removed easily.

ECOLOGICAL PYRAMIDS

Definition: The graphical representation of structure and function of trophic levels of an ecosystem is called ecological pyramid.

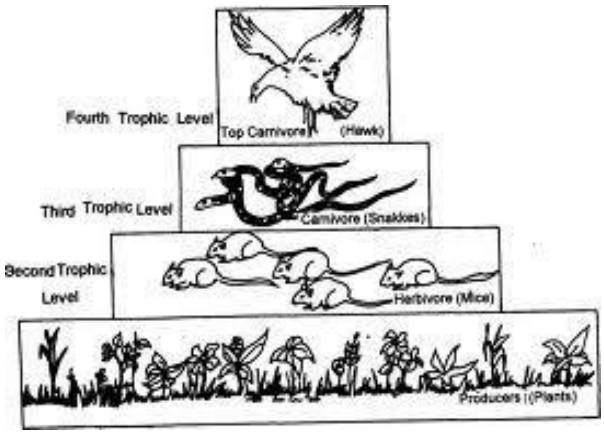
In an ecological pyramid the producers forms the base level and the tertiary consumer occupies the apex level.

Types of Ecological Pyramids

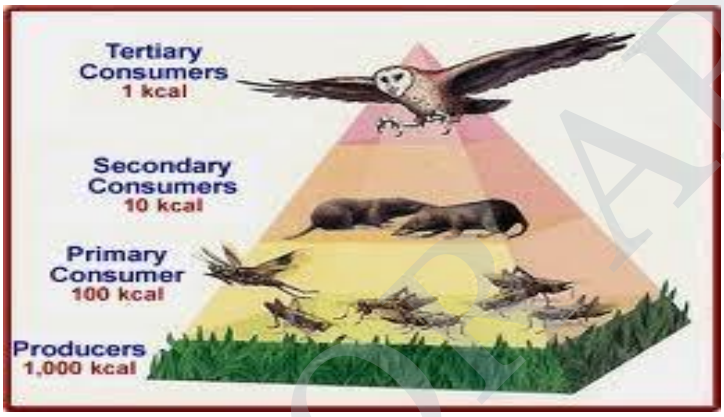
1.**Pyramids of Numbers**:

It represents the number of individual organisms present in each trophic level. e.g., Grassland ecosystem

Here, the producers are grasses which are small in size and large in numbers. So, they occupy the lower most level of the pyramid. The primary consumers (rats) occupy the second trophic level as its number is lower compared to that of grass. The secondary consumers (snakes) which are even larger in size and smaller in number form the third level. The tertiary consumers (eagles) occupy the top layer as the numbers of it is the least.

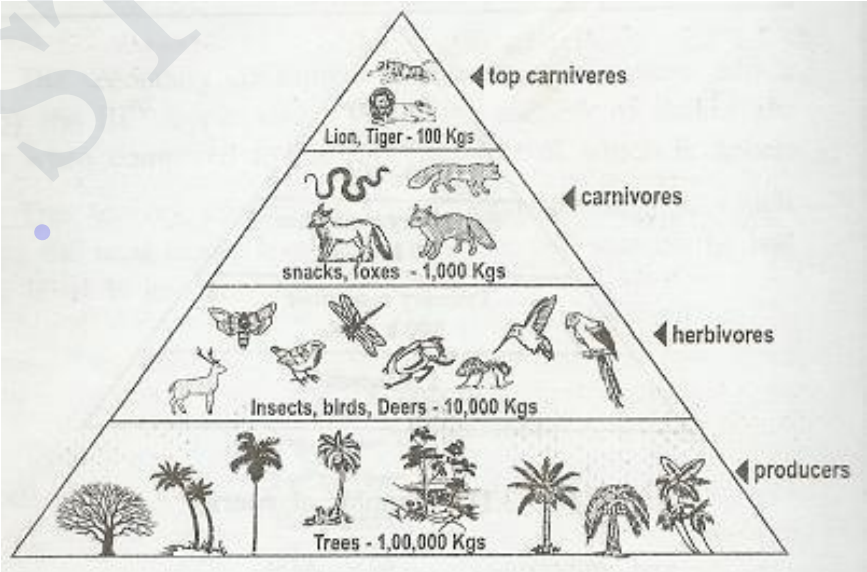


2. **Pyramids of energy**



It represents the amount of energy present in each trophic level. At every successive tropic level there is a heavy loss of energy (about 90%) in the form of heat. Thus at each next higher tropic level only 10% of energy is transferred.

3. Pyramids of energy



It represents the total amount of biomass (mass or weight of biological material or organism) present in each trophic level.

e.g., Forest ecosystem

The trees in forest ecosystem are the producers and they are maximum in number contributing to a huge biomass. The next tropic levels are the herbivores (insects, birds) and then carnivores (snakes, foxes). The topmost level is the tertiary consumers (tiger, lion) which are few and hence having low biomass.

FOREST ECOSYTEM

Forest consists of densely growing trees which cover 40% of world's land and 19% of Indian land.

Types of forests and their features

Depending on the climatic conditions forests are classified into the following types:

(a) **Tropical rain forest**: They are found near the equator. They are characterized by high temperature. Trees like teak and sandal and animals like lion and tiger are found in these forests.

(b) **Tropical deciduous forest**: They are found a little away from equator. They have warm climate and rain only during monsoon. Trees like maple, oak and animals like deer and fox are found in these forests.

(c) **Tropical shrub forest**: They have dry climate for long time. Have small deciduous trees and shrubs and animals like deer, fox, etc.

(d) **Temperate rain forest**: They are found in temperate areas with adequate rain.Coniferous trees like fir, pines and animals like squirrels, fox are found here.

(e) **Temperate deciduous forest**: These are found in areas with moderate temperatures. Trees like oak, hickory and animals like deer, fox are found in these forests.

Characteristics of forests ecosystem

1. They have warm climate and adequate rainfall, which generates number of ponds, lakes etc.
2. Forests maintain rainfall and climate.
3. Forests support many wild animals and protect biodiversity.
4. Soil is rich in nutrients and organic matter which support the growth of trees.
5. As sunlight penetration is poor, conversion of organic matter into nutrients is very fast.

Structure and function of forest ecosystem

1. **Abiotic components**: e.g., Temperature, light, rain and minerals.

They are the inorganic and organic substances found in soil and atmosphere.

2. **Biotic components**:

(a) **Producers:** Trees, shrubs

(b) **Consumers:**

(i) Primary consumers: Insects

(ii) Secondary consumers: Birds, snakes

(iii) Tertiary consumers: Tiger, lion

(c) **Decomposers**: Bacteria, fungi. Rate of decomposition of dead matter in tropical and subtropical forest is more than in temperate forest.

GRASSLAND ECOSYSTEM

Grasslands are large areas of grass with scattered trees which occupies about 20% of world's land.

1.19.1 Types and features of grasslands

1. **Tropical Grassland**: they are found near borders of tropical rain forests. They have high temperature and moderate rainfall (40 to 100cm). They are also called Savanna-type. They have tall grasses and shrubs and animals like zebra, giraffe.
2. **Temperate grassland**: They are found in centres of continents, on flat, sloped hills. They have cold winters and hot summers. Intense grazing and summer fires do not allow shrubs or trees to grow in this grassland.
3. **Polar grassland**: They are found in arctic polar region and have severe cold and strong wind with snow and ice. In summers several annual plants grow and animals like arctic wolf, arctic fox is found here.

Characteristics of grassland ecosystem

1. Grassland ecosystem is plain land occupied by grasses.
2. Soil is rich in nutrients and organic matter.
3. Since there are tall grasses, it is an ideal place for grazing animals.
4. It is characterized by low or even rainfall.

Structure and function of grassland ecosystem

1. **Abiotic components**: e.g., Nutrients (C, H, O ,N ,P , S) supplied by CO_2, H_2O, nitrates, phosphates and sulphates.
2. **Biotic components**:

(a) **Producers**: Grasses, shrubs
(b) **Consumers**:
(i) Primary consumers: Cows, deer
(ii) Secondary consumers: Snakes, lizards
(iii) Tertiary consumers: Eagles
(c) **Decomposers:** Fungi and bacteria.

DESERT ECOSYSTEM

Deserts occupy about 35% of world's land. The atmosphere is dry and hence a poor insulator.

Types and features of desert

1. **Tropical desert**: They are found in
(i) Africa: Sahara desert
(ii) India: Thar desert
They have few species and wind-blown sand dunes are common.
2. **Temperate desert**: They are found in
South California: Majave desert
They have very hot summer and very cool winter.
3. **Cold desert:** They are found in China: Gobi desert
They have cold winters and warm summers.

Characteristic features of desert ecosystem

1. The desert air is dry and climate is hot.
2. Annual rainfall is less than 25cm.
3. The soil is poor in nutrients and organic matter.
4. Vegetation is poor.

Structure and function of desert ecosystem

1. **Abiotic components**: Temperature, rainfall, sunlight

high and rainfall and nutrient cycling are very low.

2. **Biotic components:**

(a) **Producers**: Shrubs, bushes, some grass

In desert there are succulent plants like cacti which have water inside them and waxy outer coating to protect form sun.

(b) **Consumers**: Squirrels, mice, reptiles.

These animals dig holes in the ground to live and come out at night for food. Most of the desert animals can extract water from seeds.

(c) **Decomposers**: Fungi and bacteria

Desert has poor vegetation with low amount of dead organic matter. They are decomposed by few bacteria and fungi.

AQUATIC ECOSYSTEM

This deals with water bodies. The major types of organisms found in aquatic environments are determined by water salinity.

Types of aquatic ecosystems: Based on the salinity it is classified into 2 types as

(i) Fresh water ecosystem: Ponds, lakes, rivers, streams

(ii) Marine/ salt water ecosystem: Oceans, estuaries

1. Fresh water ecosystem:

POND ECOSYSTEM

Characteristic features of pond ecosystem

1. Pond is temporary, only seasonal.
2. It is stagnant fresh water body.
3. Pond gets polluted easily due to limited amount of water.

Structure and Function of Pond ecosystem

1. **Abiotic components**: Temperature, light, water, organic and inorganic compounds.
2. **Biotic components**:

(a) **Producers**: They are of 2 types

(i) ***Phytoplankton***: These are microscopic aquatic plants, which freely float on the water surface. e.g., Algae, pandorina.

(ii) ***Microphytes***: These are large floating plants and submerged plants. e.g., Hydrilla, wolfia.

(b) **Consumers**: (i) **Primary consumers** (Zooplanktons): These are microscopic animals which float freely on the water surface. e.g., Protozoa, very small fish, ciliates.

Zooplanktons are found along with phytoplankton sans they feed on them.

(ii) **Secondary consumers** (Carnivores): Insects like water beetles and small fish.

(iii) **Tertiary consumers:** Large fish like game fish.

(c) **Decomposers**: Fungi, bacteria, flagellates.

LAKE ECOSYSTEM

Lakes are supplied water by rainfall, melting snow and streams.

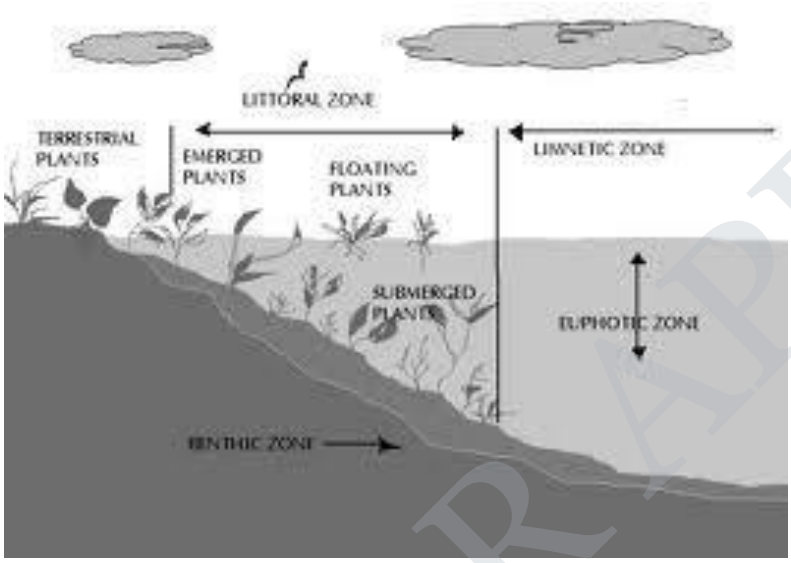
Types of lakes

1. Oligotrophic lakes: They have low nutrient concentrations.
2. Eutrophic lakes: They are over nourished by nutrients like N and P.
3. Dystrophic lakes: They have low pH, high humic content and brown waters.
4. Volcanic lakes: They receive water from magma after volcanic eruptions.
5. Meromictic lakes: They are rich in salts.
6. Artificial lakes: They are created due to construction of dams.

Zones of lake

Depending upon their distance from the shore, a lake consists of 4 distinct zones.

1. **Littoral zone**: It is the top layer of the lake. It has shallow water.
2. **Limnetic zone**: It lies below the littoral zone, where effective penetration of sunlight takes place.
3. **Profundal zone**: This is the deep open water, where it is too dark.
4. **Benthic zone**: This layer is the bottommost layer of the lake.



Characteristic feature of lake ecosystem

1. Lake is shallow fresh water body.
2. It is a permanent water body with large water resources.
3. It is useful for irrigation and drinking purpose.

Structure and function of Lake Ecosystem

1. **Abiotic components**: Temperature, light, proteins and lipids.
2. **Biotic components:**

(a) **Producers**: These are the green plants which may be submerged, free floating and amphibious plants. e.g., Phytoplankton, algae

(b) **Consumers:**

(i) Primary consumers (Zooplankton): Ciliates, protozoans.

(ii) Secondary consumers (Carnivores): Insects and small fishes.

(iii) Tertiary consumers: Large fish like game fish.

(c) **Decomposers:** Bacteria and fungi

RIVER/STREAM ECOSYSTEM

The running water of a river or stream is well oxygenated, because it absorbs oxygen from air. The numbers of animals are low in river or stream.

Characteristic features of river or stream ecosystem

1. It is fresh water and free flowing water system.
2. Due to mixing of water, dissolved oxygen content is more.
3. River deposits large amount of nutrients.

Structure and function of river ecosystem

1. **Abiotic components**: Temperature, light, pH, nutrients.
2. **Biotic components**:

(a) **Producers**: Phytoplankton, algae, water grasses.

(b) **Consumers**:

(i) Primary consumers: Water insects, snails

(ii) Secondary consumers: Birds and mammals

(c) **Decomposers**: Bacteria, fungi

MARINE/OCEAN ECOSYSTEM

Oceans cover more than two thirds of earth's surface. It supplies a vast variety of sea products and drugs. It has high concentration of salts and minerals.

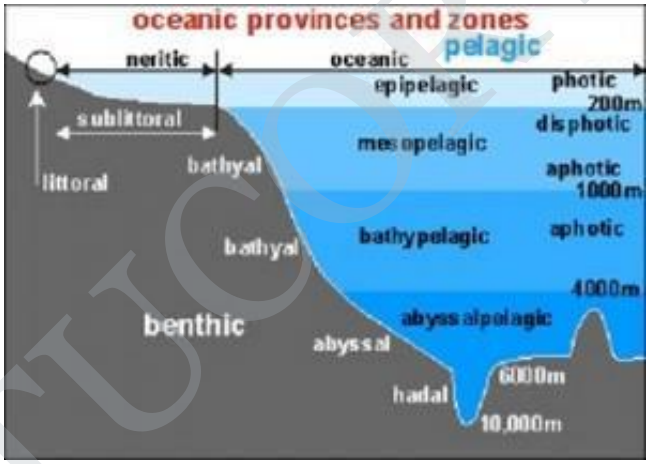
Zones of Oceans

The oceans have two major life zones.

(i) **Coastal zone**: It is relatively nutrient rich, shallow water and has high productivity because of high nutrients and sunlight.

(ii) **Open sea**: It is the deeper part of the ocean and is vertically divided into 3 regions. (a) *Euphotic zone*: It receives abundant light and shows high photosynthetic activity. (b) *Bathyal zone*: It receives dim light and is geologically active.

(c) *Abyssal zone*: It is the dark zone and is very deep (2000 to 5000 m).



Characteristic features of marine ecosystem

1. It occupies a large surface area with saline water.
2. Since, ships, submarines can sail in ocean a large number of commercial activities are carried out.
3. It is rich in biodiversity.
4. It moderates the temperature of earth.

Structure and function of marine ecosystem

1. **Abiotic components**: Temperature, light, NaCl, KCl.
2. **Biotic components**:

(a) **Producers**: Phytoplankton and marine plants

(b) **Consumers**:

(i) Primary consumers (Herbivores): Crustaceans, molluscs (ii) Secondary consumers (Carnivores): Herring, mackerel (iii) Tertiary consumers: Cod

(c) **Decomposers**: Bacteria, fungi.

ESTUARINE ECOSYSTEM

"***An estuary is a partially enclosed coastal area at the mouth of a river which joins the sea***". They are rich in nutrients and have high food potential.

Characteristics of estuarine ecosystem

1. Estuaries are transition zones, which are strongly affected by tides of sea.
2. Water characteristics are periodically changed.
3. The living organisms here have wide tolerance.
4. Salinity in estuaries are highest in summer and lowest in winter.

Structure and function of estuarine ecosystem

1. **Abiotic components**: Temperature, pH, sodium and potassium salts.
2. **Biotic components**:

(a) **Producers**: Marsh grasses, sea weeds, sea grasses.
(b) **Consumers**: Oysters, Crabs, small fishes.
(c) **Decomposers**: Bacteria, fungi.

KEYSTONE SPECIES

Within a habitat each species connects to and depends on other species. But, while each species contribute to habitat functioning, some species do more than others in the overall scheme of things. Without the work of these key species, the habitat changes significantly. These species are called "keystone species". When a keystone species disappears from its habitat, that habitat changes dramatically.

Illustration – 1

Elephants as keystone species in Grasslands

Elephants are keystone species in African grasslands. When elephants are taken away from grasslands, it is converted into forest or shrub areas by overgrowth of woody plants. As keystone species, elephants prevent this conversion.

Illustration – 2

Forest elephants hold keystone status in some woodland (forest) in western Africa

In the above forest elephants are the only species large enough to eat and disperse the seeds of some plant species whose shells are very hard. Thus only elephants can feed on them and disperse the seeds through their dung thereby maintains the forest.

Introduction to biodiversity definition: genetic, species and ecosystem diversity:

BIODIVERSITY DEFINITION: Bio means 'life' and diversity means 'variety', hence Biodiversity refers to variety of life on the earth. Planet earth (biosphere) contains more than 20 million species of organisms. They differ widely from one another. Diversification in the species is influenced by various physical and climatic factors, resulting in the production of new sub-species. Biodiversity is defined as, "the variety and variability among all groups of living organisms and the ecosystem in which they occur".

LEVELS OF BIODIVERSITY:

A. GENETIC BIODIVERSITY

The genes found in organisms can form enormous number of combinations each of which gives rise to some variability. When the genes within the same species show different version due to new combinations, it is called genetic variability. For example rice belongs to the species Oryzasativa which has many varieties that differ in size, shape, aroma etc.

B. SPECIES BIODIVERSITY

This is the variability found within the population of a species or between different species of a community. It broadly represents the species richness and their abundance in a community. Shannon Wiener index and Simpson index are two popular indices of measuring species diversity.

C. ECOSYSTEM BIODIVERSITY

This is the diversity of ecological complexity showing variations in ecological niche, trophic structure, food webs, nutrient cycling etc. The ecosystem also shows variations with respect to physical parameters like moisture, temperature, altitude, precipitation etc.

BIOGEOGRAPHICAL CLASSIFICATION OF INDIA:

S. No.	Biogeographic zone	Biotic province	Important Flora & Fauna
1	Trans-Himalayan	Upper region	Pine,deodar- Wild sheep, yak, leopard, wolf
2	Himalayan	North west, west, central and East Himalayas	Pine, cork tree, sal, dhaak- Wild bear, sambar, leopard, Sikkim stag, musk deer
3	Desert	Kutch, Thar and Ladkh	Acacia, zizyphus, khejri, date palm- Camel, bastard, wild ass, desert cat, fox, rat
4	Semi-arid	Central India, Gujarat	Acacia, date palm, peepal -Gir lion, tiger, sariska and Ranthampore tiger
5	Western ghats	Malabar coast Western ghats mountain	Sheeshan, peepal, tuna, bahera- Tortoise, frog, lizards, snakes
6	Deccan peninsula	Deccan plateau	Acacia, palaash, tuna, pine, castor- Sambar, sloth bear, tiger, cheetal, four horned stag, wild elephant, wild buffalo
7	Gangetic plain	Upper and lower Gangetic plain	Sal, acacia, jamun, mango, bael- black chinkara, stag, rhinoceros, gazzel, Aligator, turtle
8	North-east India	Brahmaputra valley	Bamboo, sal, jack fruit, tuna, Chestnut cator- Elephnat, Rhinocers, yak, deer, porcupine
9	Islands	Andaman islands, Nicobar islands & Lakshadeep islands	Bahera, Harar, jack fruit, cardamom, coconut, cloves- Dolphin, alligator, Molluscs
10	Coasts	West coast East coast	Coconut, Banana, cashew Nut – Dugong, Dolphin, Turtle, Alligator, Molluscs

VALUE OF BIODIVERSITY: (Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values)

1. **CONSUMPTIVE USE VALUE**

- **Food:** A large number of wild plants are consumed by human beings as food. About 80,000 plants are from wild. About 90% of crops are domesticated from tropical forest.
- **Drugs and medicine**: About 75% of population depends upon plant or plant extracts for medicine. Penicillin antibiotic drug is derived from the fungus penicillium.
- **Fuel:** The fossil fuels coal, petroleum and natural gas are products of fossilized biodiversity.

2. **PRODUCTIVE USE VALUE**

These are the commercially usable values where the product is marketed and sold. It may include lumber or wild gene resources that can be traded for use by scientist for introducing desirable traits in the crops and domesticated animals. It includes animal products like tusk of elephants, musk deer, silk from silk worm, wool from sheep, fur of many animals etc. Many industries like paper and pulp. Silk, textile, ivory works industry depend on them.

3. **SOCIAL VALUE**

It is associated with social life, customs, and religion and psycho-spiritual aspects of the people. Many plants are considered holy and sacred in our country like tulsi, peepal, Mango, Lotus, Bael etc. many animals like cow, snake, peacock, bull, owl etc also have significant place in social importance. The tribal people are very closely linked with the wildlife in the forest.

4. **ETHICAL VALUE**

It is otherwise called existence value. It involves ethical issues like “all life must be preserved” and “live and let live” concept. For the survival of human race, all biodiversity has to be protected because biodiversity is valuable.

5. **AESTHETIC VALUE**

People from far and wide spend a lot of time and money to visit wilderness areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco –tourism. The willingness to pay concept annually generates 12 billion revenue.

6. **OPTION VALUE**

It is the value of knowing that there are biological resources existing on the biosphere that may one day prove to be an effective option for something important in the future it suggests that any species may prove to be miracle species someday.

BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVEL:

BIODIVERSITY AT GLOBAL LEVEL:

It is estimated that there are about 20 million species of plants and animals in earth of which only 1.6 million species have been formally identified with 34 hotspot regions at the global level. There are 12 megadiversity nations which are highly rich in biodiversity which includes India. Most of the world’s biodiversity are near the equator especially tropical rain forests and coral reefs. South America also has unique species and biodiversity.

BIODIVERSITY AT NATIONAL LEVEL:

India is rich in biodiversity due to its varying climate and topographical features. It occupies only 2.5% of global land of which about 40% is under cultivation. There are 96 national parks, 572 wildlife sanctuaries 14 biosphere reserves and 2 hotspots with 46,000 plant species and 91,000 animal species, 50,000 varieties of rice, 1000 varities of mango, etc.,

1. India ranks 10th among the plant rich countries of the world
2. 11th in terms of Endemic species.
3. 6th among origin of agricultural crops.
4. 12th mega biodiversity country in the world.

BIODIVERSITY AT REGIONAL OR LOCAL LEVEL:

Tamilnadu is rich in biodiversity with natural habitat constituting 4% of country's total area which shares the Western Ghats with Kerala, Karnataka, Maharashtra, Goa and, Eastern Ghats with Andhra Pradesh and Odisha accounting for nearly about one third of the total flora of India.

1. **Point Richness**: Refers to number of species at a single point.
2. **Alpha Richness**: Refers to the number of species found in a small homogeneous area.
3. **Beta Richness**: Refers to rate of change in species composition across different habitats.
4. **Gamma Richness**: Refers to the rate of change across large landscape gradients.

INDIA AS A MEGA BIODIVERSITY NATION:

India is one of the 12 mega biodiversity countries in the world. The Ministry of environmental and forests, Government of India (2000) records 47,000 species of plants and 81,000 species of animals which is about 7% and 6.5% respectively of global flora and fauna.

1. **Endemism**: Species which are restricted to only to a particular area are known as endemic. India shows a good number of endemic species. About 62% of amphibians and 50% of lizards are endemic.
2. **Centre of origin**: A large number of species have known to originate in India. Nearly 5000 flowering species, 166 species of crop plants and 320 species of wild relatives of cultivated crops origin in India.
3. **Marine diversity**: Along 7500 km long coastline of our country in the mangroves, estuaries, coral reefs, back waters etc. there exist a rich biodiversity. More than 340 species of corals of the world are found here.

HOTSPOTS OF BIODIVERSITY

A **biodiversity hotspot** is a biogeographic region with a significant reservoir of biodiversity that is under threat from humans. To qualify as a biodiversity hotspot on Myers 2000 edition of the hotspot- map, a region must meet two strict criteria:

1. It must contain at least 0.5% or 1,500 species of vascular plants as endemics.
2. It must have lost at least 70% of its primary vegetation.

Around the world, at least 25 areas qualify under this definition, with nine others possible candidates. These sites support nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species, with a very high share of endemic species.

The importance of biodiversity: Biodiversity is often used to draw attention to issues related to the environment. It can be closely related to:

- The health of ecosystems.

of just one species can have different effects ranging from the

disappearance of the species to complete collapse of the ecosystem itself. This is due to every species having a certain role within an ecosystem and being interlinked with other species.

- The health of mankind.

Experiencing nature is of great importance to humans and teaches us different values. It is good to take a walk in the forest, to smell flowers and breathe fresh air. More specifically, natural food and medicine can be linked to biodiversity.

Hot spots of Biodiversity in India:

The hot spots of biodiversity are the geographic areas which possess the high endemic species. At the global level these are the areas of high conservation priority, if these species are lost they can never be replaced or regenerated.

Criteria for recognizing Hotspots: The richness of the endemic species is the primary criterion; they should have a significant percentage of specialized species; the site should be under threat and should contain important gene pools of plants of potential use.

Two hot spots in India are:

1. Eastern Himalayas (Indo-Burma region) and
2. Western Ghats (Srilanka region).

Eastern Himalayas: Comprises of Nepal, Bhutan and neighboring states of Northern India- 35,000 plant species are found here and 30 % are endemic – also rich in wild plants of economic value eg. Rice, banana, citrus, ginger, chilli, jute and sugarcane – Taxal yielding plant also scarcely distributed – 63% mammals are from this region- 60% of Indian Birds- huge wealth of fungi, insects, mammals and birds found in this region

Western Ghats: Comprises of parts of Maharashtra, Karnataka, Tamilnadu and Kerala – nearly 1500 endemic, dicotyledones 62% amphibians and 50% lizards are endemic here- Ternstroemia, Japonica, Rhododendron and Hypericum common plants- Blue Bird and Lizard hawk are common animals.

Biodiversity is the richness & varied species of different organisms contained in a particular ecosystem – Indian biodiversity is highly diverse and rich such that there are various hot spots. However there are numerous threats to our Biodiversity.

THREATS TO BIODIVERSITY :(Habitat loss, Poaching of wildlife & Man-wildlife conflicts)

In 2006 many species were formally classified as rare or endangered or threatened; moreover, scientists have estimated that millions more species are at risk which has not been formally recognized. About 40 percent of the 40,177 species assessed using the IUCN Red List criteria are now listed as threatened with extinction.

LOSS OF HABITAT:

***Habitat destruction*:**

Habitat destruction has played a key role in extinctions, especially related to tropical forest destruction. Factors contributing to habitat loss are: overpopulation, deforestation, pollution (air pollution, water pollution, soil contamination) and global warming or climate change. Habitat size and numbers of species are systematically related. Physically larger species and those living at

lower latitudes or in forests or oceans are more sensitive to reduction in habitat area.

Climate change:

Global warming is also considered to be a major potential threat to global biodiversity in the future. Climate change has seen many claims about potential to affect biodiversity but evidence supporting the statement is tenuous. Increasing atmospheric carbon dioxide certainly affects plant morphology and is acidifying oceans, and temperature affects species ranges, phenology, and weather, but the major impacts that have been predicted are still just *potential* impacts. We have not documented major extinctions yet, even as climate change drastically alters the biology of many species.

POACHING: Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products worth millions of dollars per year continues. The developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth in wildlife.

Overexploitation:

Overexploitation occurs when a resource is consumed at an unsustainable rate. This occurs on land in the form of overhunting, excessive logging, poor soil conservation in agriculture and the illegal wildlife trade Joe Walston, director of the Wildlife Conservation Society's Asian programs, called the latter the "single largest threat" to biodiversity in Asia. The international trade of endangered species is second in size only to drug trafficking.

MAN-WILDLIFE CONFLICTS:

CAUSES OF MAN WILDLIFE CONFLICT:

1. Dwindling habitats of elephants, Tigers, rhinos and bears due to forest shrinkage compels them to move outside forest.
2. Usually ill, weak, and injured animals have a tendency to attack the humans.
3. Earlier Forest department used to cultivate paddy, sugarcane within the sanctuaries, due to lack of such practices the animals move out of forest food.
4. Villagers put Electric Wiring around their crop field which injures the elephants and turn them violent.
5. Wildlife corridors have been disrupted which makes the animals attack human beings during their migration.

REMEDIAL MEASURES TO CURB THE CONFLICT:

1. Tiger conservation Project (TCP) has made provisions for making available vehicles, tranquillizer guns, binoculars and radio sets etc., to tactfully deal with any imminent danger.
2. Adequate crop compensation and cattle compensation scheme must be started.
3. Solar powered fencing should be provided to prevent animals from straying into fields.
4. Cropping pattern should be changed near the border.
5. Wildlife corridors should be provided.

Introduced and invasive species:

Barriers such as large rivers, seas, oceans, mountains and deserts encourage diversity by enabling independent evolution on either side of the barrier, via the process of allopatric speciation. The term to species that breach the natural barriers that would normally keep them

constrained. Without barriers, such species occupy new territory, often supplanting native species by occupying their niches, or by using resources that would normally sustain native species.

Genetic pollution:

Endemic species can be threatened with extinction through the process of genetic pollution, i.e. uncontrolled hybridization, introgression and genetic swamping. Genetic pollution leads to homogenization or replacement of local genomes as a result of either a numerical and/or fitness advantage of an introduced species. Hybridization and introgression are side-effects of introduction and invasion.

Hybridization, genetic pollution/Erosion and food security

In agriculture and animal husbandry, the Green Revolution popularized the use of conventional hybridization to increase yield. Often hybridized breeds originated in developed countries and were further hybridized with local varieties in the developing world to create high yield strains resistant to local climate and diseases. Local governments and industry have been pushing hybridization. Formerly huge gene pools of various wild and indigenous breeds have collapsed causing widespread genetic erosion and genetic pollution. This has resulted in loss of genetic diversity and biodiversity as a whole.

ENDANGERED AND ENDEMIC SPECIES OF INDIA:

1. ENDANGERED SPECIES OFINDIA

The international Union for conservation of Nature and Natural Resources (IUCN) publishes the red Data book which includes the list of endangered species of plants and animals.

S.No.	Species	Names
1	Reptiles	Gharial, green sea turtle, tortoise,python
2	Birds	Great Indian bustard, Peacock, Pelican, Great Indian hornbill, Siberian White crane
3	Carnivors Mammals	Indian Wolf, red fox, sloth bear, red panda, tiger, leopard, Stripped Hyena, Indian lion, Golden cat, desert cat, Dugong
4	Primates	Hoolock Gibbon, lion tailed Macaque, Nilgiri languor, capped monkey, Golden monkey
5	Plants	A large number of species of Orchids, Rhododendrons, Medicinal Plants like Rauvolfia serpentine, the sandal wood tree santalum, Cycasbeddonei

2. ENDEMIC SPECIES OFINDIA:

India has two biodiversity hotspots and thus possesses a large number of endemic species. Out of about 47,000 species of plants in our country 7000 species are endemic. Thus, Indian subcontinent has about 62% endemic flora, restricted mainly to Himalayas, Khasi Hills and WesternGhats. Some of the endemic flora includes orchids and species like *Sapria Himalaya*, *Uvarialurdia*

A large number out of total 81,000 species of animals in our country is endemic. The Western in amphi bians and reptiles. About 62% Amphibians and 50% lizards are

endemic to Western Ghats. Different species of Monitor lizards, reticulated python and Indian salamander and viviparous toad are some important endemic species of our country.

CONSERVATION OF BIODIVERSITY (In-situ conservation & Ex-situ conservation)

In-situ and ex-situ conservation along with their merits and limitations:

Conservation of Biodiversity: Biodiversity faces threat of extinction – due human activities – to salvage situation – conservation of biodiversity need of the hour- to preserve biodiversity to prevent their extinction and future flourishing – conservation of Biodiversity required

In-situ conservation: Involves allocating large areas of the land mass for wild life development- such areas can be closed to the public for tourism – wild life can be allowed to flourish in their own environment- promotes genetic diversity- does not stagnate the gene pool

Advantages: cheap and convenient method Species gets adjusted the natural disasters like drought, floods, forest fires.

Limitations: Large surface area of the earth required – shortage of staff and pollution may lead to improper maintenance of the habitat.

Ex-situ conservation: Involves conservation of wild life in zoos, botanical gardens-human supervision- wildlife can grow under controlled conditions - animals would be properly taken care- food, shelter and water- help in the flourishing of endangered species- possible the gene pool could stagnate and result in no genetic diversity taking place.

Advantages: Special care and attention lead to survival of endangered species– In captive breeding, animals are assured food, water, shelter and security - hence longer life span- it is carried out for the endangered species, which do not have any chances of survival in the wild.

Limitations: Expensive method- freedom of wild life is lost – animals cannot survive in such confined places.

UNIT 1 – ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY (QUESTION BANK)

PART – A

1. Define ecosystem. (May 2012)
2. Write about ecological pyramids. (May 2012)
3. What are producers, consumers and decomposers? (Nov 2011)
4. What are hotspots of biodiversity? Mention the criteria for hot spots. (Nov 2011)
5. Define genetic and species diversity. (Nov 2011)
6. What is Biodiversity? (Nov 2011, May 2011)
7. What is ecological succession? (Nov 2011)
8. Differentiate between endangered and endemic species. (Nov 2011)
9. Differentiate between food chain and food web. (Nov 2011, May 2011)
10. What is meant by hot spots of biodiversity? (May 2011)
11. What are endangered species? (May 2011)
12. Define environment and ecosystems. (May 2011)
13. What is the major significance of biodiversity? (May 2011)
14. Why knowledge on environment at individual level is very important? (May 2011)
15. What do you mean by Red Data Book? (May 2011)
16. Define Species diversity. (Nov 2010)
17. What is grassland ecosystem? (Nov 2010)

18. What are food chains? Mention their types. (Nov 2010)
19. What are the biotic components of an ecosystem? (Nov 2010)
20. Justify the need for environmental education. (Nov 2010)
21. Write short notes on wetland ecosystem. (Nov 2010)
22. Mention any two significance of Biodiversity. (Nov 2010)
23. Write a short note on biodiversity. (May 10)
24. Name various ecosystems. (May 10)
25. Suggest three important features if forest ecosystem. (May 10)
26. What is meant by food web? (May 10, Dec 09, Dec 08) (OR) What is food web? Give example. (Dec 07)
27. Define ecological pyramids. (May 10)
28. What is ecology? (May 10)
29. Why do we need environmentalist? (May 10)
30. Write a short note on biodiversity. (May 10)
31. State the significance and scope of environmental education. (Dec 09,Dec 08)
32.'India is a mega diversity nation' – Account. (Dec 09, Dec 08)
33. What are food chains and food webs? (Dec 09, May 06)
34. Define primary production and secondary production. (Dec 09)
35. Where is most of the world's biodiversity found? (Dec 09)
36. What do you mean by the term indicator species? (Dec 09)
37. What are the main kinds of organisms in aquatic life zones? (Dec 09)
38. What is ecological pyramid? Why is pyramid of energy always taking up-right? (Dec 09)
39. Define 'Hot spots of Biodiversity'. (Dec 09, Dec 08)
40. Distinguish between primary and secondary succession. (May 09)
41. What are endangered and endemic species? (May 09)
42. Mention the major causes of human-wildlife conflicts. (May 09)
43. What do you understand by the terms flora and fauna? (Dec 08)
44. What is meant by key stone species? (Dec 08)
45. What are the characteristics of the Desert ecosystem? (Dec 08)
46. Distinguish a biome and an ecosystem. (May 08) (OR) How a biome does differ from an ecosystem? (Dec 07)
47. Give the classification of Biodiversity. (May 08)
48. Define the terms producers and consumers. (May 08)
49. What is meant by genetic diversity? (May 08)
50. Define the term biodiversity. (Dec 07, May 07, Dec 05)
51. Define genetic diversity and species diversity. (Dec 07)
52. What is food chain? (May 07, Dec 06, May 06)
53. Define endangered species. (May 07) (OR) Explain endangered species. (Dec 06)
54. Explain the concept of an ecosystem. (May 07)
55. Explain ecological succession. (Dec 06)
56. State any four components of ecosystem. (4) (Dec 06)
57. What are the classifications of biotic components of ecosystems? (May 06)
58. Name the few endangered wild life species of India. (May 06)
60. Define environmental science. (Dec 05)
61. Define producers. (Dec 05)
62. Name the four ecosystems. (Dec 05)

n act ivities which destroy the biodiversity. (Dec 05)

64. Explain Biosphere. (Dec 05)

65. Explain threatened and endangered species. (Dec 05)

66. State the need for public awareness for solving environmental problems. (May 05)

67. What is biodiversity and what is its significance? (May 05)

68. What is ecological succession? (May 05)

PART – B

1. Explain the **structure and function of Ecosystem** with a neat sketch. (16) (May 2012, May 2011, Nov 2011, Nov 2010, May 10) (OR) Describe the structural features of ecosystem. (8) (Dec 09) (OR) Define ecosystem. Give an account of the structure and function of an ecosystem. (8) (May 08, May 06) (OR) What is an ecosystem? Describe the structure and function of various components of an ecosystem. (16) (Dec 05) (OR) Define and explain the term ecosystem, its types, characteristics, structure and function. (16) (May10, Dec 05)

2. Explain the conservation of Biodiversity in Global level. (8) (May 2012)

3. What is **food chain**? How it is important to nation? (8) (May 2012) (OR) Write a note on food chain. (6) (May 07, Dec 06) (OR) Explain food chain and food web. (4) (Dec 05)

4. Discuss the Universal model of **energy flow in an ecosystem** and explain how the flow of energy follows the I and II law of thermodynamics? (8) (Nov 2011) (OR) Give an account of energy flow in ecosystem. (8) (Dec 09, Dec 08, May 07, Dec 06, May 06) (OR) Explain the flow of energy through the atmosphere and its utilisation in an ecosystem. (8) (May 08) (OR) With a neat sketch explain the flow of energy through the various components of the ecosystem (producers, consumers and decomposers) (8) (Dec 07) (OR) Briefly explain the energy flow through ecosystem. (4) (Dec 05) (OR) Energy flow in an ecosystem obeys 1st and 2nd laws of thermodynamics. Justify. (6) (Dec 07)

5. What are ecological pyramids? Explain why in grassland ecosystems the pyramids of numbers are upright while in parasitic food chain it is inverted? (8) (Nov 2011)

6. Explain different methods of In-situ conservation of Biodiversity. (8) (Nov 2011)

7. What are the major causes of man-wildlife conflicts? Discuss the remedial steps that can curb the conflict. (8) (Nov 2011)

8. Explain the **values of biodiversity**. (16) (Nov 2011, May 10) (OR) Discuss the consumptive use, ethical, optional and ecosystem service value of biodiversity. (10)

(May 2011) (OR) Classify and explain the value of biodiversity. (8) (Nov 2011, Nov 2010) (OR) Enumerate the values of biodiversity. (5) (May 09) (OR) Substantiate the value of biodiversity with suitable illustrations and statistical evidences. (8) (Dec 08)

9. Explain **in-situ and ex-situ conservation of biodiversity**. (8) (Nov 2011, May 2011) (OR) Give an account of conservation of biodiversity. (16) (May 10, Dec 09, May 06) (OR) How is biodiversity conserved? Explain. (8) (Dec 08) (OR) How is conservation of biodiversity achieved? Give details. (8) (May 08) (OR) Explain the strategy adopted to conserve biodiversity. (Dec 05) Write informative notes on 'In-situ' Conservation. (8) (Dec 09, Dec 08) (OR) Explain the various methods of conversation of biodiversity. (6) (May 09) (OR) Explain in-situ and ex- situ conservation along with their merits and limitations. (8) (May 08) (OR) Describe in-situ and ex-situ conservation of biodiversity. (8) (May 06)

10. Discuss elaborately the characteristic features, structure and functions of **grassland and aquatic ecosystems**. (16) (Nov 2011) (OR) Discuss the major features of grass land ecosystem. (8) (Dec 09, May 06)

11. Explain the role of producers, consumers and decomposers in ecosystem. (8) (Nov 2011)

produ cers, consumers and decomposers in an ecosystem. (8) (May 08)

(OR) Define: Producers, Consumers and Decomposers (9) (May 07 (OR) Write short notes on: Producers, Consumers and Decomposers (3x2=6) (Dec 06)

12. What are the major factors that are responsible for the loss of biodiversity? Explain. (8) (Nov 2011)

13. Discuss the **aquatic ecosystem and forest ecosystem**. (16) (May 10) (OR) Show the structure and function of (i) Forest Ecosystem (ii) Aquatic Ecosystem (8) (Dec 09, May 08) (OR) Describe the types, characteristics features, structure and function of (i) Forest Ecosystem (ii) Aquatic Ecosystem (8+8) (Nov 2011, Dec 08, May 05)

14. Write notes on (i) Ecological pyramid (ii) Values of biodiversity (8+8) (May 2011)

15. Give a detailed account of the following: (i) Components of Ecosystem (ii) In-situ and Ex- situ conservation of biodiversity. (4+12) (May 2011)

16. Explain the structure and functions of the following: (i) Forest ecosystem (ii) Grassland ecosystem (iii) Desert ecosystem (iv) Aquatic ecosystem (16) (May 2011)

17. Write elaborately on **biodiversity at global, national local levels**. (16) (May 2011, May10, May 07)

18. Discuss the process of **Ecological Succession** with an example using neat sketch. (16) (May2011) (OR) Discuss briefly the ecological succession. Explain how it is classified. (8) (Nov 2010)

19. Write the significance of the two **Hot spots of Biodiversity** in India. (6) (May 2011, Nov 2010) (OR) Discuss the biodiversity hot-spots in India. (5) (May 09) (OR) What are the various hot spots of Bio-diversity in India? (8) (Dec 08) (OR) What do you understand by hot spots of biodiversity? Name and briefly describe two hot spots of biodiversity that extend in India. (8) (May 08) (OR) Describe the term hot spot in biodiversity. (8) (Dec 07) (OR) Explain the biodiversity of India. (8) (May 06)

20. Compare (1) Extinct & Endangered (2) Vulnerable and Rare with an example. (6) (May 2011)

21. Write a note on ecological succession and ecological pyramids. (8) (Nov 2010)

22. Explain the features of **ecological pyramids** including inverted pyramids. (8) (Nov 2010) (OR) Illustrate the ecological pyramids. (5) (May 09) (OR) Write a note on ecological pyramids and their types. (8) (Dec 08, Dec 06) (OR) Discuss the concept of ecological pyramid. (8) (Dec 07) (OR) Explain ecological pyramids. (4) (May 07)

23. What are the **threats to biodiversity**? Discuss. (8) (Nov 2010) (OR) Summarize the major threats to biodiversity. (8) (Dec 09) (OR) Identify and explain the major threats to biodiversity. (8) (May 08) (OR) What are the major causes of degeneration of biodiversity? (8) (Dec 07) (OR) What is biodiversity and explain the reasons for its decline. (8) (May 07, Dec 06) (OR) Write short notes on threats to biodiversity. (5) (May 06) (OR) What are the causes for loss of biodiversity? (4) (Dec 06) (OR) Discuss the threat faced by Indian Biodiversity. (8) (Dec 05)

24. Explain the components, structure and functions of a **desert ecosystem**. (8) (Nov 2010)

25. Describe the **biotic component** of an ecosystem. (8) (Dec 09, Dec 08) (OR) State the components of ecosystem. (10) (May 07) (OR) What are the major **biological components of ecosystem**? Explain their activities. (8) (Dec 09)

26. Discuss the importance of biodiversity. (8) (Dec 09, Dec 08)

27. Write a note on endangered and endemic species of India. (8) (Dec 09, Dec 08)

28. Discuss the major types of deserts, grass lands and forests. (8) (Dec 09)

29. Describe the major parts of the earth's life support system. (8) (Dec 09)

30. What do you understand about "Biodiversity"? Discuss the different levels of hierarchical levels to understand the concept of biodiversity. List out the major threats to biodiversity.

31. Briefly discuss the characteristic features of the various **bio geographical zones** in India. (6) (May 06)

32. Describe the salient features of tropical rain forests and temperate deciduous forests. (5) (May 09)

33. Explain the different components of an ecosystem with the help of **pond ecosystem**. (8) (Dec 07, May 06)

34. Why conversation in parks, sanctuaries and nature reserves is considered inadequate and the only sensible way is to conserve the entire ecosystem or habitats. Discuss (10) (Dec 07)

35. Explain how fat-soluble pollutants like DDT get biomagnified. (8) (Dec 07)

36. Discuss the most important advantages of ecosystems. (8) (May 07)

37. Discuss the four kinds of diversity. (4) (Dec 06)

38. Write a note on measuring biodiversity. (4) (Dec 06)

39. Why biodiversity rich in tropics? (4) (Dec 06)

40. Explain the following: (i) Forest ecosystem (ii) Ecological succession (4+4) (May 06)

41. What are the **different types of ecosystem** and explain them with an example. (16) (May 06)

42. Explain briefly the **structure of atmosphere**. (6) (Dec 05)

43. Explain the various threats to biodiversity and the measures recommended for conservation of biodiversity. (16) (May 05)

44. Explain: Ecosystem, energy flow in ecosystem, food chain, food webs and ecological pyramids. (3+3+3+3+4) (May 05)

45. Explain in detail the scope of environmental sciences. (16) (May 10)

UNIT – II
ENVIRONMENTAL POLLUTION

WHAT IS POLLUTION?

Undesirable change in the physical, chemical or biological characteristics of any component of the environment (air, water, soil) causing harmful effects on various forms of life or property is termed as environmental pollution.

INTRODUCTION:

- Pollution is derived from Latin word 'polluere' meaning contaminate any feature of environment.
- Pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings.
- Soil is a natural resource for which there is no substitute. Soil cannot be manufactured with a tank of chemicals. Soil is formed from the parent material by physical and chemical weathering of rocks. Climate and time are also important in the development of soils.
- Extremely dry or cold climates develop soils very slowly while humid and warm climates develop them more rapidly. It is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life.
- The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark top soil.
- The inorganic portion, which is made up of rock fragments, is formed over thousands of years by physical and chemical weathering of bedrock. We may enhance the soil by helping its processes along, but we can never recreate what we destroy.
- Soil pollution damages the nutritional, physical and chemical composition of soil hence it is important to understand and pollution.
- Pollution may be local, regional, trans-boundary or global. The agent which causes pollution is called pollutant.

Pollutants can be classified as:

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

Types of environmental pollution:-

1. Air pollution
2. Water pollution
3. Soil pollution
4. Marine pollution
5. Noise pollution
6. Thermal pollution
7. Nuclear hazard

AIR POLLUTION

Air pollution may be defined as, *"the presence of one or more contaminants like dust, smoke, mist and odour in the atmosphere which are injurious to human beings, plants and animals".*

Rapid industrialization, fast urbanization, rapid growth in population, drastic increase in vehicles on the roads and other activities of human beings disturbed the balance of natural atmosphere.

During several billion years of chemical and biological evolution, the composition of earth's atmosphere has varied. Today, about 99% of the volume of air we inhale consists of two gases: Nitrogen and Oxygen.

Chemical composition of atmospheric air

Constituents	%
Nitrogen	78
Oxygen	21
Argon (Ar)	< 1
CO_2	0.037
Water vapour	Remaining
O_2, He, NH_3	Trace amount

CAUSES / SOURCES OF AIR POLLUTION

The sources of air pollution are natural and man-made (anthropogenic).

Natural Sources:

The natural sources of air pollution are volcanic eruptions, forest fires, sea salt sprays, biological decay, photochemical oxidation of terpenes, marshes, extraterrestrial bodies, pollen grains of flowers, spores etc. Radioactive minerals present in the earth crust are the sources of radioactivity in the atmosphere.

Man-made Sources:

Man-made sources include thermal power plants, industrial units, vehicular emissions, fossil fuel burning, agricultural activities etc. The main pollutants emitted are fly ash and SO2. Fertilizer plants, smelters, textile mills, tanneries, refineries, chemical industries, paper and pulp mills are other sources of air pollution.

Indoor Air Pollution

The most important indoor air pollutant is radon gas. Radon gas and its radioactive daughters are responsible for a large number of lung cancer deaths each year. Radon can be emitted from building materials like bricks, concrete, tiles etc. which are derived from soil containing radium. Radon is also present in groundwater and natural gas and is emitted indoors while using them.

Indian Ambient air quality standards

Category	Area	Concentration in µg/m^3			
		SPM	SO_2	NO_X	CO
A	**Industrial and mixed use**	**500**	**120**	**120**	**5,000**
B	**Residential and rural**	**200**	**80**	**80**	**2,000**
C	**Sensitive (hill stations, tourist resorts, monuments**	**100**	**30**	**30**	**1,000**

CLASSIFICATION OF AIR POLLUTANTS:

Air pollutants can be classified depending upon the form in which they are present in the environment as:

1) Primary pollutants and 2) Secondary pollutants

Primary pollutants are those emitted directly into the atmosphere in the harmful form. eg. CO, NO, SO_2 etc., Secondary pollutants: Some of the primary pollutants might react with one another or with the basic components of air to form new pollutants. These resultant new pollutants are called secondary pollutants.

$$\text{Eg. } NO/NO_2 \xrightarrow{\text{Moisture}} (HNO_3/\ NO_3) \text{ etc.}$$

Indoor Air Pollutants: These are primary air pollutants. Important example is _Radon Gas‘

(i) Radon gas emitted from the building materials like bricks. Concrete, tiles etc. – derived from soil containing Radium

(ii) Also present in natural gas, ground water and is emitted during their usage indoors.

(iii) Burning of fuels in the kitchen, smoking, - CO, SO_2, formaldehyde, BAP(Benzo-(a) pyrene etc.

Common air pollutants sources (causes) and their effects:

(1) Carbon monoxide (CO):

Description: It is a colorless, odorless gas (hence not perceived by the nose) that is poisonous to air breathing beings. It is formed during the incomplete combustion of carbon containing fuels:

$$2\ C + O_2 \longrightarrow 2\ CO$$

In villages, people using fire wood and charcoal for their cooking purposes can cause emission of CO. The general human sources for this dangerous pollutant are: Cigarette smoking, incomplete burning of fossil fuels. About 77% comes from motor vehicle exhaust.

Health Effects: CO reacts with the Haemoglobin in red cells and reduces the ability of blood to bring Oxygen to body cells and tissues – causing headaches and anaemia. At high levels it causes coma, irreversible brain cell damage and death.

(2) Nitrogen Dioxide: It is a reddish brown irritating gas that gives photochemical smog. In the atmosphere it can get converted into Nitric Acid (HNO_3).

NO_2 + Moisture $\longrightarrow$ HNO_3

Human Sources: Fossil fuel burning motor vehicles (49%) and Industrial Power Plants (49%)

Health effects: Lung irritation and damage

Environmental effects: Acid deposition of HNO_3 could damage trees, soils and aquatic life in lakes. HNO_3 could corrode metals and eat away stone on the buildings, statues and monuments. NO_2 could damage fabrics.

(3) <u>Sulphur Dioxide:</u>

It is again an irritating gas that is also colorless. It is mostly formed from the combustion of sulphur containing fossil fuels such as coal and oil. In the atmosphere it can be converted into Sulphurous and Sulphuric acid. These are the major components of acid deposition.

Human Sources: Coal combustion in Thermal Power Plants (88%) and other industrial processes (10%)

Health Effects: Breathing problems even for healthy people

Environmental effects: Reduces visibility, acid deposition of H_2SO_4. It can cause damage to trees, soils and aquatic life in lakes.

(4) <u>Suspended Particulate Matter (SPM)</u>

These include a variety of particles and droplets (aerosols) suspended in atmospheric air for short to long periods. (Room deodorizers)

Human Sources: Burning of coal in power and industrial plants (40%), burning diesel and other fuels in vehicles (17%), agriculture, unpaved roads, construction work etc.

Health Effects: Nose and throat irritation, lung damage, bronchitis, asthma, reproductive problems and cancer.

Environmental Effects: Reduces visibility, causes acid deposition and H_2SO_4 droplets. These could damage trees, soils and aquatic life in lakes.

(5) Ozone:

This is a highly reactive gas which possess an unpleasant, irritant odour. It forms a major portion of the troposphere. It is the major component of photochemical smog.

Human Sources: Chemical reaction with volatile organic compounds (emitted mostly by cars and industries) and nitrogen oxides.

Environmental Effect: Moderates the climate.

(6) Hydrocarbons: Both aliphatic and aromatic get accumulated due to the decay of vegetable matter.

It is carcinogenic and produces an oily film on the surface and react to form secondary pollutants. Ethylene causes plant damage even at low concentrations.

Causes of Air pollution

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

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

Effects of Air Pollution

- Effects on human health: Particulates cause carcinogenic effects, accumulate in lungs and interfere with ability of lungs to exchange gases. Prolonged exposure causes lung cancer and asthma.
- Effects on plants: Gaseous pollutants enter the leaf pores and damage the leaves of crop plants, interfere with photosynthesis and plants growth and reduces nutrient uptake and causes the leaves to turn yellow, brown or drop off altogether.
- On materials: Air pollutants break down the exterior paint on cars and houses.
- Effect on stratosphere: The upper stratosphere consists of considerable amounts of ozone, which works as an effective screen for UV light. Presence of certain pollutants can accelerate the breakdown of ozone. Depletion of ozone effects human health, food productivity and climate

CONTROL OF AIR POLLUTION

Two approaches

1. Preventive technique
2. Effective control

Air pollution can be minimized by the following methods:
> Siting of industries after proper Environmental Impact Assessment studies.
> Using low sulphur coal in industries
> Removing sulphur from coal (by washing or with the help of bacteria)

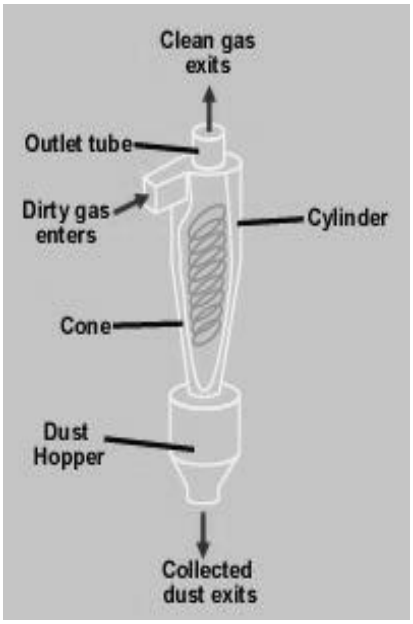
- Removing NOX during the combustion process.

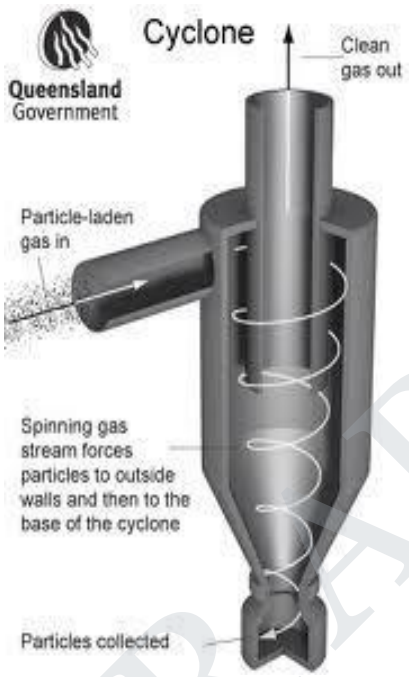
- Removing particulate from stack exhaust gases by employing electrostatic precipitators, bag-house filters, cyclone separators, scrubbers etc.

- Vehicular pollution can be checked by regular tune-up of engines ; replacement of more polluting old vehicles; installing catalytic converters ; by engine modification to have fuel efficient (lean) mixtures to reduce CO and hydrocarbon emissions; and slow and cooler burning of fuels to reduce NOx emission (Honda Technology).

- Using mass transport system, bicycles etc.
- Shifting to less polluting fuels (hydrogen gas).
- Using non-conventional sources of energy.
- Using biological filters and bio-scrubbers

REDUCTION OF AIR POLLUTION AT SOURCE
Control of particulate pollutants
Cyclones Separator





Cyclones provide a low-cost, low-maintenance method of removing larger particulates from a gas stream. The general principle of inertia separation is that the particulate-laden gas is forced to change direction. As gas changes direction, the inertia of the particles causes them to continue in the original direction and be separated from the gas stream. The walls of the cyclone narrow toward the bottom of the unit, allowing the particles to be collected in a hopper. The cleaner air leaves the cyclone through the top of the chamber, flowing upward in a spiral vortex, formed within a downward moving spiral.

Electrostatic precipitator:

The electrostatic precipitator works by removing particles and smoke from a gas stream using an induced electrostatic charge. Dust particles pass by wires that have a high DC voltage applied, which ionizes the surrounding gas.

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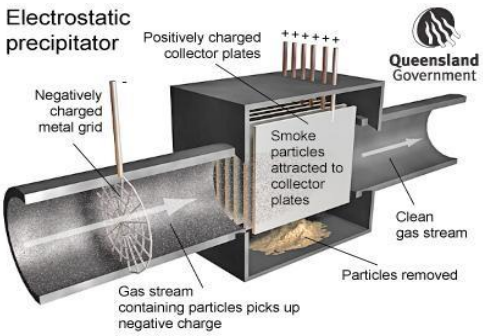
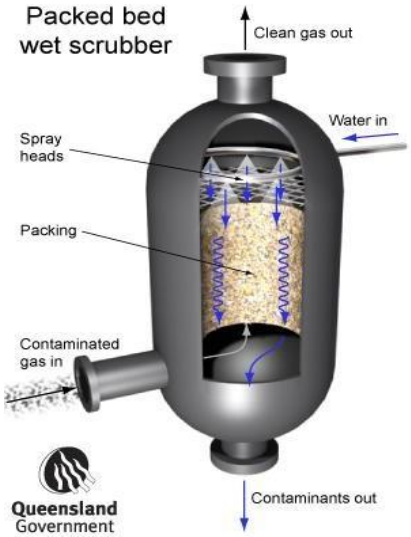
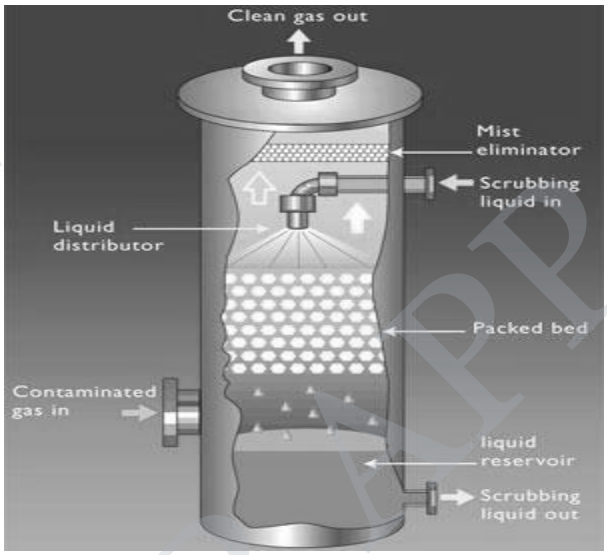


Wet scrubber

A wet scrubber is a device that removes gaseous and/or particle contaminants from a gas stream. It operates by bringing the gas stream into contact with a scrubbing liquid (usually water). Gaseous pollutants are removed by absorption into the scrubbing liquid (absorbers) while particles are removed by physical capture of the particles in the droplets.





Bag House filters

Bag filters, alternatively known as fabric filters or baghouses, use fabric filter bags to remove particles from dust-laden gas. These filters can achieve high efficiencies for very fine particles due to the build-up of particles on the surface of the bag.

Chemical and photochemical reactions in the atmosphere.

FORMATION OF SMOG

Smog is a mixture of smoke and fog in the form of suspended droplets. The Brownish smoke that frequently forms on sunny days over large cities with significant amounts of automobile traffic.

Types of smog

There are two types of smog.

1. London smog
2. Los Angles smog (or) Photochemical smog.

1. London Smog

It is a coal smoke plus fog. Fog mainly consists of mixture of SO_2 + SO_3 + humidity. It is bad in morning hours and becomes worse after sun rise. This is due to sunlight induced oxidation of SO_2 + SO_3, followed by reaction with humidity giving sulphuric acid.

$$SO_2 + (O) \longrightarrow SO_3$$
$$SO_3 + H_2O \longrightarrow H_2SO_4$$

2. Los Angles Smog (or) Photochemical smog

It is not related to smoke (or) fog. It is formed by the combination of NO, NO_2, CO_2, H_2O, CO, SO_2 and unburnt hydrocarbon particles. The important reaction is dissociation of NO_2 in sunlight.

$$N_2 + O_2 \longrightarrow 2\,NO$$
$$2NO + O_2 \longrightarrow 2NO_2$$
$$NO_2 \xrightarrow{\text{sunlight}} NO + [O]$$
$$O_2 + [O] \longrightarrow O_3$$

Health Effects: Breathing problems, cough, eye, nose and throat irritation, heart ailments, reduces resistance to colds and pneumonia.

Environmental effects: Ozone can cause damage to plants and trees, Smog can affect visibility

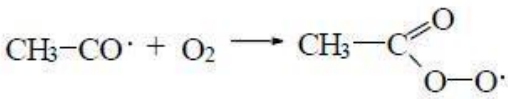
PEROXYACYL NITRATES (PAN) GENERATION MECHANISM

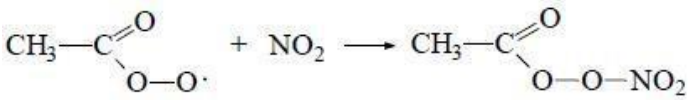
In the atmosphere peroxyacyl nitrates are not generated as they are generated in situ by photochemical reactions having NO_X and VOC as precursors.

Depending on organic radical, peroxyacyl nitrates can be: peroxy acetyl nitrates (PAN): $CH_3C(O)OONO_2$; peroxy propionyl nitrates (PPN): $CH_3CH_2C(O)OONO_2$; peroxy n-butyryl nitrates (PnBN): $CH_3CH_2CH_2C(O)OONO_2$ etc. Among these, PAN plays an important in atmospheric chemistry.

The reactions of PAN formation are based on generation of acetyl radicals by radiation of some VOC (hydrocarbons, alcohols, aldehides). For example:

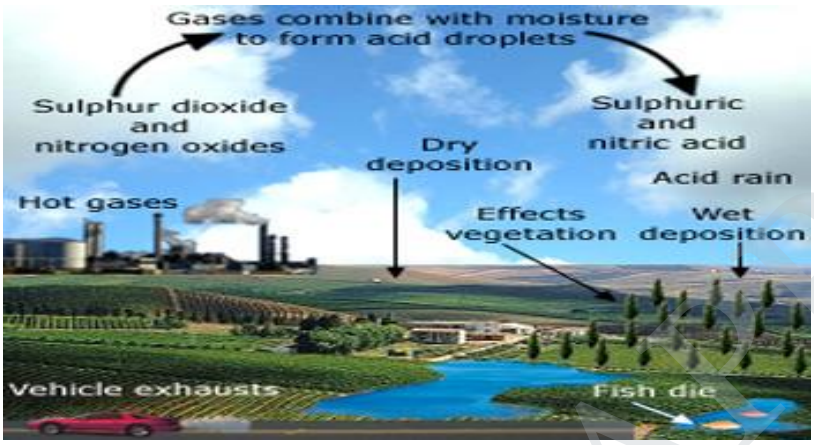
$$CH_3\text{-}CHO + HO\cdot \rightarrow H_2O + CH_3\text{-}CO\cdot$$





Acid Rain (or) Acid Precipitation

Normal rain water is always slightly acidic because of the presence of dissolved CO_2 existing in the atmosphere. Presence of SO_2 and NO_2 gases as pollutants in the atmosphere further lowers the pH of rain water due to the formation of acids. This type of precipitation of water is called acid rain (or) acid deposition.



Acid rain means the presence of excessive acids in rain water. The thermal power plants, industries and vehicles release nitrous oxide and sulphur dioxide into atmosphere due to burning of coal and oil.

When these gases react with water vapour in the atmosphere, they form acids and descend on to earth as "acid rain".

$$SO_x + H_2O \longrightarrow H_2SO_4$$

$$NO_x + H_2O \longrightarrow HNO_3$$

Effects of Acid Rain:

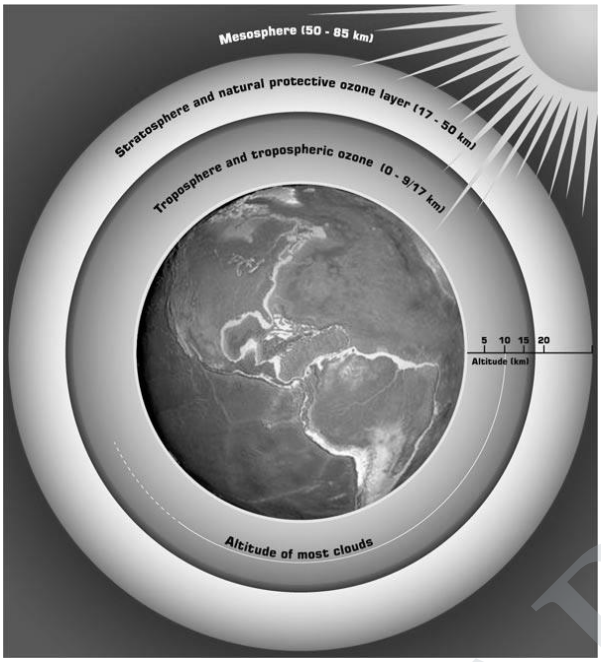
Acid rain causes acidification of lakes and streams and contributes to damage of trees at high elevations (for example, red spruce trees above 2,000 feet) and many sensitive forest soils. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage. Prior to falling to the earth, SO_2 and NOx gases and their particulate matter derivatives, sulfates and nitrates, contribute to visibility degradation and harm public health.

Ozone Layer Depletion (Ozone hole):

Ozone is a gas (O_3) found throughout the atmosphere, but most highly concentrated in the stratosphere between 10 and 50 km above sea level, where it is known as the 'ozone layer'.

Importance of ozone layer:

Without the ozone layer, life on the earth's surface would not be possible. It protects us from the damaging ultraviolet radiation of the sun. In particular it filters out UV-B radiation.



Recent evidence has shown that certain parts of the ozone layer are becoming thinner and ozone 'holes' have developed. The consequence of any thinning of the ozone layer is that more UV-B radiation reaches the earth's surface. UV-B radiation affects DNA molecules, causing damage to the outer surface of plants and animals. In humans it causes skin cancer, and eye disease.

Mechanism of Ozone layer depletion (or) Formation (or) Causes of ozone hole

In 1970, it was found that the ozone layer was attacked by chlorofluoro carbons (CFCs) which are released into atmosphere by refrigeration units, air conditioning systems, aerosol sprays and cleaning solvents.

Chlorofluoro carbons release chlorine which breaks ozone into oxygen.

$$CF_2Cl_2 + h\nu \longrightarrow Cl + CF_2Cl$$

$$CF_2Cl + O_2 \longrightarrow CF_2O + ClO$$

$$Cl + O_3 \rightarrow ClO + O_2$$

$$ClO + O^{\bullet} \rightarrow Cl + O_2$$

Effects of UV radiations on human:

1. In humans, the increased UV radiation increases the incidence in cancer (including nelanoma).
2. Reduces the functioning of immune system.
3. Cornea absorbs UV-B radiations, and a high dose of UV-B causes inflammation of cornea called snow blindness, cataract etc. Exposure may permanently damage cornea and cause cataract.

Measures to prevent ozone layer depletion

- Cut down the use of CFCs
- Do not use polystyrene cups that have chlorofluorocarbon molecules in them which destroy ozone layer.
- Use CFC free refrigerators.
- Use the chemicals derived from peaches and plums to clean computer chips and circuit boards instead of CFCs.

Measurement of Ozone (Dobson Unit)

The amount of atmospheric ozone is measured by 'Dobson spectrometer' and is expressed in Dobson units (DU).1 DU is equivalent to a 0.01 mm thickness of pure ozone at the density it possess if it is brought to the ground level (1 atm) pressure.

In temperate latitude its concentration is 350 DU.
In tropics its concentration is 250 DU.
In sub-polar region its concentration is 450 DU.

WATER POLLUTION

WATER QUALITY PARAMETERS:

The quality of water is an important parameter to be determined in order to decide the type of application or treatment required. The quality of water varies to place to place and seasons.

The followings are some important parameters of quality of water.

1. Physical parameters.
2. Chemical parameters.
3. Biological parameters

Physical Parameters

1. Colour: Colour is a shade imparted by organic or inorganic material, which change the appearance of the water. The colour of natural water range from pale straw through yellowish-brown to dark brown. The colour of natural waters is mainly due to the presence of dissolved or colloidal organic or inorganic materials.
2. Taste and Odour: Disagreeable odour and taste are objectionable for various industrial processes such as food products, beverages, textiles, paper, pulp. Most of the odour in natural waters are organic in nature, except H_2S.
3. Turbidity and sediments: Turbidity is the reduction of clarity of natural water due to the presence of finely divided, insoluble impurities suspended in water.

Chemical Parameters

1. p^H

The hydrogen ion concentration is represented by the pH value, which is defined as

$$p^H = -\log_{10}[H^+]$$

pH is defined as negative logarithm of hydrogen ion concentration.

0 ←-----→ 7 ←-------→ 14

Acidic ←-------- Neutral -------→ Basic

Generally pH of natural waters lies in the neutral range. For drinking water recommended p^H = 6.5 to 8.5. For irrigation recommended p^H = 6.0 to 9.0. Some surface waters passing over areas rich in sodium and potassium posses alkaline p^H. The rain water contaminated by the dissolved gases such as SO_2 and NO_x will have acidic p^H.

2. Acidity

Acidity of water is a measure of its base-neutralizing ability. The acidity in water is usually imparted by the dissolved carbondioxide (or) by the mineral acids. In pure water, the decrease in p^H of about 0.45 occurs as the temperature is raised by 25^0C.

$$2S + 3O_2 + 2H_2O \longrightarrow 2H_2SO_4$$

$$2FeS_2 + 7O_2 + 2\,H_2O \longrightarrow 2FeSO_4 + 2H_2SO_4.$$

2. Alkalinity

Alkalinity of water is a measure of its acid-neutralising ability. Natural alkalinity in waters is imparted by the hydroxides, carbonates and bicarbonates.

3. Fluoride

Fluoride is found in ground water as a result of dissolution from geologic formulations. Surface waters generally contain much smaller concentration of fluoride

4. Nitrogen

Nitrogen is an inert gas, which is relatively unimportant as far as water treatment is concerned.

5. Chlorides

Although chlorides are not considered as harmful as such their concentrations over 250 mg/lit impart peculiar taste to water, which is unacceptable for drinking purposes.

6. Sulphates

When sulphates are present in excess amount in drinking water, they may produce a cathartic effect on the people consuming such water.

7. Nitrates

Excessive concentrations of nitrates are undesirable especially for infants. The maximum contaminant level for nitrate is 10 mg/lit.

9. Arsenic

Arsenic is a toxic heavy metal even a very small dose can result in severe poisoning. Only 0.05 mg/lit has been recommended for arsenic in drinking water.

Biological impurities

Micro-organisms are more abundant in surface waters, where as in deep well waters, the bacterial count is very low or even absent. The growth of these organisms in water, used for industrial purposes, may cause serious problems and hence effective measures must be taken to prevent the growth of these organisms. Organic growths in water generally take place at temperatures ranging from 10^0C - 35^0C.

Specifications for Drinking Water

The common specifications recommended by the U.S Public Health for Drinking Water are given below.

1. Water should be clear and odourless.
2. It should be cool.
3. It should be pleasant to taste.
4. Turbidity of the water should not exceed 10 ppm.
5. pH of the water should be in the range of 7.0 - 8.5.
6. Chloride and sulphate contents should be less than 250 ppm.
   Total hardness of the water should be less than 500 ppm.
8. Total dissolved solids should be less than 500 ppm.
9. Fluoride content of the water should be less than 1.5 ppm.
10. The water must be free from disease-producing bacteria.
11. Water should be free from objectionable dissolved gases like H_2S.
12. Water should be free from objectionable minerals such as lead, chromium, manganese and arsenic salts

WATER POLLUTION

Water pollution may be defined as, "the alteration in physical, chemical and biological characteristics of water which may cause harmful effects on humans and aquatic life."

Causes of Water Pollution

Disease causing agents

1. Oxygen depleting wastes
2. Inorganic plant nutrients
3. Excess pesticides
4. Water soluble organic chemicals
5. Variety of organic chemicals
6. The sediments of suspended matter
7. Water soluble radioactive isotopes
8. Hot water released by power plants & industries
9. Acid drainage into rivers.

Two types of pollutions:

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

Non-point source of pollution: When a source of pollution cannot be readily identified such as agricultural runoff, acid rain etc, it is called as non-point source of pollution.

Effects of Water pollution

1. Large amount of human waste in water increase the number of bacteria which cause gastro intestinal diseases, Water borne diseases diarrhea, typhoid etc.
2. If more organic matter is added to water the O_2 is used up. This causes fish and other forms of O_2 dependent aquatic life dies.
3. High levels of organic chemicals (acids, salts& toxic metals) can make the water
   a. unfit to drink, harm fish and other aquatic life, reduce crop yields.
   b. Variety of organic chemicals / oil gasoline, plastics & detergents are harmful to aquatic life and human life.
4. Radioisotopes cause birth defects, cancer and genetic damage.
5. Hot water has low solubility of oxygen which may change the breeding cycles of various aquatic organisms.
6. Accidental oil spills cause environmental damage.
7. NO_3 contamination causes Blue baby disease (Methaemoglobinaceae).

CONTROL OF WATER POLLUTION

(i) Judicious use of agrochemicals like pesticides and fertilizers which will reduce their surface run-off and leaching. Avoid use of these on sloped lands.Use of nitrogen fixing plants to supplement the use of fertilizers.

(ii) Adopting integrated pest management to reduce relying on pesticides.

(iii) Prevent run-off of manure. Divert such run-off to basin for settlement. The nutrient rich water can be used as fertilizer in the fields.

(iv) Separate drainage of sewage and rain water should be provided to prevent overflow of sewage with rainwater.

(v) Planting trees would reduce pollution by sediments and will also prevent soil erosion.
(vi) Setting up of effluent treatment plants to treat waste water can reduce the pollution load in the recipient water. The treated effluent can be reused either for gardening or cooling purposes or wherever possible.

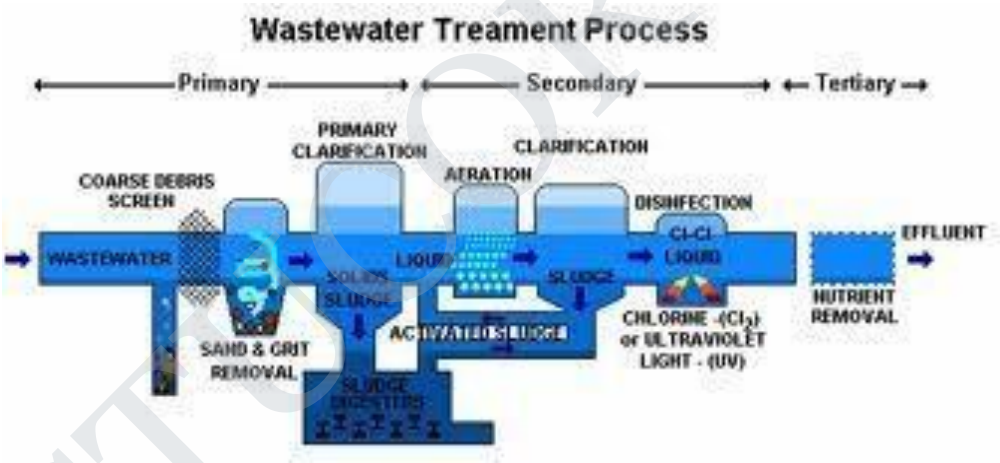
(vii) Root zone process has been developed by Thermax by running contaminated water through the root zone of specially designed reed beds. These have the capacity to absorb from the surrounding air through their stomata openings. It creates O2 rich conditions where bacteria and fungi oxidize the wastes.
(viii) Providing sanitation and waste water treatment facility.
(ix) Integrated nutrient management (INM) and integrated pest management (IPM) practices will reduce the effects caused due to excess pesticides.

WASTE WATER TREATMENT

Primary treatment (or) settling process

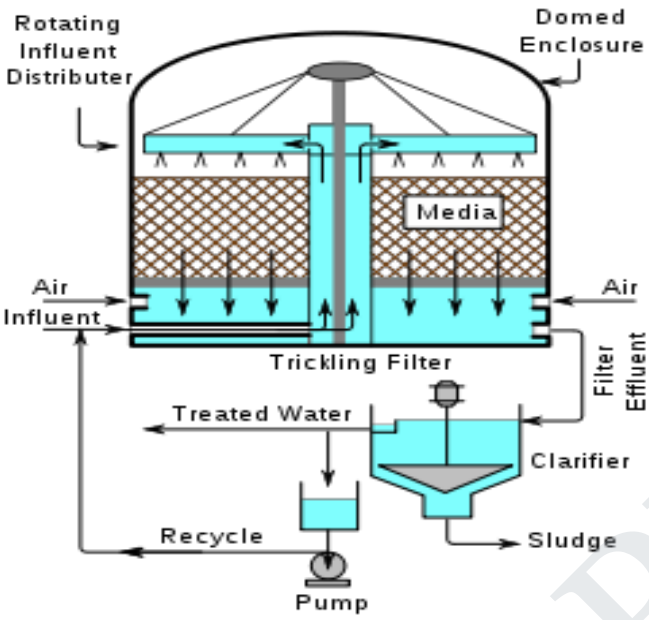
In this treatment, greater proportion of the suspended inorganic and organic solids are removed from the liquid sewage by settling. In order to facilitate quick settling coagulants like alum, ferrous sulphate are added.
These produce large gelatinous precipitates, which entrap finely divided organic matter and settle rapidly.

$$Al_2(SO_4)_3 + 6H_2O \longrightarrow 2Al(OH)_3 \downarrow + 3H_2SO_4.$$

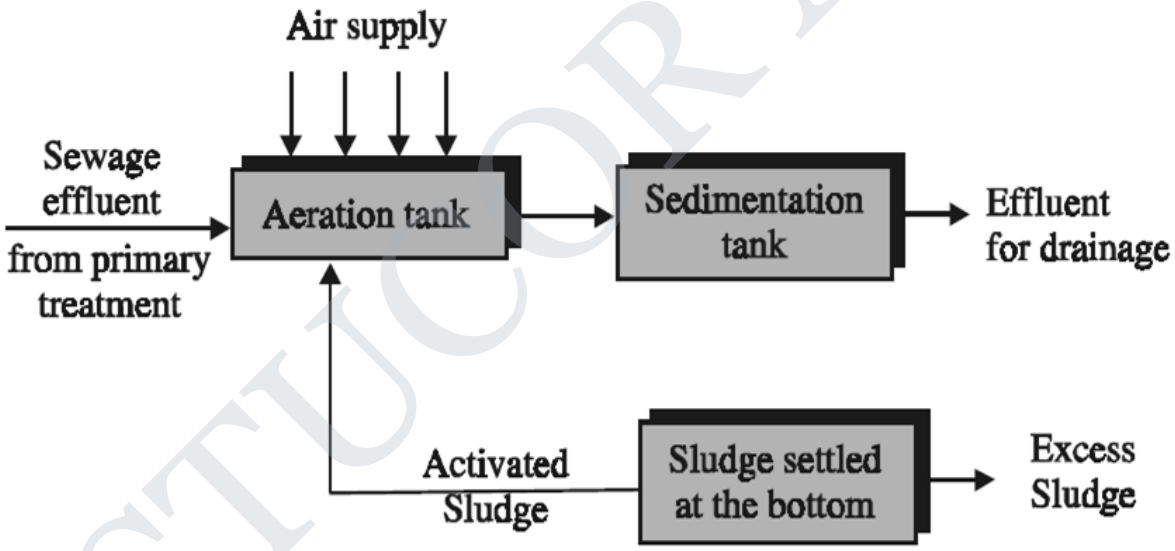


TRICKLING FILTER

Trickling filter is a circular tank and is filled with either coarse or crushed rock. Sewage is sprayed over this bed by means of slowly rotating arms.
When sewage starts percolating downwards, microorganisms present in the sewage grow on the surface of filtering media using organic material of the sewage as food.
After completion of aerobic oxidation the treated sewage is taken to the settling tank and the sludge is removed. This process removes about 80-85% of BOD.



2. Activated sludge process



IV. Tertiary treatment

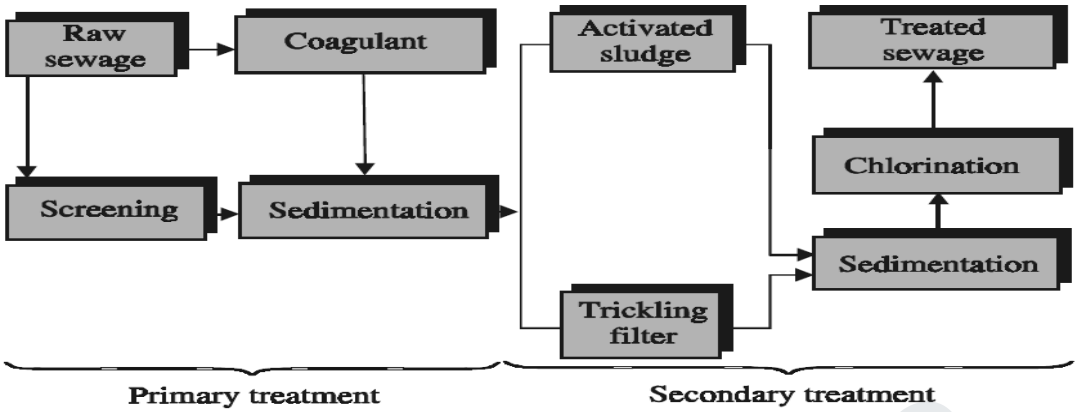
After the secondary treatment, the sewage effluent has a lower BOD (25 ppm), which can be removed by the tertiary treatment process.

In the tertiary treatment, the effluent is introduced into a flocculation tank, where lime is added to remove phosphates.

From the flocculation tank the effluent is led to ammonia stripping tower, where p^H is maintained to 11 and the NH_4 is converted to gaseous NH_3.

Then the effluent is allowed to pass through activated charcoal column, where minute organic wastes are adsorbed by charcoal. Finally the effluent water is treated with disinfectant (chlorine).

V Disposal of sludge



Component	%
Mineral matter (inorganic)	45
Organic matter	5
Soil water	25
Soil air	25

SOIL POLLUTION

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

Composition of soil

Types, effects and sources (causes) of soil pollution

Soil pollution mainly results from the following sources

1. Industrial wastes.

The industrial pollutants are mainly discharged from the various origins such as pulp and paper mills, chemical industries, oil refineries, sugar factories, tanneries, textiles, steel, distilleries, fertilizers, pesticides, coal and mineral mining industries, drugs, glass, cement, petroleum and engineering industries etc.,

2. Urban wastes.

Urban wastes comprises both commercial and domestic wastes consisting of dried sludge of sewage. All the urban solid wastes are commonly referred to as refuse.

This refuse contains garbage and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products.

Urban domestic wastes though disposed off separately from the industrial wastes, can still be dangerous. This is so because they cannot be easily degraded.

3. Agricultural practices.

Modern agricultural practices pollute the soil to a large extent. Today with the advancing agro-technology, huge quantities of fertilizers, pesticides, herbicides, weedicides are added to increase the crop yield. Apart from these farm wastes, manure, slurry, debris, soil erosion containing mostly inorganic chemicals are reported to cause soil pollution.

4. Radioactive pollutants.

Radioactive substances resulting from explosions of nuclear dust and radioactive wastes (produced by nuclear testing laboratories and industries) penetrate the soil and accumulate there by creating land pollution.

5. Biological agents.

Soil gets large quantities of human, animal and bird's excreta which constitute the major source of land pollution by biological agents.

Causes of Soil Pollution

- Soil erosion
- Soil contaminants
- Fertilizers and pesticides
- Excess use of irrigation water

Effects of Soil Pollution

Food shortage

1. Desertification
2. Decrease in the extent of agricultural land
3. Top soil erosion
4. Excess use of irrigation leads to waterlogging and soil salinization.
5. Fertilizer run off leads to the eutrophication of waterways.

Control measures

Proper soil conservation measures to minimize the loss of top soil

1. Soil erosion can be controlled by a variety of forestry and farm practices
2. Reducing deforestation and substituting chemical manures by animal wastes would also help to arrest soil erosion in the long term. Maintaining soil productivity is vital and essential for sustainable agriculture.

Proper dumping of unwanted materials

Excess of waste products by man and animals cause chronic disposal problem. Open dumping is most commonly practiced method. Recently controlled tipping is followed for solid waste disposal. The surface so obtained then can be used for housing or sports field.

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

Recycling and Reuse of wastes

To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc., should be recycled and reused.

SOLID WASTE MANAGEMENT

- The combined effects of population explosion and changing modern living standards have had a cumulative effect in the generation of a large amount of various types of wastes.
- Management of solid waste is very important in order to minimize the adverse effects of solid wastes.
- Any material that is thrown away or discarded as unwanted is considered as solid waste.

Types

1. Garbage or food waste
2. Rubbish
3. Agricultural waste
4. Industrial waste
5. Hazardous waste

Cause

- Over population
- Affluence
- Technology

Effects

1. Health hazard
2. Environmental impact

Control measures

Solid waste management include

1. The waste generation
2. Collection of solid waste
3. Disposal of solid waste
   - Land fill- Disposal of municipal waste in the upper layers of the mantle.
   - Incineration- Burn highly combustible wastes at very high temperature
   - Composting or Bio degradation- Decompose the organic components of the municipal solid wastes.

Waste utilization

a) Reuse
b) Recycling
c) Reclamation

SOLID WASTE MANAGEMENT

Management of solid waste has, therefore, become very important in order to minimize the adverse effects of solid wastes. Solid waste (waste other than liquid or gaseous) can be classified as municipal, industrial, agricultural, medical, mining waste and sewage sludge.

Sources of Urban and Industrial Wastes

Urban waste

Urban waste consists of medical waste from hospitals; municipal solid wastes from homes, offices, markets (commercial waste) small cottage units, and horticulture waste from parks, gardens, orchards etc. Waste from homes (Domestic waste) contains a variety of discarded materials like polyethylene bags, empty metal and aluminium cans, scrap metals, glass bottles, waste paper, diapers, cloth/rags, food waste etc.

1. Waste from shops mainly consists of waste paper, packaging material, cans, bottles, polyethylene bags, peanut shells, eggshells, tea leaves etc.
2. Biomedical waste includes anatomical wastes, pathological wastes, infectious wastes etc.
3. Construction/demolition waste includes debris and rubbles, wood, concrete etc.
4. Horticulture waste and waste from slaughter houses include vegetable parts, residues and remains of slaughtered animals, respectively.

Industrial waste:

Industrial waste consists of a large number of materials including factory rubbish, packaging material, organic wastes, acids, alkalis and metals etc.

Effects of Solid Wastes:

Municipal solid wastes heap up on the roads due to improper disposal system. This produces foul smell and breeds various types of insects and infectious organisms besides spoiling the aesthetics of the site.

MANAGEMENT OF SOLID WASTE:

For waste management we stress on .three R‘s-Reduce, reuse and recycle before destruction and safe storage of wastes.

(I) REDUCTION IN USE OF RAW MATERIALS:

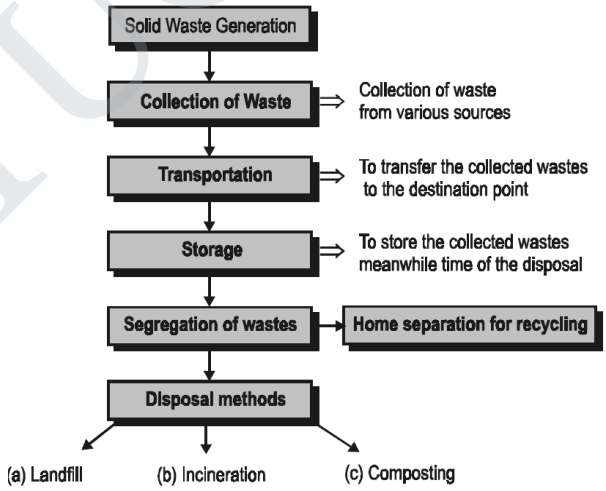
Reduction in the use of raw materials will correspondingly decrease the production of waste. Reduced demand for any metallic product will decrease the mining of their metal and cause less production of waste.

(II) REUSE OF WASTE MATERIALS:

The refillable containers which are discarded after use can be reused. Villagers make casseroles and silos from waste paper and other waste materials. Making rubber rings from the discarded cycle tubes which are used by the newspaper vendors, instead of rubber bands, reduces the waste generation during manufacturing of rubber bands.

(III) RECYCLING OF MATERIALS:

Recycling is the reprocessing of discarded materials into new useful products. (i) Formation of some old type products e.g. old aluminium cans and glass bottles are melted and recast into new cans and bottles.



Methods of disposal of Solid Waste

1. Landfill
2. Incineration
3. Composting

1. Landfill

Solid wastes are placed in sanitary landfill system in alternate layers of 80cm thick refuse, covered with selected earth fill of 20cm thickness. After two or three years, solid waste volume shrinks by 25-30% and the land is used for parks, roads and small buildings.

2. Incineration (or) Thermal process

It is a hygienic way of disposing solid waste. It is more suitable if the waste contains more hazardous material and organic content.

It is a thermal process and is very effective for detoxification of all combustible pathogens.

It is an expensive technology compared to land-fill and composting because incinerators are costly.

3. Composting

It is another popular method practiced in many cities in our country. In this method, bulk organic waste is converted into fertile manure by biological action.

The separated compostable waste is dumped in underground earthen trenches in layers of 1.5 m and is finally covered with earth of about 20 cm and left over for decomposition.

Sometimes certain microorganisms such as actinomycetes are introduced for active decomposition.

Within 2 to 3 days biological action starts, the organic matters are being destroyed by actinomycetes and lot of heat is liberated increasing the temperature of the compost by about 75^0C and finally the refuse is converted to powdery brown coloured odourless mass known as humus and has a fertilizing value which can be used for agricultural field.

The compost contains lot of nitrogen essential for plant growth apart from phosphates and other minerals.

MARINE POLLUTION

Marine pollution is defined as the introduction of substances to the marine environment directly or indirectly by man resulting in adverse effects such as hazardous to human health, obstruction of marine activities and lowering the quality of sea water

Sources

1. Municipal waste & sewage from residences and hotels in coastal towns
2. Pesticides and fertilizers from agriculture
3. Petroleum & oil washed off from roads enter sewage system & finally into seas
4. Ship accidents & accidental spillage at
5. Off shore oil exploration also pollute the sea water to a large extent
6. Dry docking
7. Pollution due to organic wastes
8. Pollution due to oil
9. Tanker accidents
10. Volcanic eruptions in the sea.
11. Deep sea mining

Effects of marine pollution

- A large amount of organic wastes can also result in the development of ‘red tides‘. These are phytoplankton blooms because of which the whole area is discolored.
- Commercially important marine species are also killed due to clogging of gills and other structures.
- For salt marshy plants oil slick can affect the flowering, fruiting and germination.

- The coral reefs are the productive ecosystems offer many benefits to people. These coral reefs are threatened by a) the sediments from deforestation carried by the runoffs.
- Drill cuttings dumped on the seabed result in the production of toxic sulphides in the bottom sediment thus eliminating the benthic fauna.

Control measures of marine pollution

- Introduction of sewage treatment plants to reduce BOD of final product before discharging into sea.
- Cleaning oil from surface waters and contaminated beaches can be accelerated through the use of chemical dispersants which can be sprayed on the oil.
- Load on top system reduces oil pollution cleaned with high pressures jets of water.
- Crude oil washing: The spillage is removed by jets of crude oil while the cargo is being unloaded.

(i) Toxic pollutants from industries and sewage treatment plants should not be discharged in coastal waters.
(ii) Run off from non-point sources should be prevented to reach coastal areas.
(iii) Sewer overflows should be prevented by having separate sewer and rain water pipes.
(iv) Dumping of toxic, hazardous wastes and sewage sludge should be banned.
(i) Developmental activities on coastal areas should be minimized.
(ii) Oil and grease from service stations should be processed for reuse.
(iii) Oil ballast should not be dumped into sea.
(iv) Ecologically sensitive coastal areas should be protected by not allowing drilling.

NOISE POLLUTION

Sound is mechanical energy from a vibrating source. Unpleasant and unwanted sound is called noise.

Sound can propagate through air, liquid or solid. Sound is pressure perturbation in the medium through which it travels. Sound pressure creates alternate compression and rarefaction. The number of c and r per unit time is called frequency.

Sound pressure does not produce linear impact on human. A logarithmic scale has been devised.

Noise is measure in terms of SPL which is a log ratio of sound P to a std. P. It has a dimensionless unit decibel (dB). The international reference P is 2X10 power -5 Pa. Sound can affect ears either by loudness or by pitch (frequency). The CPCB has recommended the permissible noise levels for various places.

Sounds and their decibel scale

1. Rocket engine – 180 dB
2. Jet plane take off – 150 dB
3. Threshold of pain – 140 dB
4. Recorded music (max) – 130 dB
5. Construction works, news paper press – 100 dB
6. Motor cycle – 90 dB
7. Ordinary conservation – 70/80 dB
8. Air conditioning unit/ Light traffic – 60 dB
9. Normal living room – 50 dB
10. Library or soft whisper – 30 B
11. Threshold of hearing – 0 dB

Sources of noise pollution

1. Industrial units
2. Transportation modes
3. Construction activities
4. Celebrations
5. Electric home appliances

Effects of noise pollution

i. Interferes communication
ii. Hearing damage (90 dB)
iii. Physiological and Psychological disorders

Control of noise pollution

- Reduction in source of noise]
- Noise making machines should be kept in containers with sound absorbing media
- Proper oiling will reduce noise from machinery
- Using silencers – fibrous material
- Planting trees
- Legislation can prevent excess sound production, unnecessary horn blowing etc.

THERMAL POLLUTION

Thermal pollution is the degradation of water quality by any process that increases the ambient water temperature. The increase in temperature decreases the dissolved oxygen/oxygen supply and affects ecosystem composition.

2.8.1 Causes

- Nuclear power plant
- Domestic sewage
- Hydro-electric power

Effects

1. Reduction in dissolved oxygen
2. Increase in toxicity
3. Direct mortality

Control measures

- Cooling towers
- Cooling ponds
- Spray ponds

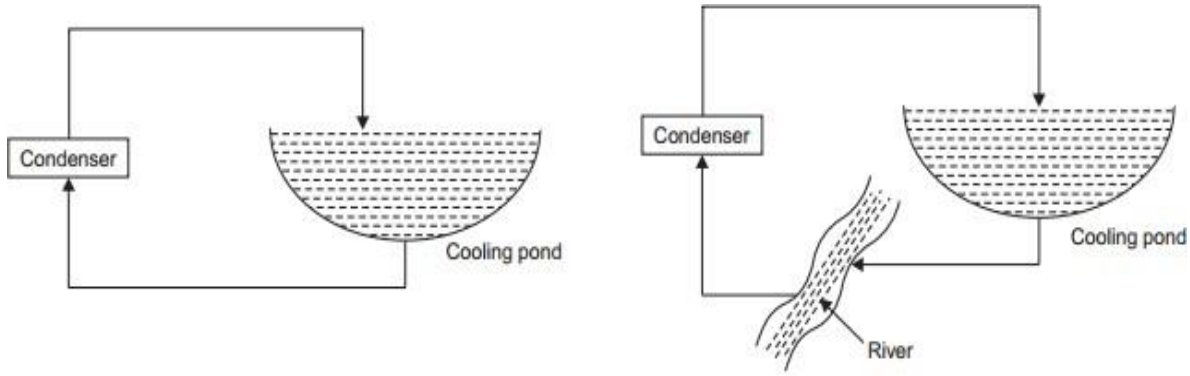
CONTROL OF THERMAL POLLUTION:

The following methods can be employed for control of thermal pollution:

(i) Cooling ponds
(ii) Spray Ponds
(iii) Cooling towers

(i) Cooling Ponds:

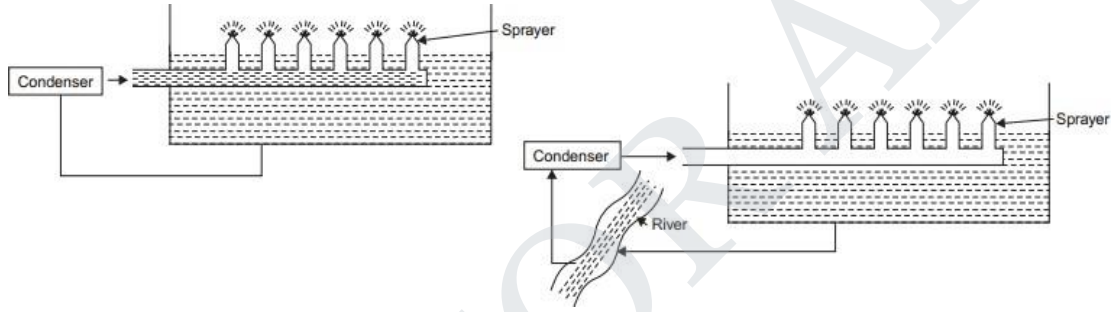
Water from condensers is stored in ponds where natural evaporation cools the water which can then be recirculated or discharged in nearby water body.



Dissipation of heat by cooling ponds.

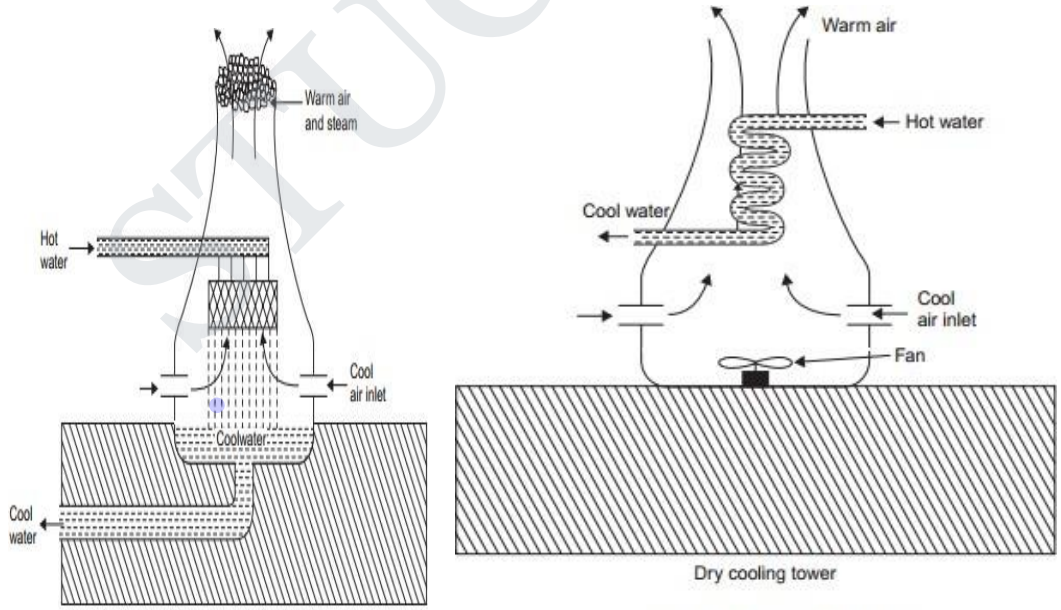
(ii) Spray Ponds:

The water from condensers is received in spray ponds. Here the water is sprayed through nozzles where fine droplets are formed. Heat from these fine droplets is dissipated to the atmosphere.



(iii)Cooling Towers:

(a) Wet cooling tower (b) Dry cooling tower

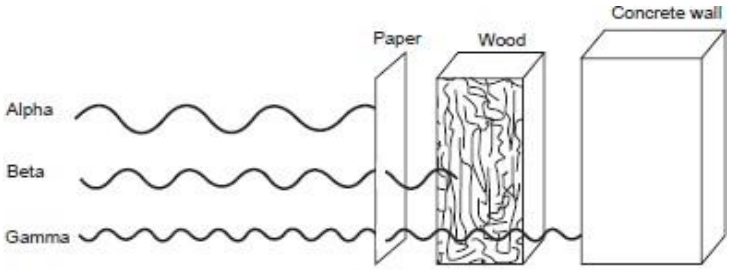


Cooling towers: Wet and dry.

NUCLEAR HAZARDS

Radioactive substances are present in nature. They undergo natural radioactive decay in which unstable isotopes spontaneously give out fast moving particles, high energy radiations or both, at a fixed rate until a new stable isotope is formed. The isotopes release energy either

in the form of gamma rays (high energy electromagnetic radiation) or ionization particles i.e. alpha particles and beta particles.
Alpha particles can be interrupted by a sheet of paper while beta particles can be blocked by a piece of wood or a few millimeters of aluminium sheet. The gamma rays can pass through paper and wood but can be stopped by concrete wall, lead slabs or water.



Variable penetration power of ionisation radiations emitted by radioisotopes.

Sources of Radioactivity

(i) Natural sources
(ii) Anthropogenic (man-made) sources.
(i) Natural Sources: Sources of natural radioactivity include cosmic rays from outer space, radioactive radon-222, soil, rocks, air, water and food, which contain one or more radioactive substances.
(ii) Anthropogenic sources: These sources are nuclear power plants, nuclear accidents, X-rays, diagnostic kits, test laboratories etc. where radioactive substances are used.

Effects of Radiations
Ionizing radiations can affect living organisms by causing harmful changes in the body cells and also changes at genetic level.
(i) Genetic damage is caused by radiations, which induce mutations in the DNA, thereby affecting genes and chromosomes. The damage is often seen in the offspring and may be transmitted upto several generations.
(ii) Somatic damage includes burns, miscarriages, eye cataract and cancer of bone, thyroid, breast, lungs and skin
Control of Nuclear Pollution
(i) Siting of nuclear power plants should be carefully done after studying long term and short term effects.
(ii) Proper disposal of wastes from laboratory involving the use of radioisotopes should be done.

ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

- Use stairs instead of elevators
- Use public transportation walk or ride a bicycle
- Plant trees around building
- Turn off lights, television sets and computer when not in use.
- Pay immediate attention to leaks in pipes.
- Install waste saving equipment.
- Recycle glass metal and paper.
- Compost garden waste
- Segregate waste and recycle
- Buy locally made long losing material
- Buy environmentally degradable products.
- Take some bag from home to market to purchase.

Each individual should change his or her life style in such a way as to reduce environmental pollution

Help more in pollution prevention than pollution control.

- Use eco-friendly products.
- Cut down the use of chlorofluorocarbons (CFCs) as they destroy the ozone layer.
- Use the chemicals derived from peaches and plums to clean computer chips and circuit boards instead of CFCs.
- Use CFC free refrigerators.
- Reduce your dependency on fossil fuel especially coal or oil.
- Save electricity by not wasting it when not required because electricity saved is electricity generated without polluting the environment. Put on warm clothes rather than switching on a heater.
- Adopt and popularize renewable energy sources.
- Improve energy efficiency. This will reduce the amount of waste energy, i.e. more is achieved with less energy.
- Promote reuse and recycling wherever possible and reduce the production of wastes.
- Use mass transport system. For short-visits use bicycle or go on foot. Decrease the use of automobiles.
- Use pesticides only when absolutely necessary and that too in right amounts. Wherever possible integrated pest management, including alternate pest control methods (biological control), should be used.
- Use rechargeable batteries. Rechargeable batteries will reduce metal pollution.
- Use less hazardous chemicals wherever their application can be afforded. Baking soda, vinegar and borax can help in cleaning, bleaching and softening. Baking soda can replace modern deodorants.
- The solid waste generated during one manufacturing process can be used as a raw material for some other processes.
- Use low phosphate, phosphate-free or biodegradable dish washing liquid, laundry detergent and shampoo. This will reduce eutrophication of water bodies.
- Use organic manure instead of commercial inorganic fertilizers

Role of Women in Environmental Protection

Women play an important role in environmental protection, considering their status in social production, consumption and their influence to future generations at home. Various roles of women are

1. In rural areas, women plant trees and grass, grow vegetables with the drip-irrigation method in order to save water.
2. In urban areas, they go shopping using cloth bags to reduce white pollution.
3. Women refuse to use disposal products to save energy and resources
4. Women choose green products instead of poor quality that harm the environment.
5. Women reduce the amount of trash they dispose off so as to recycle natural resources.
6. Women buy non-phosphate detergents to reduce the incidence of water pollution.
7. They refuse to eat the meat, so variety of animals are preserved.
8. They value paper and thus protect trees.
9. Women bring the concept of environmental protection into families and thus plant a green seed in the heart of children.

POLLUTION CASE STUDIES

BHOPAL GAS TRAGEDY

The careless siting of industries and relatively poor regulatory controls leads to ill health in the surroundings.

The Bhopal gas tragedy on December 2nd 1984, where Union Carbide's Plant leaked 43 tons of Methyl Isocynate and other substances, used in the manufacture of pesticides is one of the worst industrial accidents in the recent past.

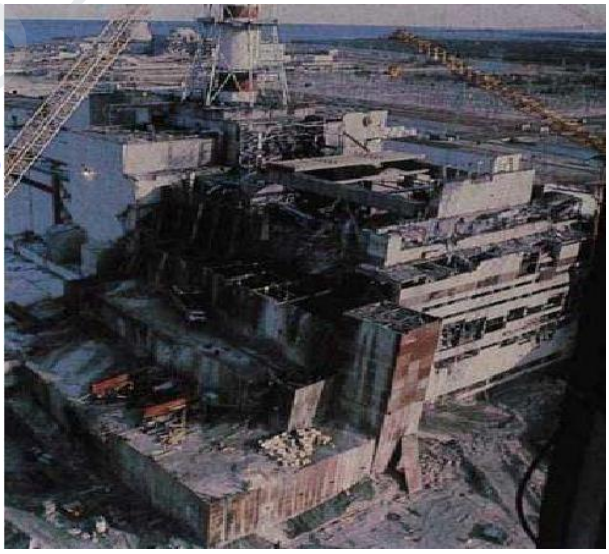
Of the 5,20,000 people who were exposed to the gas - 8,000 died during the first week and another 8,000 later. The impact of the survivors is visible even today.

Bhopal gas tragedy plant

CHERNOBYL REACTOR INCIDENT

On April 25, 1986, Russian engineers and scientists begin preliminary tests on Chernobyl power plant's 4th reactor. In order to control the experiment, the automatic control system was shut down. After some work, stability was reached at very low power outputs. Unfortunately, manual control of the water pressure wasn't maintained. The reactor began to create excess heat. Without the automatic control, the control rods couldn't be reinserted in time; a deadly chain reaction had begun. Within a matter of 3-4 seconds, the reactor went from 5% output to 100 times its normal level.

The water in the reactor flash- boiled, creating an explosion that leveled thousands of tons of concrete and steel, including the housing for the reactor. The steam carried almost 70% of the nuclear material out of the reactor into the surrounding environment. Several thousand volunteers died on the scene, and it is estimated that 7,000 to 10,000 volunteers died in total, considering short and long-term effects. Thousands of miles from the birth defect rate became double the world average.



Chernobyl Reactor

It is also estimated that 150,000 were put at risk for thyroid cancer, and over 800,000 children were put at risk of contracting leukemia. 2 million acres of land (1/5 of the usable farmland in the Ukraine) was, and still is, completely unusable. It remains difficult to determine the scope of the disaster; radiation resulting from the event was detected all over the globe. It is estimated that it may cost up to $400 billion and will take up to 200 years to correct the damage done to the area, and to compensate those affected by the meltdown.

CASHEW IN KASARGOD, KERALA POISONOUS NUTS

Endosulfan, a pesticide banned by many countries in the world including India was extensively sprayed aerially in the cashew plantations of Plantation Corporation of Kerala (PCK) spread over 2209 hectares in various divisions of Kasargod district, Kerala. Endosulfan is slated to be phased out globally under the Stockholm Convention 2001, to which India is a signatory. The pesticide is classified as an organochlorine compound and its breakdown products are persistent in the environment, with an estimated half-life of nine months to six years. It is known to potentially bioaccumulate in humans and other animals, in the liver, kidneys and fatty tissue. PCK started using this pesticide in 1979 and unusual health disorders were reported from places like Vaninagar, Adur, Mulleria, Padre etc. The people were unaware that this was a lethal poison.

A study conducted by the Centre for Science and Environment (CSE) confirmed the presence of high quantities of endosulfan in the samples of water, soil, fruits, mother‘s milk and blood in Kasargode. Further disorders of the central nervous system, cerebral palsy, mental and physical retardation, epilepsy and congenital anomalies like stag horns, liver cancer, blood cancer, infertility, miscarriages, hormonal imbalances, skin diseases and asthma have been reported. All these disorders were traced to endosulfan effects. After mass agitations and several reports by various agencies, the use of endosulfan was banned in Kerala in August 2001. Though, the state government has paid compensations, the rehabilitation of the living victims is really tough and challenging. Reports reveal that approximately, 224 people were critically affected and 226 have a 60percent disability. This tragedy was spread over 20 villages in the state.

GROUNDWATER POLLUTION IN INDIA

An example of groundwater pollution caused by excessive extraction is that fluoride contamination. It has spread across 19 states and across a variety of ecological regions ranging from the Thar desert, the Gangetic plains and the Deccan plateau. Source: When the bedrock weathers the fluoride leaches into water and the soil. surfaced during the last three decades - extraction of groundwater which has resulted in the tapping of aquifers with high fluoride concentrations was noticed during 1970s and the 1980s when there was massive state investment in rural water development for irrigation as well as for drinking. Encouraged by state subsidies on diesel and electricity, people invested in diesel and submersible pumps in a bid to extract groundwater through borewells. This policy aggravated the fluoride problem. Effects: combines with the bones as it has an affinity for calcium phosphate in the bones. Excess intake of fluoride can lead to dental fluorosis, skeletal fluorosis or non-skeletal fluorosis. Correction: - Deflouridation plants and household water treatment kits are stop-gap solutions.

MARINE POLLUTION IN TAMIL NADU: OCEANS NOT SPARED

Industrial pollution has threatened the natural habitats of pearls in the pearl banks of Tuticorin coast in the Gulf of Mannar. It has affected fish and other organisms as far as 30 kms south of Tuticorin due to effluents released from chemical industries. Tannery wastes have caused the pollution of coastal waters from Chennai to Vedaranyam.

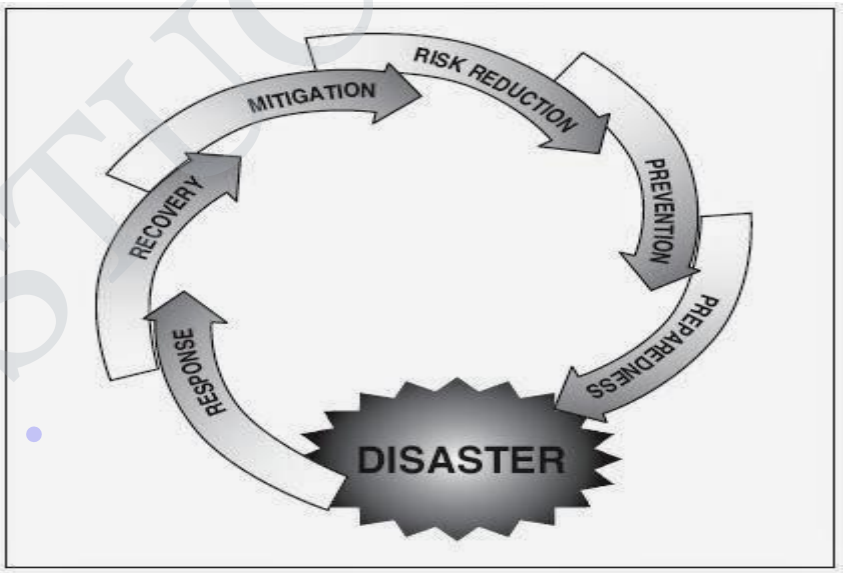
The effect of diversity of phytoplankton ecology of mangrove estuaries of Tuticorin is greatly affected by industrial effluents. The Chennai coastal waters showed high levels of pesticides like DDT, lindane, endosulphan and heptachlor. The bioaccumulation of these pesticides in marine organisms could pose major health hazards.

NOISE HITS WHALES IN HONG KONG

Studies have shown that shipping traffic in Hong Kong, which is one of the busiest ports in the world with approximately half a million oceanic vessels traveling through its waters every year (including over 10,000 transits by high speed ferries) has caused changes in the dolphin and whale behavior especially in response to fast moving vessels. A special sanctuary was established by the Hong Kong government in 1995, surrounding the islands of Sha Chau and Lung Kwu Chau, an important place occupied by the humpback dolphins. At any given time approximately 200 vessels surrounds this sanctuary. The sanctuary was a measure to mitigate boat traffic and tremendous noise produced. Adjacent to the sanctuary is an airport, where 700 planes descend and take off every day, directly over the sanctuary. All the above activities have caused high noise input into the natural whale habitat. Noise, a major anthropogenic stress factor has caused a general decline in the whale populations.

DISASTER MANAGEMENT:
EARTHQUAKE

- An earthquake (also known as a quake, tremor or temblor) is the result of a sudden release of energy in the Earth's crust that creates seismic waves.
- Seismic waves are waves of energy that travel through the Earth's layers, and are a result of an earthquake, explosion, or a volcano that imparts low-frequency acoustic energy
- The seismicity, seismism or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time.



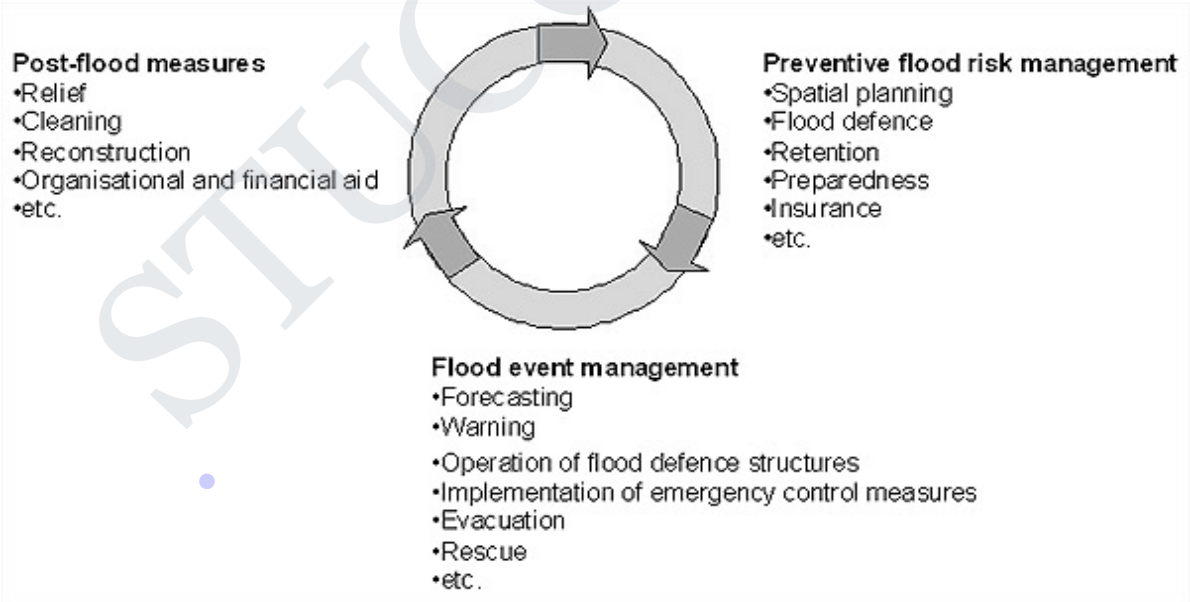
FLOODS

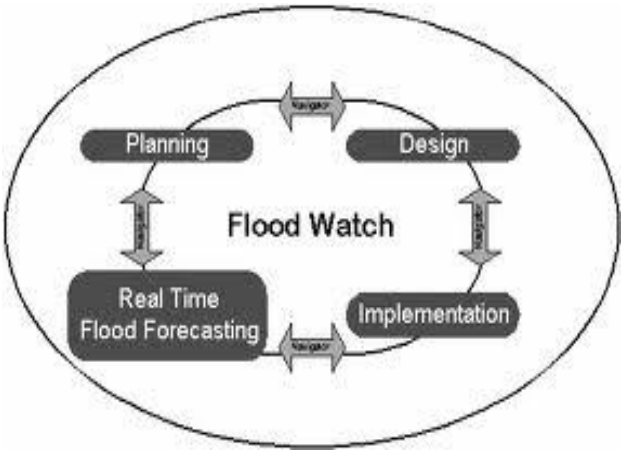
- Floods refer to huge amount of water reaching land in a short span of time, causing land surface to be submerged under water – at places, where, land surface is usually not covered with water.

Floods could be caused due to natural causes, or, human activities, or, a combination of both. Floods are caused by discharge of huge volume of water in a short span of time.

Some of the possible reasons for such huge discharge of water could be:

- Very heavy rainfall (say: due to cyclones, typhoons etc.) in a short span of time. It should be noted that the amount of rainfall itself is not a sufficient cause, the duration within which the rainfall is receive is equally important contributor
- Breakage of dams etc.
- Very high tidal waves (sometimes in the aftermath of a seismic activity, e.g. earthquakes) etc. – also called tsunamis





Cyclone

In meteorology, a cyclone is an area of closed, circular fluid motion rotating in the same direction as the Earth. This is usually characterized by inward spiraling winds that rotate anti-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere of the Earth. Most large-scale cyclonic circulations are centered on areas of low atmospheric pressure

Landslides

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope due to gravity. The materials may move by falling, toppling, sliding, spreading, or flowing.

Causes

Heavy rainfall, snowmelt, changes in water level, stream erosion, changes in ground water, earthquakes, volcanic activity, disturbance by human activities.

Effects

Loss of forest, loss of human life, some landslides may cause tsunami.

Major land slide

The Thistle, Utah, landslide cost in excess of $200 million dollars to fix. The landslide occurred during the spring of 1983, when unseasonably warm weather caused rapid snowmelt to saturate the slope.

Public awareness

- Among students through education
- Among the masses through mass media
- Among the planners, decision makers and leaders
- Role of Non Government Organisations (NGO)

Unit III - NATURAL RESOURCES

Natural resources (economically referred to as land or raw materials) occur naturally within environment existing relatively undisturbed by mankind, in the natural form.

FOREST RESOURCES: It is one of the most important renewable natural resources on this earth. About one-third of the world's land surface is covered with forest.

Commercial uses
(i) Man depends heavily on a larger number of plant and animal products from forests for his daily needs.
(ii) The chief product that forests supply is wood, which is used as fuel, raw material for various industries as pulp, paper, newsprint, board, timber for furniture items, other uses as in packing articles, matches, sports goods etc.
(iii) Indian forests also supply minor products like gums, resins, dyes, tannins, fibers, etc.
Many of the plants are utilized in preparing medicines and drugs; Total worth of which is estimated to be more than $300 billion per year.
(iv) Many forests lands are used for mining, agriculture, grazing, and recreation and for development of dams.

Depending upon the climate conditions, forest may be classified as:

1. Tropical Rain Forests: They are evergreen broadleaf forests found near the equator. They are characterized by high temperature, high humidity and high rainfall, all of which favor the growth of trees.
2. Tropical deciduous forests: They are found a little away from the equator and are characterized by a warm climate the year round. Rain occurs only during monsoon.
3. Tropical scrub forests: They are found in areas where the day season is even longer.
4. Temperate rain forests: They are found in temperate areas with adequate rainfall. These are dominated by trees like pines, firs, redwoods etc.
5. Temperate deciduous forests: They are found in areas with moderate temperatures.
6. Evergreen coniferous forests (Boreal Forests): They are found just south of arctic tundra. Here winters are long, cold and dry. Sunlight is available for a few hours only.

Ecological uses:
The ecological services provided by our forests may be summed up as follows:

(i) Production of Oxygen: The main greenhouse gas carbon dioxide is absorbed by the forests as a raw material for photo synthesis. Thus forest canopy acts as a sink for carbon dioxide thereby reducing the problem of global warming caused by greenhouse gas CO_2
(ii) Wild life habitat: Forests are the homes of millions of wild animals and plants. About 7 million species are found in the tropical forests alone.
(iii) Regulation of hydrological Cycle: Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the runoff. They control climate through transpiration of water and seed clouding.

(iv) Soil Conservation: Forests bind the soil particles tightly in their roots and prevent soil erosion. They also act as wind breakers.

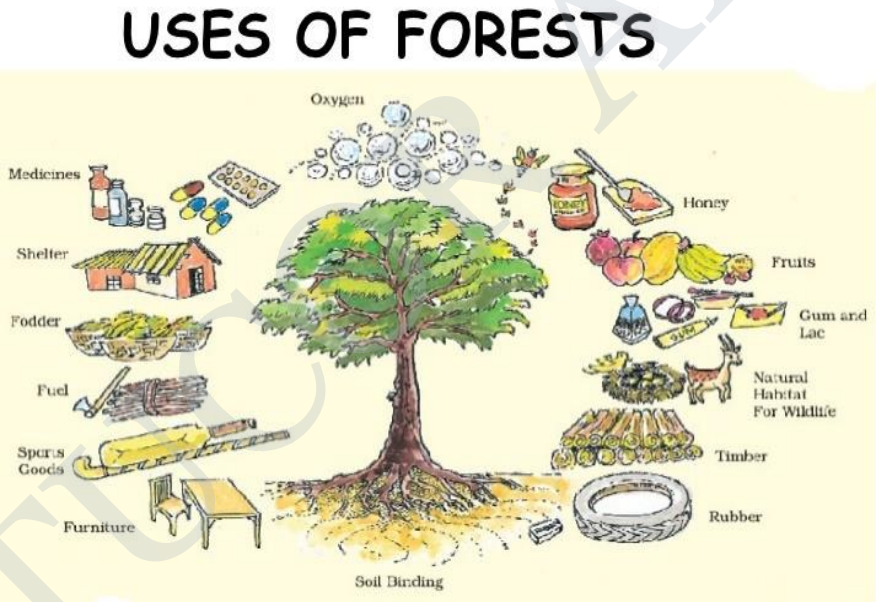
(v) Pollution moderators: Forests can absorb many toxic gases and can help in keeping the air pure and in preventing noise pollution.

Aesthetic values: Forests also have aesthetic values and serve as generates of important species. Ex;

1. Tribal utilize bamboo and wild grass for making other products like mats, baskets, cots etc.,
2. There are varieties of daily plants fruits, leaves, seeds, roots are used as food by tribal and poor people.
3. Many kinds of alcoholic drinks and medicines are derived.
4. Aromatic oils and other oils used for lighting and cooking, are also derived from forests.

Touristic value: Ecotourism provides a growing income for those who have facilitated it.

Uses of Forests:



Over Exploitation of Forests: Due to over-population the materials supplied by the forest like food, medicine, shelter, wood and fuel are not sufficient to meet the people's demand. Hence exploitation of forest materials is going to increasing day by day. Causes for over exploitations are.

Especially with growing civilization, the demand for raw materials like timber, pulp, minerals, fuel wood, etc., increases resulting in large scale logging, mining, building and cleaning forests.

The international timber trade alone is worth over US $ 40 billion per year.
The devastating effects of deforestation in India include soil, water and wind erosion, estimated to cost over 16,400 cores every year.


Effects of over exploitation:

1. Leads to migration of the *farmers.*
2. Environmental damage caused by *over exploitation.*
3. Tropical forests are destroyed at *very fast rate.*
4. Countless *plant species and animals* at very fast rate.
5. Marine pollution will go into extinction.
6. Dumping of wastes into *land, water and air* has become a severe problem.

Deforestation: It is the process of removal of forest resources due to many natural or man-made activities. In general deforestation means destruction of forests.

The total forests area of the world in 1900 was estimated to be 7,000 million hectares which was reduced to 2890 million ha in 1975 fell down to just 2,300 million ha by 2000. Deforestation rate is relatively less in temperature countries, but it is very alarming in tropical countries. Deforestation is a continuous process in India where about 1.3 hectares of forest land has been lost. The per capita availability of forest in India is 0.08 hectares per person which is much lower than the world average of 0.8 hectares. The presence of waste land is a sign of deforestation in India.

Causes of Deforestation: Major causes of deforestation are listed below:

1. Development projects
2. Shifting cultivation
3. Fuel requirements cutting and burning
4. Construction of dams
5. Growing food needs.
6. Forest fire


Consequences of deforestation: Some of the effects of deforestation are listed below:
a) Effect on climate: Global warming, Less rainfall, Hot climate etc.,

b) Effect on biodiversity: Loss of medicinal plants, Loss of timber and fuel wood.

c) Effect on resources: Loss of land resource, Loss of soil fertility, Soil erosion and Drastic changes in biogeochemical cycles

d) Effect on economy: Increase in medicinal values, Demand of industrial products etc.,

e) Effect on food: Loss of fruit production, Loss of root based foods.

Preventive measures or avoid of deforestation:

1. Planting of new trees.
2. Use of wood for fuel should be discouraged.
3. Forests pests can be controlled by spraying pesticides.
4. Forest fire must be controlled by modern techniques.
5. Over grazing by cattle must be controlled.
6. Steps should be taken by government to discourage the migration of people.
7. Education and awareness programmes must be conducted.
8. Strict implementation of law of forest conservation act.

Case Studies:
(i) Desertification in hilly regions of the Himalayas:
Desertification in Himalayas, involving clearance of natural forests and plantation of monocultures like Pinus roxburghi, Eucalyptus camadulensis etc., have upset the ecosystem by changing various soil and biological properties.
The area is invaded by exotic weeds. These areas are not able to recover and are losing their fertility.

(ii) Disappearing Tea gardens in Chhota Nagpur:

Following the destruction of forest rain fall declined in Chhota Nagpur to such an extent that tea-gardens also disappeared from the region.

(iii) Waning rain fall in Udhagamandalam:

The rainfall pattern was found to fluctuate with wooded land area in the hills. When the Nilgiri mountains had luxuriant forest cover annual rainfall used to be much higher.

TIMBER EXTRACTION: Logging for valuable timber such as teak and mahogany not only involves a few large trees per hectare but about a dozen more trees since they are strongly interlocked with each other by vines etc.

Uses: 1. Industries like pulp and paper, composite wood, furniture etc.,
2. Developmental activities like railways, boats, road construction etc.,

Effects:
1. Large scale timber extraction causes deforestation.
2. It is leads to soil erosion, loss of fertility, landslides, loss of biodiversity etc.,
3. It is also leads to loss of tribal culture and extinction of tribal people.
4. Thickness of forest also reduced.

Also road construction for making approach to the trees causes further damage to the forests.
In India, firewood demand would continue to rise in future mostly consumed in rural areas, where alternative sources of energy, are yet to reach.


MINING: It is the process of extracting minerals resources and fossil fuels like coal from the earth.
Types of mining: It is generally divided into two types.
1. Surface mining: shallow deposits.
2. Underground mining: deep deposits.
Steps involved in mining: It involves the following five steps.
Step 1: Exploration (investigation and searching of minerals)
Step 2: Development
Step 3: Exploitation (extraction of minerals)
Step 4: Ore processing (Separation of ores)
Step 5: Extraction and purification of minerals.

More than 80,000 ha of land of the country are presently under the stress of mining activities.

Effects of mining:
- ✓ Mining activity not only destroys trees, but also affects soil, water and air.
- ✓ Destruction of natural habitat.
- ✓ Due to continuous removal of minerals, forest covers, trenches are mixed with ground water.
- ✓ Vibration are developed, which leads to earthquake.
- ✓ When materials are disturbed in significant quantities during mining process.
- ✓ Noise pollution is another problem from mining operations.
- ✓ It also reduces the shape and size of the forest areas.
- ✓ Sometimes landslides may also occur.

- ✓ Migration of people from mining areas to other areas for searching land and food.
- ✓ Indiscriminate mining in Goa since 1961 has destroyed more than 50,000 ha of forest land.
- ✓ Mining of radioactive mineral in Kerala, Tamilnadu and Karnataka are posing similar threats of deforestation.

DAMS AND THEIR EFFECTS ON FORESTS AND TRIBAL PEOPLE:
Dams are the massive artificial structures built across the river to create a reservoir in order to store water for many beneficial purposes. However, it's also responsible for the destruction of vast areas of forest and displacement of local people.

India scenario: India has more than 1600 large dams.

States	Number of dams
Maharashtra	More than 600 dams
Gujarat	More than 250 dams
Madhya Pradesh	More than 130 dams

Tehri dam is the highest built across the river in the state of Uttaranchal.

Effects of dams:
- ✓ *Thousands of hectares* of forest have been cleared for executing river.
- ✓ The forest also cleared for residential accommodation, storing materials, laying roads etc.,
- ✓ *Hydroelectric projects* also have led to loss of forest.
- ✓ Construction of dams under these projects led to *killing of wild animals & aquatic life.*
- ✓ The big river valley projects also cause water logging which leads to *salinity and fertility of the land.*

Ex: 1. Narmada sagar project: (it has submerged 3.5 lakes hectares of forest in teak and bamboo trees).
2. Tehri dam: 1000 hectares of forest affecting about 430 species of plants.

Effects of dam on tribal people:

- ✓ Tribal people are ill-treated by modern society.
- ✓ Many of the displaced people were not recognized and resettled or compensated.
- ✓ Tribal people and their culture cannot be questioned and destroyed.
- ✓ Displacement and cultural change affects the tribal people for both mentally and physically.
- ✓ Tribal people will not suit with the new areas and hence they will be affected by many diseases.
- ✓ The greatest social cost of big dam is the widespread displacement of tribal people; such a biodiversity cannot be tolerated.

WATER RESOURCES: Water is an important component of all living beings. Nearly 80% of earth's surface is covered by water.

Ex: 1. A tree is made up of 60% by weight of water
2. Animals are made up of 50-65% of water

Forms of water: Water exists in three phases, solid, liquid and gas. It is circulated in accordance with the hydrological cycle.

1.9.2 Hydrological cycle

1. Evaporation
2. Precipitation
3. Transpiration

1. **Evaporation** : The transformation of water from liquid to gas phases as it moves from the ground or bodies of water into the overlying atmosphere. The source of energy for evaporation is primarily solar radiation. Evaporation often implicitly includes transpiration from plants, though together they are specifically referred to as evapotranspiration. Total annual evaporation amounts to approximately 505,000 km^3 (121,000 cu mi) of water, 434,000 km^3 (104,000 cu mi) of which evaporates from the oceans.

2. **Precipitation:** Condensed water vapor that falls to the Earth's surface .Most precipitation occurs as rain, but also includes snow, hail, fog drip, graupel, and sleet. Approximately 505,000 km^3 (121,000 cu mi) of water falls as precipitation each year, 398,000 km^3 (95,000 cu mi) of it over the oceans.

3. **Condensation:** The transformation of water vapor to liquid water droplets in the air, creating clouds and fog.

4. **Transpiration:** The release of water vapor from plants and soil into the air. Water vapor is a gas that cannot be seen.

Snowmelt :The runoff produced by melting snow.

Runoff : The variety of ways by which water moves across the land. This includes both surface runoff and channel runoff. As it flows, the water may seep into the ground, evaporate into the air, become stored in lakes or reservoirs, or be extracted for agricultural or other human uses.

Infiltration: The flow of water from the ground surface into the ground. Once infiltrated, the water becomes soil moisture or groundwater.

Subsurface Flow: The flow of water underground, in the vadose zone and aquifers. Subsurface water may return to the surface (e.g. as a spring or by being pumped) or eventually seep into the oceans. Water returns to the land surface at lower elevation than where it infiltrated, under the

force of gravity or gravity induced pressures. Groundwater tends to move slowly, and is replenished slowly, so it can remain in aquifers for thousands of years.

Sublimation: The state change directly from solid water (snow or ice) to water vapor.

Flow chart

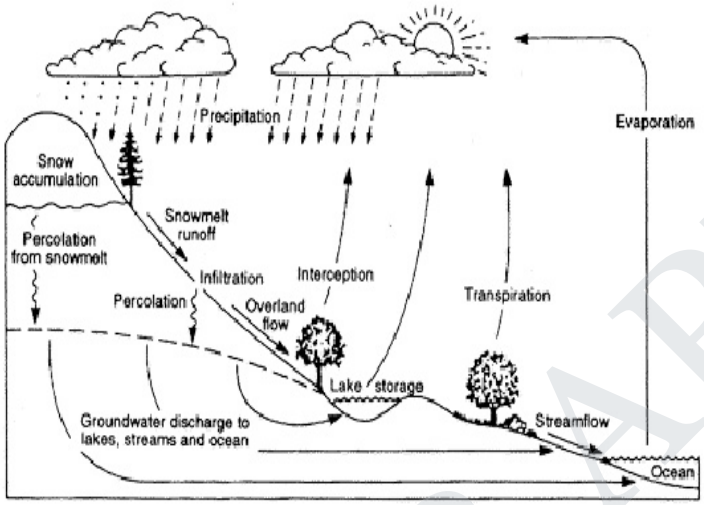


Fig. Water Cycle

Uses of water Resources-Different Types: (Mainly two types)

1. Consumptive Use: Water is completely utilized and is not reused: (in domestic application, industry and irrigation).
2. Non-Consumptive Use: Water is not completely utilized and is reused: (Hydro power plant).
3. Other important Use of Water:

(i) Mainly used for domestic purposes- drinking, cooking, washing, bathing etc.,
(ii) Due to its unique properties, water is of multiple uses for all living organisms.
(iii) Water is absolutely essential for life.
(iv) Most of the life processes take place in water contained in the body.
(v) Uptake of nutrients, their distribution in the body, regulation of temperature, and removal of wastes are all mediated through water.
(vi) Human beings depend on water for almost every developmental activity.
(vii) Water is used for drinking, irrigation, and transportation, washing and waste disposal for industries and used as a coolant for thermal power plants.
(viii) Water shaped the earth's surface and regulates our climate.

OVER UTILIZATION OF SURFACE AND GROUND WATER: With increasing human population and rapid development, the world water withdrawal demands have increased many folds and a large proportion of the water withdrawn is polluted due to anthropogenic activities.

Out of the total water reserves of the world, about 97% is salty water and only 3% is fresh water. Even this small fraction of fresh water is not available to us as most of it is locked up in polar ice caps and just 0.003% is readily available to us in the form of ground water and surface water.

Effects of over exploitation of water:

1. Decrease of Ground Water - Due to increased usage of ground water, the ground water level decreases.

Reason: a) The erratic and inadequate rainfall.

b) The building construction activities are sealing the permeable soil zone, reduce the area for percolation of rain water and increase in surface runoff.

2. Ground subsidence: When the ground water withdrawal is more than its recharge rate, the sediments in the aquifer get compacted, which results in sinking of overlaying land surface (Ground subsidence).

Problems:

1. Structural damage in buildings
2. Fracture in Pipes
3. Reversing the flow of canals and tidal flooding.
3. Lowering of water table: Over utilization of ground water disturb the hydrological cycle.
1. Lowering of water table
2. Decreased pressure in the aquifers and change in the speed and direction of water flow.
4. Intrusion of salt water: In coastal area, over exploitation of ground water would lead to rapid intrusion of salt water from the sea.

Problems: Water cannot be used for drinking and agriculture

5. Earthquake and landslides: Over utilization of ground water leads to decrease in water level, which cause earthquake, landslides and famine.

6. Earthquake and Landslides - As a result of over utilization of ground water, the level of ground water getting depleted.

7. Pollution of water - When ground water level near the agricultural land decrease. water containing the nitrogen as nitrate fertilizer, percolates rapidly into the ground and pollute the ground water.

Problems: Water becomes unsuitable for potable use by infants, when nitrate concentration exceeds 45 mgs/ lit**.**

FLOODS AND DROUGHT:

1. Heavy rainfall often causes floods in the low-lying coastal areas.
2. Prolonged downpour can also cause the over-flowing of lakes and rivers resulting into floods.
3. When annual rainfall is below normal and less than evaporation, drought conditions are created.

Fig. Drought

Causes of flood and drought:

(i) Deforestation, overgrazing, mining, rapid industrialization, global warming etc., have contributed largely to a sharp rise in the incidence of floods.

(ii) Deforestation leads to desertification and drought too. When the trees are cut, the soil is subject to erosion by heavy rains, winds and sun.

(iii) The removal of thin top layer of soil takes away the nutrients and the soil becomes useless. The eroded soils exhibit droughty tendency.

Preventive measures:

1. Clear knowledge in control of drought and desertification can be very useful for dealing with the problem.
2. Carefully selected mixed cropping helps to optimize production and minimize the risks of crop failures.
3. Social forestry and Wasteland development can prove quite effective to fight the problem, but it should be based on proper understanding of ecological requirement and natural process.

CONFLICTS OVER WATER: Indispensability of water and its unequal distribution has often led to inter-state or international disputes. Issues related to sharing of river water have been largely affecting our farmers and also shaking our governments. Many countries are engaged in bitter rivalries over this precious resource.

For instance,

(i) Argentina and Brazil, dispute each other's claims to the La Plata river,
(ii) India and Pakistan fight over the rights to water from the Indus,
(iii) Mexico and USA have come in conflict over the Colorado river,
(iv) India and Bangladesh are fighting for Bhrahmaputra river, and
(v) Iran and Iraq contest for the water from Shatt-Al- Arab River.

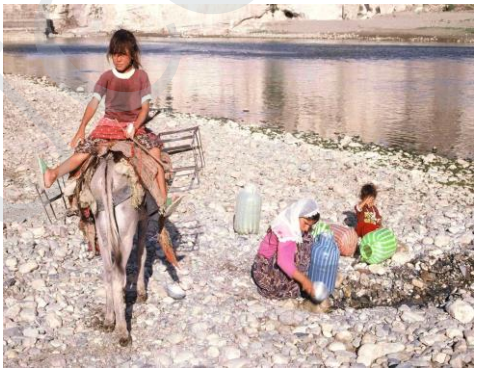


Fig. Conflicts of water

Within India, water conflicts are still being continues between the states.

For Eg.,

1. Sharing of Krishna water between Karnataka and Andhra Pradesh,
2. Sharing of Siruvani water between Tamilnadu and Kerala, and others.
3. Sharing of Cauvery between Karnataka and Tamilnadu
4. On June 2,1990, the Cauvery Water dispute Tribunal was set up which through an interim award directed Karnataka to ensure that 205 TMCF of water was made available in Tamil Nadu's Mettur dam every year, till a settlement was reached.

5. In 1991-1992 due to good monsoon, there was no dispute. In 1995, the situation turned into a crisis due to delayed rains and an expert Committee was set up to look into the matter which found that there was a complex cropping pattern in Cauvery basin.
6. Samba paddy in winter, Kuravai paddy in summer and some cash crops demanded intensive water; thus aggravating the water crisis.
7. Proper selection of crop varieties, optimum use of water, better rationing are suggested as some measures to solve the problem

1.13 BIG-DAMS –BENEFITS AND PROBLEMS

Dams are built across the river in order to store water for drinking, agricultural, industrial purpose. Now days they are mainly used for the hydropower production.

Benefits:

1. Dams are built to control flood and store flood water.
2. Used for diverting the water from river into a channel.
3. Used mainly for drinking and agricultural purposes.
4. Dams are built for generating electricity.
5. Dams are used for recreational purposes
6. Navigation and fishery can be developed in the dam area.

Problems: Problems of constructing dams:

Upstream problems:

- Displacement of tribal people.
- Loss of non-forest land.
- Loss of forests, flora and fauna.
- Landslips, sedimentation and siltation occurs.
- Stagnation and water logging around reservoirs retards plant growth.
- Breeding of vectors and spread of vector-borne diseases.
- Reservoir induced seismicity causes earthquakes.
- Navigation and aquaculture activities can be developed in the dam area.

Downstream problems:

- ✓ Water logging and salinity due to over irrigation.
- ✓ Reduce water flow and slit deposition in rivers.
- ✓ Salt water intrusion at river mouth.
- ✓ Sediments carrying nutrients get deposited in the reservoir, the fertility of the land along the river gets reduced.
- ✓ Due to structural defects the dam may collapse suddenly and destroy many living organisms.
- ✓ Salt water intrusion at river mouth.

MINERAL RESOURCES: Minerals are naturally occurring substances with definite chemical and physical properties.

Formation of mineral deposits: ‘Concentration of minerals at a particular spot, which can be extracted profitably, gives rise to a mineral deposit. Formation of these deposits is a very slow biological process-it takes millions of years.

Various Biological Processes

- ✓ Minerals formed, due to the biological decomposition of dead animals and organic matters

- ✓ Minerals formed, due to the concentration of minerals during cooling of molten rock.
- ✓ Formed due to evaporation of sea water
- ✓ Formed due to oxidation-Reduction reaction inside the earth
- ✓ Minerals also formed, due to concentration of minerals during weathering, transport and sedimentation.

Classification of Mineral Resources:

1. Identified Resources - The location, existence, quantity and quality of these mineral resources are known by direct geological evidences and measurements.
2. Undiscovered Resources - To exist on the basis of geological knowledge and theory but their specific locations, quantity, and quality are unknown
3. Reserves-identified resources - From which a usable minerals can be extracted profitably.

Uses of minerals:

- Development of industrial plants and machinery – *Fe, Al, Cu* etc.,
- Construction, housing, settlements - *Fe, Al, Ni* etc.,
- Generation of energy - Coal, Lignite, Uranium etc.,
- Designing defence equipments, weapons, ornaments.
- Agricultural purposes, as fertilizers, seed dressings and fungicides - Ex: zineb (Zn), Maneb (Mn)
- Jewellery - Au, Ag, Pt, and Diamond.
- Making of alloys for various purposes - Phosphorites.
- Communication purposes - Telephone wires, cables, electronic devices.
- Medicinal purposes (Ayurvedic) - Sulphur pyrites.

Table 1 Distribution and uses of major reserves and metals

Metals	Major world reserves	Major uses
Aluminum	Australia, Jamaica	Packing food items, transportation, utensils, electronics
Chromium	CIS(The common wealth of Independent states), South Africa	For making high strength steel alloys, in textiles and tanning industries
Copper	U.S.A, Canada, CIS	Electronic and electrical goods, building, construction, vessels
Iron	CIS, Canada, U.S.A	Heavy machinery, steel production transportation means.
Manganese	South Africa, CIS	For making high strength heat resistant steel alloys
Platinum	South Africa, CIS	Use in automobiles, catalytic converters, electronics, medical uses.
Gold	South Africa, CIS, Canada	Ornaments, medical use, electronic use, in aerospace

Silver	Canada, South Africa	Photography, electronic jewellery.
Nickel	CIS, Canada	Chemical industry, steel alloys

Table 2 Major uses of some of the nonmetallic minerals

Non-metal mineral	Major uses
Silicate minerals	Sand and grovel for construction, bricks, paving etc.
Limestone	Used for concrete, building stone, used in agriculture for neutralizing acid soils, used in cement industry
Gypsum	Used in plaster wall-board, in agriculture
Potash, phosphorite	Used as fertilizers
Sulphur pyrites	Used in medicine, car battery, industry

Environmental impacts of mineral extraction:
Mining: 'Mining is the process of extraction of metals from a mineral deposits'
Types of Mining:

1. Surface Mining: Process of extraction of raw materials from the near-surface deposits.
2. Underground Mining: Process of extraction of raw materials below the earth's surface.

Open-pit Mining - Machines dig holes and remove the ores. Ex: Fe, Cu, Limestone, sand stone, marble etc.,
Dredging: Chained buckets and draglines used, which scrap up the minerals from under water mineral deposit.
Strip Mining: the ore is stripped off by using bulldozers, stripping wheels.
Environmental Damage: - (Caused by Mining activities)

1. Devegetation and defacing of landscape
2. Groundwater contamination
3. Underground Mining
4. Surface water pollution
5. Air pollution
6. Subsidence of land
7. Occupational Health Hazards:

Effects of over exploitation of mineral resources:

1. Rapid depletion of mineral deposits
2. Wastage and dissemination of mineral deposits
3. Causes environmental pollution

Remedial measures:

1. Adopting eco-friendly mining technology
2. Utilization of low grade ores by using microbial – leaching technique. In this method, the ores are inoculated with the desired strains of bacteria like Thiobacillus ferroxidans, which remove the impurities and leave the pure mineral.
3. Re-vegetating mined areas with appropriate plants
4. Gradual restoration of flora
5. Prevention of toxic drainage discharge.
6. Modernization of the mining industries

7. Search for new deposit
8. Reuse and Recycling of the metals

Case studies:

1. Mining and quarrying in Udaipur:

Soap stones, building stone, and dolomite mines spread over 15,000 hectares in Udaipur have caused many adverse impacts on environment. About 150 tons of explosives are used per month in blasting. The Maton mines have badly polluted the Ahar river. The hills around the mines are suffering from acute soil erosion.

The waste water flows towards a big tank of "Bag Dara".

Due to scarcity of water people are compelled to use this effluent for irrigation purpose.

The animals like tiger, lion, deer, and birds have disappeared from the mining area.

2. Mining in Sariska and Tiger Reserve in Aravallis:

The Aravalli range is spread over about 692 Km in the North-west India covering Gujrat, Rajasthan, Haryana, and Delhi. The hill is rich in mineral resources. Mining operations within and around the Sariska Tiger reserve has left many areas permanently infertile and barren.

The precious wild life is under serious threat.

FOOD RESOURCES: Food is an essential requirement for survival of life. Main components are carbohydrates, fats, proteins, minerals and vitamins.

1. Croplands: Produces Grains and provides 76% of the earth's food. (Rice, wheat, maize, barley, sugarcane, potato, etc.,)

2. Rangelands: From the grazing livestock and provides 17% of the world's food. (Meat, Milk, fruits etc.,)

3. Oceans: Oceanic fisheries supply about 7% of the world's food. (Fish, prawn, crab)

Major food sources:

- ✓ Earth is provided with more than thousands of edible plants and animals.
- ✓ Only 15 plants and 8 terrestrial animal species supply 90% of our global intake of calories.

Ex: Rice, wheat, maize, barley, sugarcane, potato, pulses, fruits, vegetables, milk, meat, fish and sea food. Rice, wheat and maize are the major grains, provide more than 50% of the calories people consume.

World Food Problems:

1. Arises due the would population increases and cultivable land area decreases.
2. Environmental degradation like soil erosion, water logging, water pollution, salinity, affect agricultural lands.
3. Urbanization-deteriorates the affect agricultural lands.
4. Food grains are the major food for the people all over the world, the food problem raises.

5. Human activity-which degrade most of the earth's net primary productivity which supports all life.
Effects:
1. Every 40 million people die of undernourishment and malnutrition.
2. This means that every year our food problem is killing as many people as were killed by the atomic bomb dropped on Hiroshima during World War II.
3. This statistic emphasizes the need to increase our food production, and also to control population growth.
4. It is estimated that 300 million are still undernourished.

Under nutrition and Malnutrition:

1. Nutrition or nourished: The minimum calorie intake on a global scale-2,500 calories/ day.
2. Under nutrition or under nourished: People who cannot buy enough food to meet their basic energy needs suffer from under nutrition. They receive less than 90% of these minimum dietary calories. Effects- Mental retardation and infectious diseases such as measeles and diarrohea.
3. Malnutrition or malnourished - Deficiency or lack of nutrition often leads to malnutrition resulting in several diseases. Growth, Anemia, Goitre, Cretinism, Blindness etc.,

Impacts of overgrazing and agriculture

Overgrazing: Overgrazing can limit livestock production. Over grazing occurs when too many animals graze for too long and exceed the carrying capacity of a grass land area.

Impact of overgrazing

1. Land degradation: Overgrazing removes the grass cover. The humus content of the soil is decreased and it leads to poor, dry, compacted soil.
2. Soil erosion: The soil roots are very good binders of soil. When the grasses are removed, the soil becomes loose and susceptible to the action of wind and water.
3. Loss of useful species: Due to overgrazing the nutritious species like cenchrus, panicum etc. are replaced by thorny plants like Parthenium, Xanthium etc. These species do not have a good capacity of binding the soil particles and, therefore, the soil becomes more prone to soil erosion.

Agriculture: 'Agriculture is an art, science and industry of managing the growth of plants and animals for human use'. It includes cultivation of the soil, growing and harvesting crops, breeding and raising livestock, dairying and forestry.

Types of Agriculture:
1. Traditional agriculture
2. Modern or Industrialized agriculture

Traditional Agriculture: It involves a small plot, simple tools, surface water, organic fertilizers and a mix of crops. They produce enough food to feed their families and to sell it for their income.
Effects or Impacts of traditional agriculture:

a) Deforestation: cutting and burning of trees
b) Soil erosion: clearing of forest cover exposes the soil to wind and rainfall.
c) Loss of nutrients: organic matter in the soil gets destroyed and most of the nutrients are taken up by the crops within a short period. Thus soil becomes poor in nutrient, which makes the farmers shift to another area.
Modern Agriculture: It makes use of hybrid seeds of single crop variety, high-tech equipment's, lot of fertilizers, pesticides, and water to produce large amount of single crops.
Effects or Impacts of Modern agriculture:
1. Problems in using fertilizer:
- ✓ Micronutrient imbalance: (excess N, P, K-causes micronutrient imbalance).
- ✓ Blue baby syndrome: (Nitrate exceeds 25 mg/lit, it causes serious health problem).
- ✓ Eutrophication: (A large Proportion of N & P fertilizer used in crop yield, is washed off by the run off) (affect the aquatic life).

2. Problems in using Pesticides:
First generation pesticides (As, S, Pb, Hg)
Second generation pesticides (DDT)
(i) Death of non-Target organisms
(ii) Bio-magnification (Non bio-degradable-harmful to the human beings).
(iii) Risk of cancer
3. Desired quality of an ideal pesticide:
1. Kill only the target species
2. It must be a bio-degradable
3. It's should not produce new pests
4. It's should not produce any toxic pesticide vapors.
5. Excessive synthetic pesticide should not be used.
6. Chlorinated or Organophosphate pesticides are hazardous-should not be used.

4. Water logging: 'Is the land where water stand for most of the year'.
Problems: Mechanical strength of the soil decrease sand crop yield falls.
Causes: Excessive water supply to the croplands, Heavy rain, Poor drainage
Remedy: Preventing excessive irrigation, Sub-surface drainage technology and bio-drainage by trees like Eucalyptus
5. Salinity: (pH of the water-exceeds 8.0): The water, not absorbed by the soil, undergo evaporation leaving behind a thin layer of dissolved salts in the topsoil. This process of accumulation of salts is called salinity of the soil ($NaCl$, $CaCl_2$, $MgCl_2$, Na_2SO_4, Na_2CO_3, $NaHCO_3$).
Problems: Due to salinity, the soil becomes alkaline and crop yield decreases.
Remedy: The salt deposit is removed by flushing, Sub-surface drainage system the salt water is flushed out slowly.

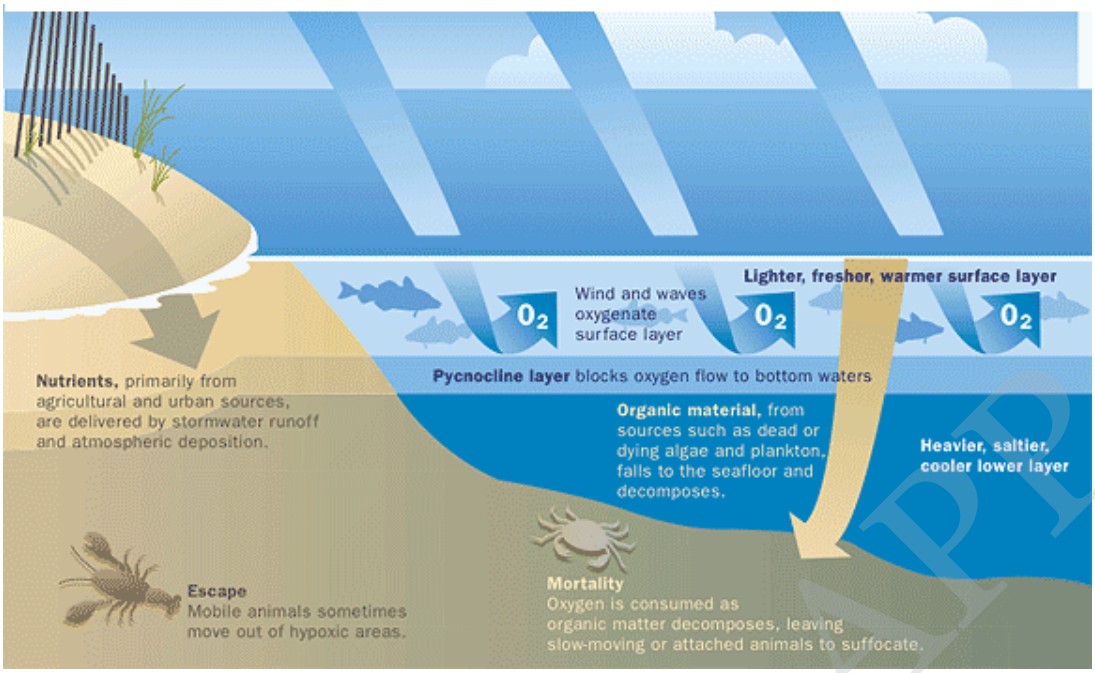


Fig. Eutrophication

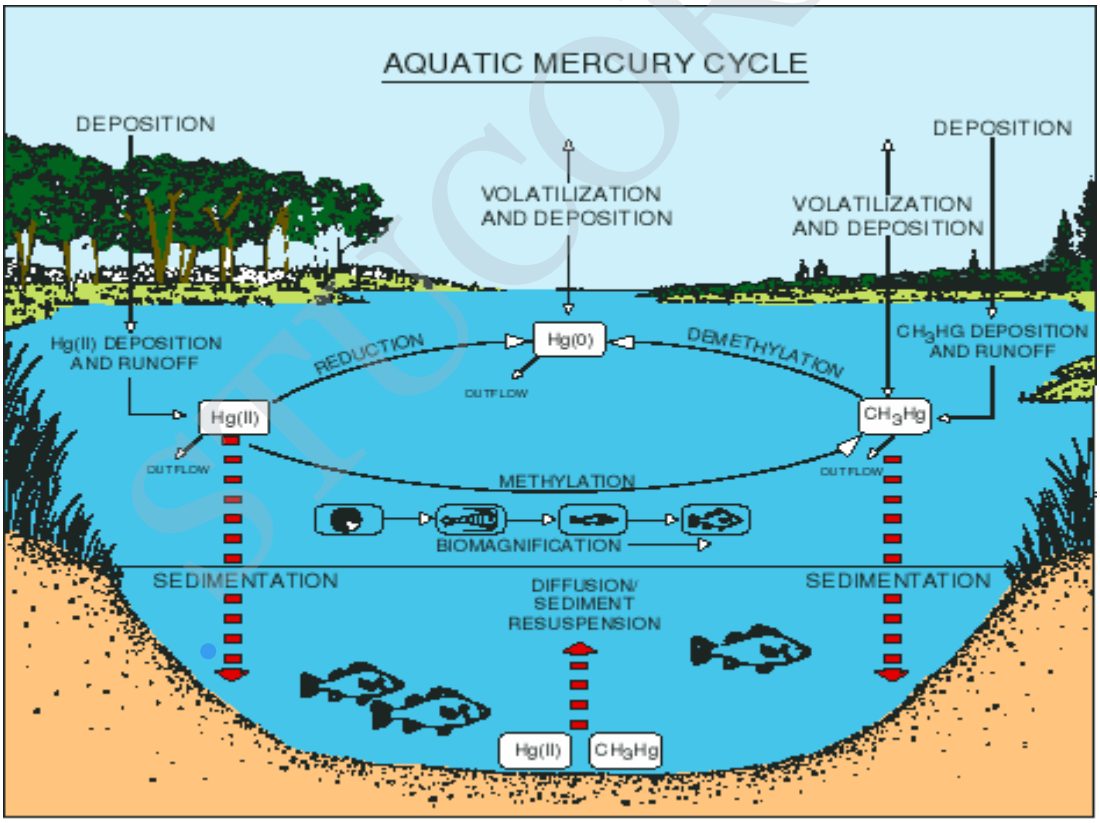


Fig. Biomagnification

Case studies:
1. Salinity and water logging in Punjab, Haryana and Rajasthan:
The first alarming report of salt-affected wasteland formation due to irrigation practices came from Haryana in 1858.
2. Several villages in Panipat, and Delhi lying in Western Yamuna Canal were suffering from salinity problems.
3. The floods of 1947, 1950, 1952, 1954-55 in Punjab resulted in aggravated water logging with serious drainage problems.
4. Rajasthan too has suffered badly in this regard following the biggest irrigation project "Indhra Gandhi Canal Project".

ENERGY RESOURCES:
Definition: Energy may be defined as, "any property, which can be converted into work."
(or)
Energy is defined as, "the capacity to do work."

Forms of energy, some of immediately used to do work; others require some process of transformation. Life is unthinkable without energy.
All the developmental activities in the world are directly or indirectly dependent upon energy.
Energy production and energy utilization are the indicators of a country's progress.

Development of energy:
1. The first form of energy is the fire.
2. The early man discovered fire and used it for cooking and heating purposes
3. Wood is the main source of energy, which is later replaced by coal.
4. Coal is now being replaced by the oil and gas.
5. Now due to insufficient availability and price hike, people started of thinking and using several alternative sources of energy.

Wood → coal → oil → alternate energy (solar, wind, tidal energy)

Growing energy Needs:
(i) Energy is essential to all human societies.
(ii) All industrial process like, mining, transport, living, heating and cooling in buildings, all require energy.
(iii) With the demands of growing population, the world is facing further energy deficit,
Our life style is also changing from al simple way of life to luxurious life style. At present 95% of the commercial energy is available only from the fossil fuels like coal, oil and natural gas, and are not going to last for many years. It would be really ironic if fuel becomes more expensive than food.

Energy Distribution –World Scenario
U.S.A and Canada 5% of the world's population- consume 25% of the available world's energy resources.
It has been observed, that in U.S.A and Canada an average person consumes 300 GJ (Giga Joules; equal to 60 barrels of oil) per year.

But in poor countries like Bhutan, Nepal and Ethiopia, an average person consumes less than 1 GJ per year. So a person in a developed country consumes almost as much energy in a single day as one person consumes in a whole year in a poor country. From the above scenario it is clear that our life style and standard of living are closely related to energy needs.

1. Renewable energy resources (or) non-conventional energy resources:

Natural resources can be regenerated continuously and are inexhaustible. They can be used again and again in an endless manner.

Example: Wood, solar energy, wind energy, hydropower energy, etc.,

Merits of renewable energy resources:

1. Unlimited supply.
2. Provides energy security.
3. Fits into sustainable development concept.
4. Reliable and the devices are modular in size.
5. Decentralized energy production.

2. Non- Renewable energy resources (or) Conventional energy resources:

Natural resources which cannot be regenerated once they are exhausted. They cannot be used again.

Example: Coal, petroleum, natural gas, and nuclear fuels.

Even our renewable resources can become non-renewable if we exploit them to such extent their rate of consumption exceeds their rate of regeneration.

Wood is renewable resources but not coal-why?

Wood is renewable resources because we can get new wood by growing sapling into a tree within 15-20 years. But the formation of coal from trees has taken millions of years and cannot be regenerated in our life time.

RENEWABLE ENERGY RESOURCES: Renewable resources are parts of our natural environment and form our eco-system

1. SOLAR ENERGY:

The energy that we get directly from the sun is called solar energy.

The nuclear fusion reactions occurring inside the sun release enormous amount of energy in the form of heat and light.

The solar energy received by the near earth space is approximately1.4 kJ/s/m^2 known as solar constant.

Methods of Harvesting Solar Energy:

(i) Solar cells (or) photovoltaic cells (or) PV cells:

Solar cells consist of a p-type semiconductor (such as Si doped with B) and n-type semi-conductor (Si doped with P). They are in close contact with each other. When the solar rays fall on the top layer of p-type semi-conductor, the electrons from the valence band get promoted to the conduction band and cross the p-n junction into n-type semi-conductor.

There by potential difference between two layers is created, which causes flow of electrons (ie.,an electric current)

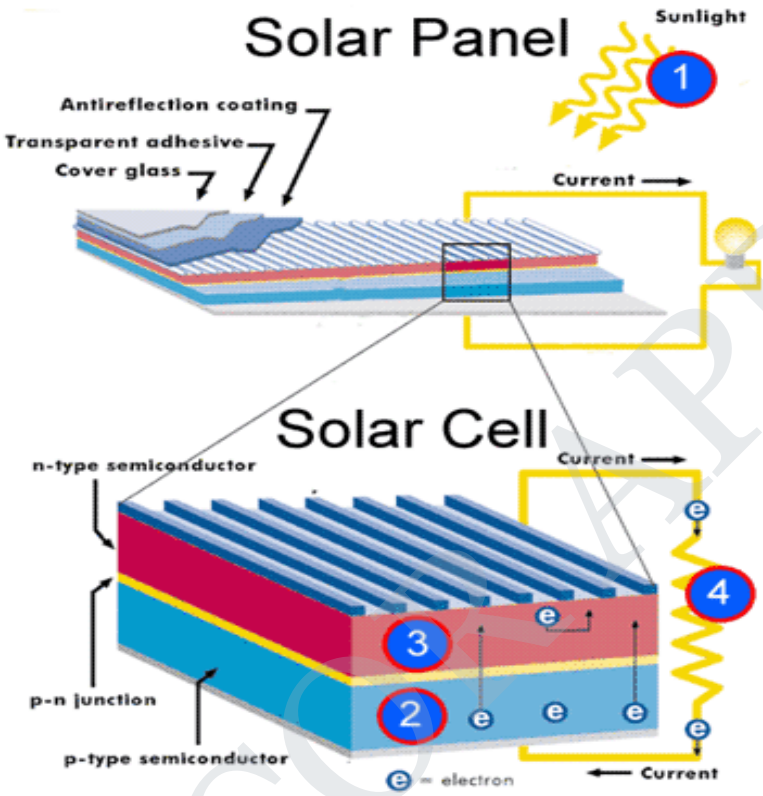


Fig. Solar cell

Uses:
Used in calculators, electronic watches. Street lights, water pumps to run radios and TVs.

(ii) Solar Battery: When a large number of solar cells are connected in series it forms a solar battery. Solar battery produces more electricity which is enough to run water pump, to run street-light, etc., They are used in remote areas where conventional electricity supply is a problem.

(iii) Solar heat collectors: Solar heat collectors consist of natural materials like stones, bricks, (or) materials like glass, which can absorb heat during the day time and release it slowly at night.

Uses:
Used in cold places, where houses are kept in hot condition using solar heat collectors.

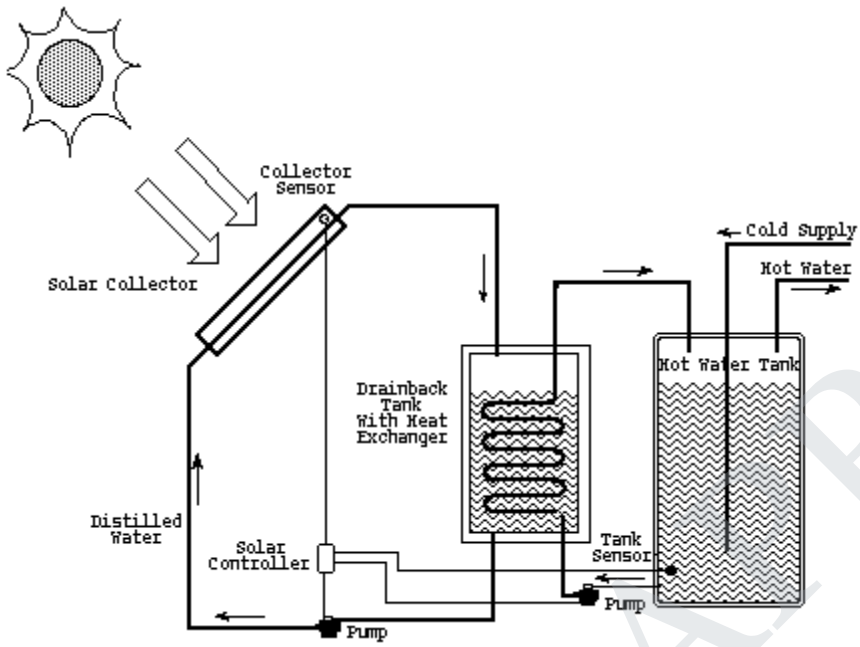


Fig. Solar heat collector

(iv) Solar water heater: It consists of an insulated box inside of which is painted with black paint. Provided with a glass lid to receive and store solar heat. Inside the box it has black painted copper coil, through which cold water is allowed to flow in, which gets heated up and flows out into a storage tank. From the storage tank water is then supplied through pipes.

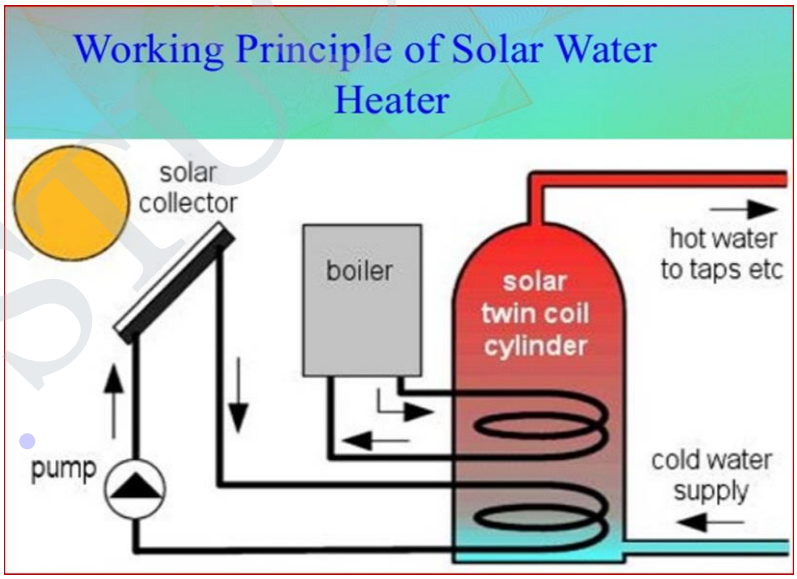


Fig. Solar water heater

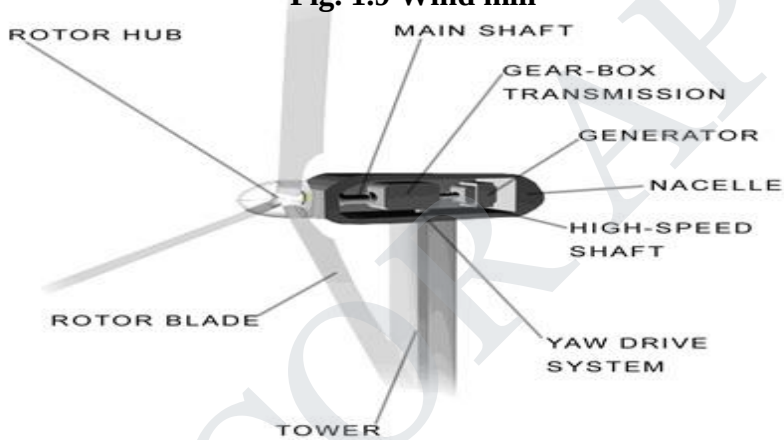
2. WIND ENERGY:

Definition: Moving air is called wind. Energy recovered from the force of the wind is called wind energy. The energy possessed by wind is because of its high speed. The wind energy is harnessed by making use of wind mills.

Harvesting of wind energy:

(i) Wind Mills: The strike of blowing wind on the blades of the wind mill makes it rotating continuously. The rotational motion of the blade drives a number of machines like water pump, flour mills and electric generators.

Fig. 1.9 Wind mill



(ii) Wind farms: When a large number of wind mills are installed and joined together in a definite pattern it forms a wind farm. The wind farms produce a large amount of electricity.

Conditions:

The minimum speed required for satisfactory working of a wind generator is 15 km/hr.

Advantages:

It does not cause any air pollution

It is very cheap.

3. OCEAN ENERGY:

It can be generated by following ways.

(i) Tidal energy (or) Tidal power: Ocean tides, produced by gravitational forces of sun and moon, contain enormous amount of energy. The "high tide" and "low tide" refer to the rise and fall of water in the oceans. The tidal energy can be harnessed by constructing a tidal barrage.

During high tide, the sea-water is allowed to flow into the reservoir of the barrage and rotates the turbine, which intern produces electricity by rotating the generators.

During low tide, when the sea level is low, the sea water stored in the barrage reservoir is allowed to flow into the sea and again rotates the turbine.

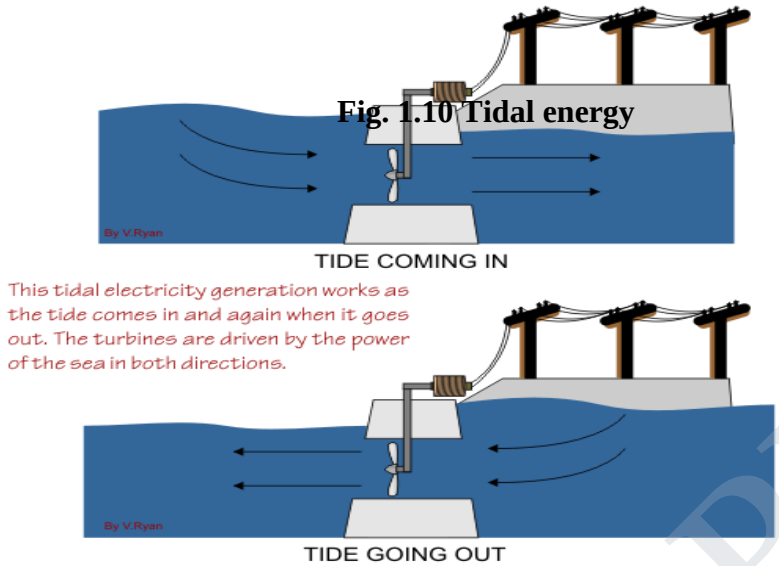


Fig. 1.10 Tidal energy

Significance of Tidal energy:

- ✓ Tidal power plants do not require large areas.
- ✓ As the sea water is inexhaustible, it is completely independent of the uncertainty of precipitation.
- ✓ It is pollution free energy sources, it does not use any energy fuel and also produced any wastes.

(ii) Ocean thermal energy (OTE): There is often large temperature difference between the surface level and deeper level of the tropical oceans. This temperature difference can be utilized to generate electricity. The energy available due to the difference in temperature of water is called ocean thermal energy.

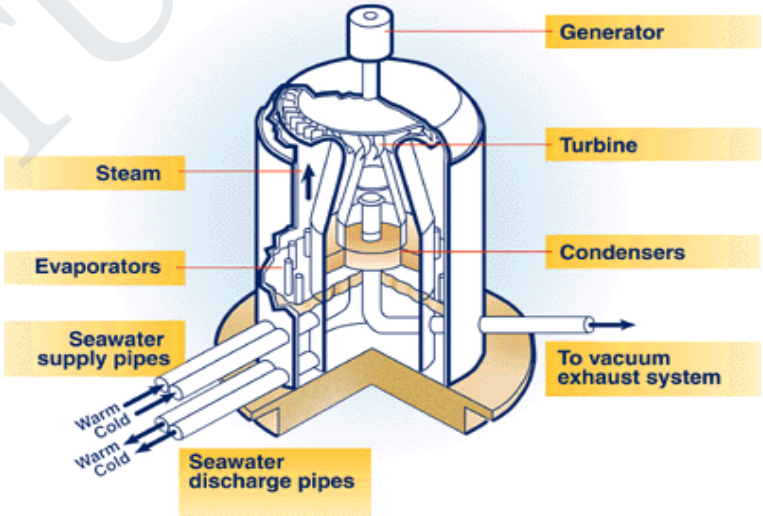


Fig. Ocean thermal energy

Condition:

The temperature difference should be of 20^0C or more is required between surface water and deeper water.

Process:

The warm surface water of ocean is used to boil a low boiling liquid like ammonia.

The high vapour pressure of the liquid, formed by boiling is then to turn the turbine of the generator and generates electricity.

The cold water from the deeper ocean is pumped to cool and condense the vapour into liquid.

Significance:

- ✓ OTE is continuous, renewable and pollution free.
- ✓ The use of cold deep water, as the chiller fluid in AC.
- ✓ Electric power generator by OTE can be used to produce hydrogen.

(iii) Geo-thermal Energy:

1. Temperature of the earth increases at a rate of 20-75^0C per km, when we move down the earth surface.
2. High temperature and high pressure steam fields exists below the earth's surface in many places.
3. The energy harnessed from the high temperature present inside the earth is called geothermal energy.

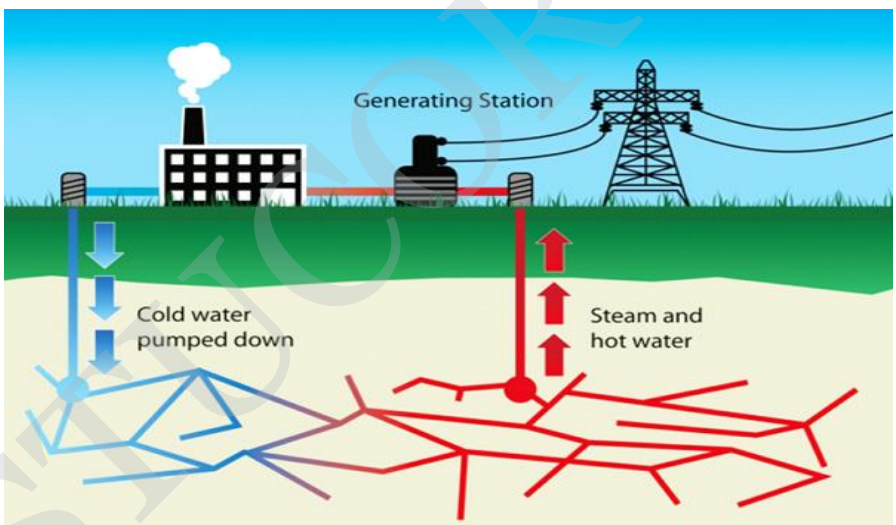


Fig. Geothermal energy

a) Natural geysers:

In some places, the hot water (or) steam comes out of the ground through cracks naturally in the form

b) Artificial geysers:

In some places, we can artificially drill a hole up to the hot region and by sending a pipe in it, we can make the hot water or steam to rush out through the pipe with very high pressure. Thus, the hot water (or) steam coming out from the natural (or) artificial geysers is allowed to rotate the turbine of a generator to produce electricity.

BIOMASS ENERGY: Biomass is the organic matter, produced by plants or animals, used as sources of energy. Most of the biomass is burned directly for heating, cooling and industrial purposes. Eg: Wood, crop residues, seeds, cattle dung, sewage, agricultural wastes.

Biogas: Mixture of methane, carbondioxide, hydrogen sulphide, etc., It contains about 65% of methane gas as a major constituent

Biogas is obtained by the anaerobic fermentation of animal dung or plant wastes in the presence of water.

(i) **Bio fuels:**

Biofuels are the fuels, obtained by the fermentation of biomass. Eg: Ethanol, Methanol

(a) Ethanol:

Ethanol can be easily produced from the sugarcane. Its calorific value is less when compared to petrol, and produces much less heat than petrol.

(b) Methanol:

Methanol can be easily obtained from ethanol or sugar-containing plants.

Its calorific value is also too low when compared to gasoline and diesel. **(c) Gasohol:**

Gasohol is a mixture of ethanol+gasoline.

In India trial is being carried out to use Gasohol in cars and buses.

i. Gasohol is common fuel in Brazil and Zimbabwe for running cars and buses.

ii. Methanol is very useful since it burns at a lower temperature than gasoline or diesel. Due to its high calorific value, hydrogen can serve as an excellent fuel.

iii. Moreover it is non-polluting and can be easily produced.

iv. Presently H_2 is used in the form of liquid hydrogen as a fuel in spaceships.

(ii) Hydrogen Fuel: Hydrogen can be produced by thermal dissociation or photolysis or electrolysis of water. It possesses high calorific value, it is non-polluting, because the combustion product is water.

$$2H_2 + O_2 \text{ ----> } 2H_2O + 150KJ$$

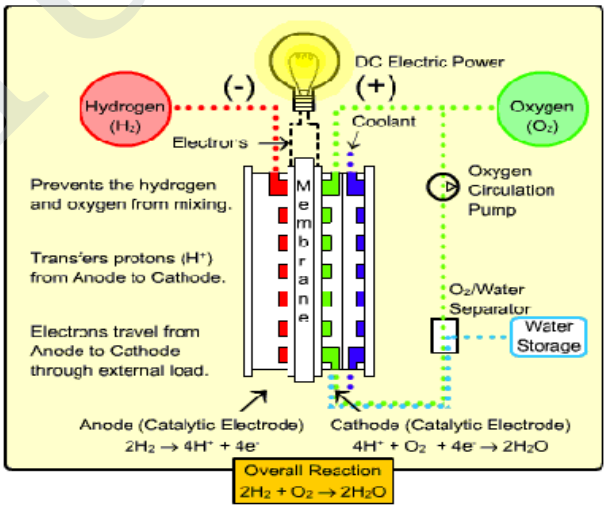


Fig. Hydrogen fuel cell

Disadvantages of hydrogen fuel:
1. Hydrogen is highly inflammable and explosive in nature
2. Safe handling is required
3. It is difficult to store and transport.

NON-RENEABLE ENERGY SOURCES:
1. Coal: Coal is a solid fossil fuel formed in several stages as buried remains of land plants that lived 300-400 million years ago were subjected to intense heat and pressure over millions of years.
Various stages of coal
Wood ⟶ Peat ⟶ Lignite ⟶ Bituminous coal ⟶ Anthracite

1. The carbon content of Anthracite is 90% and its calorific value is 8700 k.cal.
2. The carbon content of bituminous, lignite and peat are 80, 70 and 60% respectively
3. India has about 5% of world's coal. Indian coal is not good because of poor heat capacity.

Disadvantages
1. When coal is burnt it produces CO_2 causes global warming
2. Since coal contains impurities like S and N, it produces toxic gases during burning.

2. Petroleum: Petroleum or crude oil = hydrocarbons +small amount S, O, N.
Occurrence
The fossil fuel formed by the decomposition of dead animals and plants that were buried under lake and ocean at high temperature and pressure for million years
Fractional distillation
Hydrocarbons are separated by fractioning the crude oil.
Petroleum World Scenario
1. 67% oil reserves.
2. 25% of the oil reserves in Saudi Arabia.

At the present rate of usage, the world's crude oil reserves are expected to get exhausted in just 40 years.

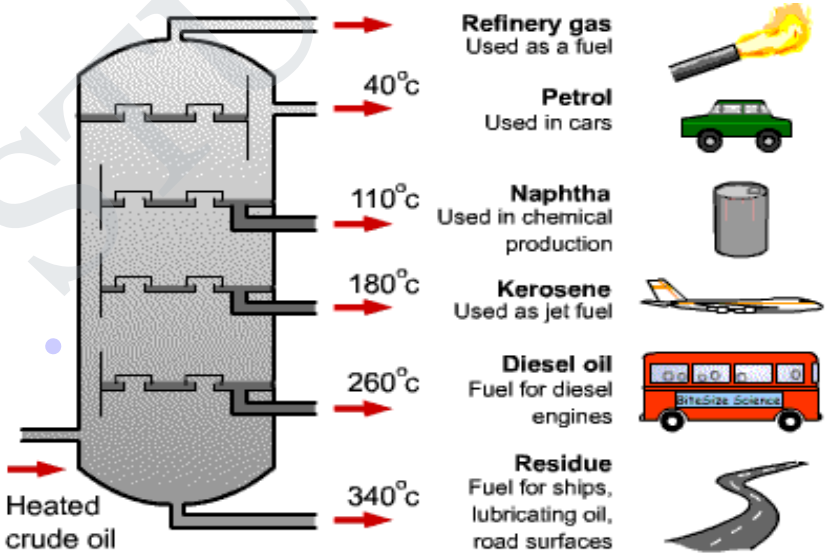


Fig. Fractionating column

3. LPG (Liquefied Petroleum Gas):

1. The petroleum gas, converted into liquid under high pressure as LPG
2. LPG is colorless and odorless gas.
3. During bottling some mercaptans is added, to detect leakage of LPG from the cylinder.

4. Natural Gas:

1. Mixture of 50-90% methane and small amount of other hydrocarbons.
2. Its calorific value ranges from 12,000-14,000 k-cal/$m^{3.}$

(i) Dry gas: If the natural gas contains lower hydrocarbons like methane and ethane, it is called dry gas.

(ii)Wet gas: If the natural gas contains higher hydrocarbons like propane, butane along with methane it is called wet gas.

Occurrence: Formed by the decomposition of dead animals and plants, those were buried under lake and ocean, at high temperature and pressure for millions of years.

5. **NUCLEAR ENERGY:**

Dr. H. Bhabha –father. India has 10 nuclear reactors, which produce 2% of India's electricity.

(i) Nuclear Fission: Heavier nucleus is split into lighter nuclei, on bombardment by fast moving neutrons, and a large amount of energy is released.

Eg: Fission of U^{235} When U^{235} nucleus is hit by a thermal neutron, it undergoes the following reaction with the release of 3 neutrons.

$$U_{92}^{235} + n^1_0 \rightarrow Ba^{139}_{56} + Kr^{94}_{36} + 3n^1_0 + \text{Energy}$$

Each of the above 3 neutrons strikes another U^{235} nucleus causing (3x3) 9 subsequent reactions. These 9 reactions further give rise to (3x9) 27 reactions.

This process of propagation of the reaction by multiplication in threes at each fission is called chain reaction:

Fission reaction of U^{235} is given below.

$$_{92}U^{235} + {}_0n1 \rightarrow {}_{36}Kr^{92} + {}_{56}Ba^{141} + 3\ {}_0n^1 + \text{energy}$$

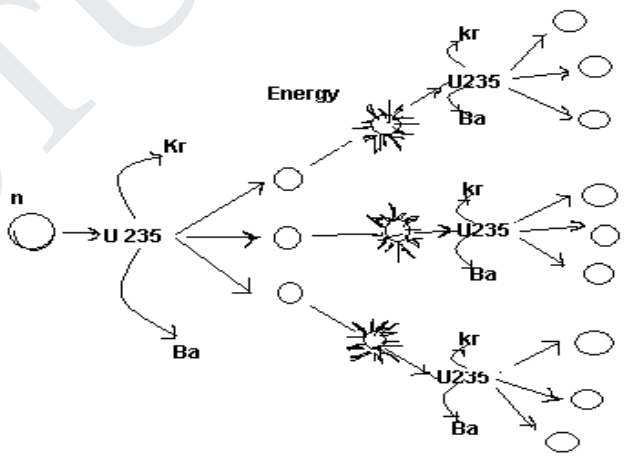


Fig. Nuclear fission-chain reaction

(ii) Nuclear fusion:

Lighter nucleuses are combined together at extremely high temperatures to form heavier nucleus and a large amount of energy is released.

Eg: Fusion of H^2, Two hydrogen-2 (Deuterium) atoms may fuse to form helium at 1 billion ^0C with the release of large amount of energy

$$_1H^2 + _1H^2 \rightarrow _3He^2 + _0n^1 + \text{energy}$$

Nuclear power of India:

Tarapur(Maharashtra),
Ranapratap Sagar (Rajasthan)
Kalpakkam (Tamilnadu)
Narora (U.P).

USES OF ALTERNATE (RENEWABLE) ENERGY SOURCES:

1. Why Alternate (Renewable) Energy Sources are required?

The importance of solar energy can be emphasized particularly in view of the fact that fossil fuels and other conventional sources are not free from environmental implications.

2. least pollution, safety and security snags and are universally available have the best enhance of large scale utilization in future

3. Hydro-electric power generation is expected to upset the ecological balance existing on earth Besides space heating, hydel power plants critically pollute the aquatic and terrestrial biota.

4. Radioactive pollutants released from nuclear power plants are chronically hazardous.

The commissioning of boiling water power reactors (BWRS) have resulted in the critical accumulation of large number of long lived radionuclides in water. The dangerous radiowaste cannot be buried in land without the risk of polluting soil and underground water.

5. The burning of coal, oil, wood, dung cakes and petroleum products has well debated environmental problems. The smoke so produced causes respiratory and digestive problems leading to lungs, stomach and eye diseases.

6. The disposal of fly ash requires large ash ponds and may pose a severe problem considering the limited availability of land. Thus the non-conventional sources of energy are needed.

Objectives:

To provide more energy to meet the requirements of increasing population.
To reduce environmental pollution
To reduce safety and security risks associated with the use of nuclear energy.

LAND RESOURCES: It provides food, fibre, wood, medicine and other biological materials Soil is the mixture of inorganic materials (rocks and minerals) and organic materials (dead animals and plants).

Top soil is classified as renewable resources.

Uses of land resources:

1. Land provide, food, wood, minerals, etc., for us
2. Land nurtures the plants and animals that provide our food and shelter.
3. Land is used as watershed or reservoir
4. Land acts as a dust bin for most of the wastes, created by the modern society.
5. Land is used for construction of buildings, industries.

LAND DEGRADATION: Process of degradation of soil or loss of fertility of the soil.

Harmful effects of land degradation:
(i) The soil texture and soil structure are deteriorated
(ii) Loss of soil fertility, due to loss of invaluable nutrients
(iii) Increase in water logging, salinity, and alkalinity and acidity problems.
(iv) Loss of economic social and biodiversity.

Causes of land degradation:
1. Population - Land resources degraded by over population &over exploitation.
2. Urbanization - Urbanization leads to deforestation, reduces the land
3. Fertilizers and pesticides -Increased applications of fertilizers and pesticides leads to pollution of land and water and soil degradation.
4. Damage of top soil - Increase in food production generally leads to damage to top soil through nutrient depletion.
5. Water-logging - Soil erosion, salination and contamination of the soil with industrial wastes all cause land degradation.
6. Soil erosion - Soil erosion is the process of removal of superficial layer of the soil from one place to another.
Harmful effects of soil erosion:
(i) Soil fertility is lost because of loss of top soil layer.
(ii) Loss of its ability to hold water and sediment.
(iii) Sediment runoff can pollute water and kill aquatic life.
Types of soil erosion:
(i**) Normal erosion:** Gradual removal of top soil by the natural process.
The rate of erosion is slower.
(ii) Accelerated erosion: Caused by man-made activities. The rate of erosion is much faster than the rate of formation of soil.
Causes of soil erosion:
(i) Water: Affects soil erosion in the form of rain, run-off, rapid flow, wave action.
Sheet erosion: When there is uniform removal of a thin layer of soil from a large surface area, it is called sheet erosion.
Rill erosion: when there is rainfall and rapidly running water produces finger-shaped grooves or rills over the area, it is called rill erosion.
Gully erosion: When the rainfall is very heavy, deeper cavities or gullies are formed, which may be U or V shaped.
Slip erosion: This occurs due to heavy rainfall on slopes of hills and mountains.
Stream bank erosion: During the rainy season, when fast running streams take a turn in some other direction, they cut the soil and make caves in the bank.
(ii) Wind: Wind is the important climatic agent, who carry away the fine particles of soil and creates soil erosion.
Saltation: This occurs under the influence of direct pressure of stormy wind and the soil particles of 1-1.5 mm diameter move up in vertical direction.
Suspension: Here fine soil particles (less than 1mm diameter) which are suspended on the air are kicked up and taken away to distant places.

Surface creep: Here the large particles (5-10 mm diameter) creep over the soil surface along with wind.

(iii) Biotic agents: Overgrazing, mining and deforestation are the major biotic agents, cause soil erosion. Deforestation without reforestation, overgrazing by cattle, surface mining without land reclamation, irrigation techniques that lead to salt build- up, water logged soil, make the top soil vulnerable to erosion. 35% of world soil erosion is due to overgrazing. 30% of world soil erosion is due to deforestation.

(iv) Landslides: Causes soil erosion.

(v)Construction: Construction of dams, buildings, roads removes the protective vegetal cover and leads to soil erosion.

Control of soil erosion (or) soil conservation practices:

1. Conservational till farming (or) no-till farming:

In tradition method, the land is ploughed and soil is broken up and leveled to make a planting surface. This disturbs the soil and makes it susceptible to erosion. However, no-till-farming causes minimum disturbance to the top soil. Here the tilling machines make slits in the unploughed soil and inject seeds, fertilizers and water in the slit. So the seed germinates and the crop grows.

Fig. Conservational till farming

2. Contour farming: It involves planting crops in rows across the contour of gently sloped land. Each row acts as a small dam to hold soil and to slow water runoff.

Fig. Contour farming

3. Terracing: It involves conversion of steep slopes into broad terraces, which run across the contour. This retains water for crops and reduces soil erosion by controlling runoff.

Fig. Terracing

4. Alley cropping (or) Agro forestry: It involves planting crops in strips or alleys between rows of trees of shrubs that can provide fruits and fuel wood. Even when the crop is harvested, the soil will not be eroded because trees and shrubs still remain on the soil and hold the soil particles.

Fig. Alley cropping

4. **Wind breaks or shelter belts:** The trees are planted in long rows along the boundary of cultivated lands, which block the wind and reduce soil erosion. Wind breaks help in retaining soil moisture, supply of some wood for fuel and provide habitats for birds.

Fig. Wind breaks

DESERTIFICATION: Progressive destruction or degradation of arid or semiarid lands to desert. Desertification leads to the conversion of range lands or irrigated croplands to desert. Desertification is characterized by devegetation, depletion of ground water, salination and soil erosion.
Harmful effect of desertification: Around 80% of the productive land in the arid and semi-regions are converted into desert. Almost 600 million people are threatened by desertification.

Causes of Desertification:
(a) Deforestation: The process of denuding and degrading a forest land initiates a desert. If there is no vegetation to hold back the rain water, soil cannot soak and groundwater level do not increase. This also increases, soil erosion, loss of fertility.
(b) Over grazing: The increase in cattle population heavily grazes the grass land or forests and as a result denudes the land area.
The denuded land becomes dry, loose and more prone to soil erosion and leads to desert.
(c) Water management: Over utilization of ground water, particularly in the coastal regions, is resulting in saline water intrusion into aquifers which is unfit for irrigation.
(d) Mining and quarrying: These activities are also responsible for loss of vegetal cover and denudation of extensive land area leading to desertification.
(e) Climate change: Formation of deserts may also take place due to climate change, ie., failure of monsoon, frequent droughts.
(f) Pollution: Excessive use of fertilizers and pesticides and disposal of toxic water into the land also leads to desertification.

LANDSLIDES: Landslides are the downward and outward movement of a slope composed of earth materials such as rock, soil, artificial fills. Other names of landslides are rockslide, debris slide, slump, earth flow and soil creep.

Man induced landslides
During construction of roads and mining activities huge portions of fragile mountainous areas are cut and thrown into adjacent areas and streams. These land masses weaken the already fragile mountain slopes and lead to landslides called man induced landslides.

Causes of landslides:
1. Removal of vegetation: In the sloppy area creates soil erosion, which leads to landslides.

2. Underground mining: Cause subsidence of the ground.
3. Transport: Due to the movement of buses and trains in the unstable sloppy region cause landslides.
4. Addition of weight: Addition of extra weight (or) construction on the slope areas leads to landslide.
5. Ground water level: Over exploitation of ground water also leads to landslides.
Harmful effect of landslides:
1. Landslide increases the turbidity of nearby streams, thereby reducing their productivity.
2. Destruction of communication links.
3. Loss of habitat and biodiversity.
4. Loss of infrastructure and economic loss.

CONSERVATION OF NATURAL RESOURCES - ROLE OF AN INDIVIDUAL: Different natural resources like forests, water, soil, food, mineral and energy resources play a vital role in the development of a nation. While conservation efforts are underway at National as well as International level, the individual efforts for conservation of natural resources can go a long way.

I. Conserve Water:
- Use minimum water for all domestic purposes.
- Check for water leaks in pipes.
- Use drip irrigation method and reduce evaporation.
- The wasted water, coming out from domestic usages, it can be used for watering the plants.
- Building rainwater harvesting system.

II. Conserve energy:
- Switch off lights, fan, and other appliances when not in use.
- Use solar water heater for cooking food.
- Grow trees near the house and get a cool breeze and shade.
- Use always pressure cooker.
- Ride bicycle or just walk instead of car & scooter.
- Dry the clothes in sunlight instead of driers.

III. Protect the soil:
- Grow different types of plants in garden and open places, which bind the soil reduce erosion.
- While constructing the house don't uproot the trees as far as possible.
- Don't irrigate the plants using strong flow of water, which will wash off the top of soil.
- Soil erosion prevented by sprinkling irrigation.
- Use green manure in the garden.

IV. Conservation of Food Resources:
- Eat only minimum amount food.
- Don't waste the food.
- Cooke only required amount of the food.
- Don't cook food unnecessarily.
- Don't store large amounts of food grains and protect them from damaging insects.

V. Promote Sustainable Agriculture:

- Do not waste food. Take as much as you can eat.
- Reduce the use of pesticides.
- Fertilize your crop primarily with organic fertilizers.
- Eat local and seasonal vegetables. This saves lot of energy on transport, storage and preservation.
- Control pests by a combination of cultivation and biological control methods.

EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFE STYLE:

Sustainable development: It is the development of healthy environment without damaging the natural resources.

Unsustainable development: It is the degradation of the environment due to over utilization and over exploitation of natural resources.

Life style in different countries: Life style in world can be explained in two ways.

Most developed countries:

22% of world's population,
88% natural resources,
85% total global income

Less developed countries:

78% world's population,
12% natural resources,
15% total global income

(They are still struggling hard with their large population, poverty and also consume too low natural resources leading to unsustainability).

Causes of Unsustainable:

- ✓ Over population in poor countries, consume too low resources with low income.
- ✓ Rich countries consume more resources with more income.

Conditions for sustainable life style:

- ➢ To achieve a more balanced and equitable distribution of natural resource and income.
- ➢ Rich countries should lower down their consumption levels, while the minimum needs of the poor people.

GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING
UNIT-4
SOCIAL ISSUES AND ENVIRONMENT

4.1 UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT

Until two decades ago the world looked at economic status alone as a measure of human development.
Thus countries that were economically well developed and where people were relatively richer were called **Advanced Nations/Developed Nations** while the rest where poverty was widespread and were economically backward were called **Developing Nations.**

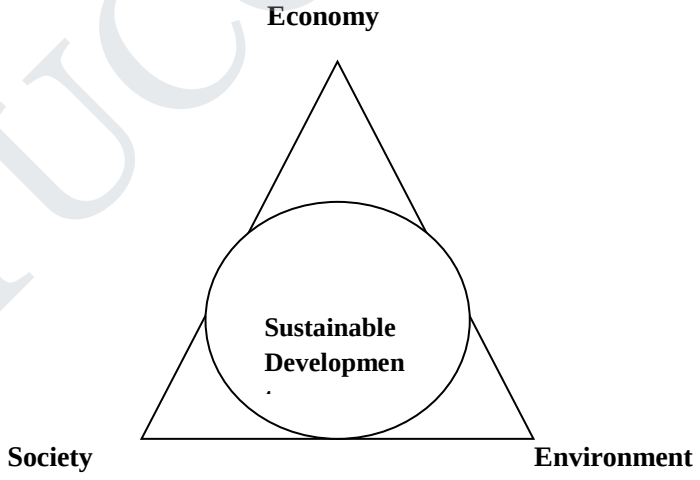
Developed Nations not only exploited their own natural resources rapidly but also used the natural resources of developing countries to grow even larger economies. Later they realized that their lives were being seriously affected by the environmental consequences of development based on economic growth alone. This form of development did not add to the quality of life as the environmental conditions had begun to deteriorate.

The current strategies of economic development are using up resources of the world so rapidly that our future generations, would have serious environmental problems, much worse than those that we are facing at present and considered unsustainable for the world's long-term development. The newer concept of development has come to be known as "**Sustainable Development**".

The nations of the world came to clearly understand these issues in the UN Conference on Environment and Development (UNCED), popularly known as "**The Earth Summit**", held at Rio de Janeiro, **Brazil in 1992**.

Sustainable Development:

- Norwegian Prime Minister and Director of World Health Organization **G.H. Brundtland** defined it as "**Meeting the needs of the present without compromising the ability of future generations to meet their own needs**".



- It is a multidimensional concept aiming at benefits derived from the interaction between society, economy and environment.

Key aspects for Sustainable Development-

- **Inter-generational equity**
  - This emphasizes that we should minimize any adverse impacts on resources and environment for future generations.

- This can be possible only if we stop over-exploitation of resources, reduce waste discharge and emissions and maintain ecological balance.

❖ **Intra-generational equity**
- This emphasizes that the development processes should seek to minimize the wealth gaps within and between nations and lead to sustainability. i.e., The technology should address to the problems of the developing countries, producing drought tolerant varieties for uncertain climates, vaccines for infectious diseases, clean fuels for domestic and industrial use.

Important measures for sustainable development-

❖ **Using appropriate technology**
- It should be locally adaptable, co-friendly, resource-efficient and culturally suitable.
- The Technology should use less of resources, local labor and should produce Minimum waste.

❖ **3-R approach**
- **Reduce** - This insists on minimization of resource usage.
- **Reuse** - Using it again and again instead of passing it on to the waste stream.
- **Recycle** - This reduces pressure on our resources as well as reduces waste generation and pollution.

❖ **Prompting environmental education and awareness**
- Making environmental education the centre of all learning process will greatly help in changing the thinking and attitude of people towards our earth and the environment.

❖ **Resource utilization as per carrying capacity**
- **Renewable resources:** In order to attain sustainability, it is very important to consume the natural resources in such a way that the consumption should not exceed the regeneration capacity.
- **Non-renewable resources:** For sustainability non-renewable resources should be conserved by recycling and reusing.

Sustainability of a system depends largely upon the carrying capacity of the system. **Carrying capacity** has two basic components:

1. **Supporting capacity** -the capacity to regenerate.
2. **Assimilative capacity** -the capacity to tolerate different stresses.

"Consumption should not exceed regeneration and changes should not be allowed to occur beyond the tolerance capacity of the system".

In order to attain sustainability it is very important to utilize the resources based upon the above two properties of the system.

In case of human beings, the carrying capacity concept becomes all the more complex because unlike other animals, human beings, not only need food to live, but need so many other things to maintain the quality of life.

A True sustainable development should aim at optimum use of natural resources with

- High degree of reusability
- Minimum wastage
- Least generation of toxic by-products
- Maximum productivity.

4.2 URBAN PROBLEMS RELATED TO ENERGY

❖ **Urban sprawl**
- Earlier a big majority of human population lived in rural areas and their economic activities centered on agriculture, cattle rearing, fishing, hunting or some cottage industry.
- It was some 200 years ago, with the dawn of Industrial era, the cities showed a rapid development.

- More than 50 percent of the world population lives in urban areas and there is increasing movement of rural people to cities in search of employment.
- The urban growth is so fast that it is becoming difficult to accommodate all the industrial, commercial and residential facilities within a limited municipal boundary. As a result, there is spreading of the cities into the sub-urban or rural areas too. This phenomenon is called urban sprawl.

❖ **Urbanization**

Urbanization is the movement of human population from rural areas to urban areas for the want of better education, communication, health, employment etc.

❖ **Causes of urbanization**

Cities are the main centers of economic growth, trade, transportation, education, medical facilities and employment. Hence rural people move to cities.

In developing countries too urban growth is very fast and in most of the cases it is uncontrollable and unplanned growth. Due to high population density and high energy demanding activities, a higher standard life and their life style the urban problems related to energy are much more magnified as compared to the rural population.

❖ **The energy demanding activities include**

- Residential and commercial lighting.
- Transportation means including automobiles and public transport for moving from residence to workplace.
- Modern life-style using a large number of electrical gadgets in everyday life.
- Industrial plants using a big proportion of energy.
- A large amount of waste generation which has to be disposed off properly using energy based techniques.
- Control and prevention of air and water pollution which need energy dependent technologies.

❖ **Solution for urban energy problem**

- Urban people should be encouraged to use public transport instead of individual transport modes like cars or motor cycles.
- Energy consumption must be minimized.
- Energy production capacity may be increased.
- Use of energy efficient technologies adopted.
- Usage of Solar energy and wind energy should be encouraged.
- Apart from encouraging energy saving methods strict laws and penalties have to be imposed together with energy audit.

4.3 WATER CONSERVATION

Water conservation refers to reducing use of fresh water, through technological or social methods.

❖ **Need for water conservation**

1. Rising population
2. Growing industrialization
3. Expanding agriculture
4. Decrease in rainfall
5. Overexploitation of ground water has raised the demand for water.

Efforts have been made to collect water by building dams and reservoirs and digging wells some countries have also tried to recycle and desalinate (remove salts) water. Conserving water has become a prime environmental concern. The idea of ground water recharging by harvesting rainwater is gaining importance in many cities.

Strategies that can be adopted to conserve water-

❖ **Decreasing run-off losses**

Huge water-loss occurs due to runoff on soils, which can be reduced by allowing most of the water to infiltrate into the soil. This can be achieved by using the following techniques.

a. **Contour cultivation** on small furrows and ridges across the slopes trap rainwater and allow more time for infiltration. Terracing constructed on deep soils has large water-storage capacity.On gentle slopes trapped run off is spread over a large area for better infiltration.
b. **Conservation-bench terracing** involves construction of a series of benches for catching the runoff water.
c. **Water spreading** is done by channeling or lagoon-leveling.
    - In **channeling**, the water-flow is controlled by a series of diversions with vertical intervals.
    - In **lagoon leveling**, small depressions are dug in the area so that there is temporary storage of water.
d. **Chemical wetting agents** (**Surfactants**) increase the water intake rates when added to normal irrigated soils.
e. **Surface crop residues** Tillage, mulch, animal residues etc. help in reducing run-off by allowing more time for water to penetrate into the land.
f. **Chemical conditioners** like gypsum ($CaSO_4.2H_2O$) when applied to sodic soils improve soil permeability and reduce run off. Another useful conditioner is HPAN (hydrolyzed polyacrylonitrile).
g. **Water-storage structures** like farm ponds, dug-outs etc. built by individual farmers can be useful measures for conserving water through reduction of runoff.

- **Reducing evaporation losses**
    - This is more relevant in humid regions.
    - Horizontal barriers of **asphalt** placed below the soil surface increase water availability and increase crop yield by 35-40%. This is more effective on sandy soil but less effective on loamy sand soils.
    - A co-polymer of starch and acrylonitrile called **super.** it has been reported to absorb water upto 1400 times its weight. The chemical has been found to be useful for sandy soils.
- **Storing water in soil**
    - Storage of water takes place in the soil root zone in humid regions when the soil is wetted to field capacity.
    - By leaving the soil fallow for one season water can be made available for the crop grown in next season.
- **Reducing irrigation losses**
    - Irrigation in early morning or late evening to reduce evaporation losses.
    - Sprinkling irrigation and drip irrigation conserve water by 30-50%.
    - Growing hybrid crop varieties with less water requirements and tolerance to saline water help conserve water.
- **Re-use of water**
    - Treated wastewater can be used for ferti-irrigation.
    - Use grey water from washings, bath-tubs etc. for watering gardens, washing cars or paths.
- **Preventing wastage of water**
    - This can be done in households, commercial buildings and public places.
    - Closing taps when not in use
    - Repairing any leakage from pipes.
    - Using small capacity flush in toilets.
- **Increasing block pricing**
    - The consumer has to pay a proportionately higher bill with higher use of water.
    - This helps in economic use of water by the consumers.

The goals of water conservation efforts include

- **Sustainability** - To ensure availability for future generations, the withdrawal of fresh water from an ecosystem should not exceed its natural replacement rate.

- **Energy conservation** - Water pumping, delivery, and wastewater treatment facilities consume a significant amount of energy.
- **Habitat conservation** - Minimizing human water use helps to preserve fresh water habitats for local wildlife and migrating waterfowl, as well as reducing the need to build new dams and other water diversion infrastructure.

Methods of water conservation

There are so many methods available for water conservation of which the following are important methods

1. Rainwater harvesting
2. Watershed management

4.4. RAINWATER HARVESTING

Rainwater harvesting is a technique of increasing the recharge of groundwater by capturing and storing rainwater. This is done by constructing special water-harvesting structures like dug wells, Percolation pits, lagoons, check dams etc.

- **Objectives of Rainwater harvesting**
  - To reduce run off loss.
  - To avoid flooding of roads.
  - To meet the increasing demands of water.
  - To raise the water table by recharging ground water.
  - To reduce groundwater contamination.
  - To supplement groundwater supplies during lean season.
- **Methods**
  - By storing in tanks or reservoirs above or below ground.
  - By constructing pits, dug-wells, lagoons, trench or check-dams on small rivulets
  - By recharging the groundwater.

Before adopting a rain-water harvesting system, the soil characteristics, topography, rainfall pattern and climatic conditions should be understood. Rainwater harvesting helps in recharging the aquifers, improves groundwater quality by dilution, improves soil moisture and reduces soil erosion by minimizing run-off water

- **Traditional Rain Water Harvesting**
  - In **high rainfall** areas rainwater is collected from roof-tops into storage tanks. In foot hills, water flowing from springs is collected by embankment type water storage.
  - In **Himalayan foot-hills** people use the hollow bamboos as pipelines to transport the water of natural springs. **Rajasthan** is known for its tankas. (Underground tanks) and khadins (embankments) for harvesting rainwater.
  - In our ancient times Talaabs, Baawaris, Johars, Hauz were used to collect rain-water and ensured adequate water supply in dry periods.

- **Modern Techniques of Rain Water Harvesting**
  - In **arid and semi-arid regions** artificial ground water recharging is done by constructing shallow percolation tanks.
  - **Check-dams** made of any suitable native material (brush, poles, rocks, plants, loose rocks, wire nets, stones, slabs, sacks etc.) are constructed for harvesting runoff from large catchment areas.
  - Rajendra Singh of Rajasthan popularly known as water man has been doing a commendable job for harvesting rainwater by building check dams in Rajasthan and he was honored with the prestigious Magsaysay Award for his work.
  - Groundwater flow can be intercepted by building **groundwater dams** for storing water underground. As compared to surface dams, groundwater dams have several advantages like minimum evaporation loss, reduced chances of contamination etc.

- In **roof top rainwater harvesting**, which is a low cost and effective technique for urban houses and buildings, the rain-water from the top of the roofs is diverted to some surface tank or pit through a delivery system which can be later used for several purposes.

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Some of the benefits of rainwater harvesting are as follows-

- Increases water availability
- Checks the declining water table
- Is environmentally friendly
- Improves the quality of groundwater through the dilution of fluoride, nitrate, and salinity
- Prevents soil erosion and flooding especially in urban areas

4.5 WATERSHED MANAGEMENT

Watershed

It is defined as the land area from which water drains under gravity to a common drainage channel. It is a delineated area with a well-defined topographic boundary and one water outlet.

The watershed can range from a few square kilometers to few thousand square kilometers in size. The watershed comprises complex interactions of soil, landform, vegetation, land use activities and water. A watershed affects us as it is directly involved in sustained food production, water supply for irrigation, power generation, and transportation as well as for influencing sedimentation and erosion, vegetation growth, floods and droughts.

Thus, management of watersheds, treating them as a basic functional unit, is extremely important and the first such Integrated Watershed Management was adopted in 1949 by the Damodar Valley Corporation.

Watershed degradation

The watersheds are very often found to be degraded due to uncontrolled, unplanned and unscientific land use activities. Overgrazing, deforestation, mining, construction activities, industrialization, shifting cultivation, natural and artificial fires, soil erosion and ignorance of local people have been responsible for degradation of various watersheds.

Watershed Management

Rational utilization of land and water resources for optimum production causing minimum damage to the natural resources is known as watershed management.

The objectives of watershed management are as follows-

- To rehabilitate the watershed through proper land use adopting conservation strategies for minimizing soil erosion and moisture retention so as to ensure good productivity of the land for the farmers.
- To manage the watershed for beneficial developmental activities like domestic water supply, irrigation, hydropower generation etc.
- To minimize the risks of floods, droughts and landslides.
- To develop rural areas in the region with clear plans for improving the economy of the region.

Watershed Management Practices

In the **Fifth Five Year Plan**, watershed management approach was included with a number of programmes for it and a national policy was developed. The practices of conservation and development of land and water are taken up with respect to their suitability for peoples benefit as well as sustainability.

Various measures taken up for management include the following-

- **Water harvesting**
  - Proper storage of water is done with provision for use in dry seasons in low rainfall areas.
- **Afforestation and Agroforestry**
  - They help to prevent soil erosion and retention of moisture. In high rainfall areas woody trees are grown in between crops to substantially reduce the runoff and loss of fertile soil.
  - In Dehradun, trees like Eucalyptus and Leucaena and grasses like Chrysopogon are grown along with maize or wheat to achieve the above objectives.
- **Mechanical measures for reducing soil erosion and runoff losses**

- Several mechanical measures like terracing, bunding, bench terracing, no-till farming, contour cropping, strip cropping etc. are used to minimize runoff and soil erosion particularly on the slopes of watersheds.
- **Bunding** has proved to be a very useful method in reducing runoff, peak discharge and soil loss in Dehradun and Siwaliks.

❖ **Scientific mining and quarrying**
- Due to improper mining, the hills lose stability and get disturbed resulting in landslides, rapid erosion etc.
- **Contour trenching** at an interval of 1 meter on overburden dump, planting some soil binding plants like Ipomoea and Vitex and draining of water courses in the mined area are recommended for minimizing the destructive effects of mining in watershed areas.

❖ **Public participation**
- People involvement cooperation as well as participation has to be ensured to the success of any watershed management programme.
- Properly educating the people about the campaign and its benefits or sometimes paying certain incentives to them can help in effective people's participation.

Successful watershed management has been done at Sukhomajri Panchkula, Haryana through active participation of the local people. Watershed management in Himalayan region is of vital importance since most of the watersheds of our country lie here. Several anthropogenic activities accelerate its slope instability which needs to be prevented. On steeper slopes with sliding faces, straw mulching tied with thin wires and ropes helps in establishing the vegetation and stabilizing the slopes. Efforts should be made to protect the watershed by preventing overgrazing, terracing and contour farming to check runoff and erosion etc.

4.6 RESETTLEMENT

Economic development raises the quality and standard of living of the people of a country. Developmental projects are planned to bring benefits to the society. However, in the process of development, very often there is over-exploitation of natural resources and degradation of the environment.

The native people(under privileged tribal people) of the project site are directly affected. Various types of projects result in the displacement of the native people who undergo tremendous economic and psychological distress, as the socio-economic and ecological base of the local community is disturbed.

❖ **Displacement problems due to dams:**
- The big river valley projects is one of the most serious socio-economic impacts due to large scale displacement of local people from their ancestral home and loss of their traditional profession or occupation.
- India is one of countries in the world leading in big dam construction. The **Hirakund Dam** has displaced more than 20,000 people residing in about 250 villages. The **Bhakra Nangal Dam** was constructed during 1950.s and till now it has not been possible to rehabiltate even half of the displaced persons. **Tehri Dam** on the river Bhagirathi, construction of which was green signalled after three decades of long campaign against the project by the noted activist Sunderlal Bahuguna the propagator of Chipko Movement .

❖ **Displacement due to Mining:**
- Mining causes displacement of the native people. Several thousands of hectares of land area are covered in mining operation and the native people are displaced.
- Sometimes displacement of local people is due to accidents occurring in mined areas like subsidence of land that often leads to shifting of people.

- **Displacement due to Creation of National Parks:**
  - When some forest area is covered under a National Park, it is a welcome step for conservation of the natural resources. But, it also has a social aspect associated with it which is often neglected.
  - A major portion of the Forest is declared as core-area, where the entry of local dwellers or tribals is prohibited. When these villagers are deprived of their ancestral right or access to the forests, they usually retaliate by starting destructive activities.

4.7 REHABILITATION

The United Nations Universal Declaration on Human Rights [Article25 (1)] has declared that right to housing is a basic human right. In India, most of the displacements have resulted due to land acquisition by the government for various reasons. For this purpose, the government has the Land Acquisition Act, 1894 which empowers it to serve notice to the people to vacate their lands if there is a need as per government planning.

Provision of cash compensation in lieu of the land vacated exists in section 16 of the Act. The major issues related to displacement and rehabilitation is as follows-

- Tribals are usually the most affected amongst the displaced who are already poor. Displacement further increases their poverty due to loss of land, home, jobs, food insecurity, loss of access to common property assets, increased morbidity and mortality and social isolation.
- Break up of families is an important social issue arising due to displacement in which the women are the worst affected and they are not even given cash/land compensation.
- The tribals are not familiar with the market policies and trends. Even if they get cash compensation, they get alienated in the modern economic set-up.
- The land acquisition laws ignore the communal ownership of property, which is an inbuilt system amongst the tribals. Thus the tribals lose their communitarian basis of economic and cultural existence. They feel like fish out of water.
- Kinship systems, marriages, social and cultural functions, their folk-songs, dances and activities vanish with their displacement. Even when they are resettled, it is individual-based resettlement, which totally ignores communal settlement.
- Loss of identity and loss of the intimate link between the people and the environment is one of the biggest losses. The age-long indigenous knowledge, which has been inherited and experienced by them about the flora, fauna, their uses etc. gets lost.

Rehabilitation Policy

There is a need for a comprehensive National Rehabilitation Policy. Different states are following different practices in this regard. There is a need to raise public awareness on these issues to bring the resettlement and rehabilitation plans on a humane footing and to honour the human rights.

Case study

The much debated Sardar Sarovar Project which plans to build 30 big, 135 medium and 3000 minor dams on the Narmada River and its tributaries is estimated to submerge almost as much area as it is meant to irrigate. A total of 573 villages, consisting of about three lakh people are going to be affected due to submergence under water. As a result of the big dams the community rights of the tribal's is breached. It is a traumatic experience to get uprooted from ones native place where its generations have lived and move to a new place as a total stranger. Very often the family breaks up. It is a big price that the tribal's have to pay for a big dam project which is supposed to bring happiness and prosperity to the country. In return of this big sacrifice, the tribal's must be given adequate compensation in the form of land, jobs, cash compensation etc. and care should be taken to improve their quality of life

4.8 ROLE OF NON-GOVERNMENT ORGANISATIONS (NGO's)

Voluntary organizations can help by advising the government about some local environmental issues and at the same time interacting at the grass-root levels. They can act as an effective and viable link between the two. They can act both as an action group or a pressure group. They can be very effective in organizing public movements for the protection of environment through creation of awareness.

The **Chipko Movement** for conservation of trees by Dasholi Gram Swarajya Mandal in Gopeshwar or the Narmada Bachao Andolan organized by Kalpavriksh, are some of the instances where NGO's have played a landmark role in the society for conservation of environment.

The Bombay Natural History Society (**BNHS**), the World Wide Fund for Nature - India (**WWF**, India) Kerala Sastra Sahitya Parishad,Centre for Science and Environment (**CSE**) and many others are playing a significant role in creating environmental awareness through research as well as extension work.

The recent report by CSE on more than permissible limits of pesticides in the cola drinks sensitized the people all over the country.

4.9 ENVIRONMENTAL ETHICS

It refers to the issues, principles and guidelines relating to human interactions with their environment. The environmental crisis is an outward manifestation of the crisis of mind and spirit. It all depends on how do we think and act. If we think Man is all powerful and the supreme creature on this earth and man is the master of nature and can harness it at his will it reflects our human-centric thinking.

On the other hand, if we think Nature has provided us with all the resources for leading a beautiful life and she nourishes us like a mother, we should respect her and nurture her is an earth-centric thinking.

The first view urges us to march ahead gloriously to conquer the nature and establish our supremacy over nature through technological innovations, economic growth and development without much botheration to care for the damage done to the planet earth.

The second view urges us to live on this earth as a part of it, like any other creation of Nature and live sustainably. So, we can see that our acts will follow what we think. If we want to check the environmental crisis, we will have to transform our thinking and attitude. That in turn, would transform our deeds, leading to a better environment and better future. These two world-views are discussed here in relation to environmental protection:

- **Anthropocentric Worldview**

  This view is guiding most industrial societies. It puts human beings in the center giving them the highest status. Man is considered to be most capable for managing the planet earth. The guiding principles of this view are-
  - Man is the planets most important species and is the in-charge of the rest of nature.
  - Earth has an unlimited supply of resources and it all belongs to us.
  - Economic growth is very good and more the growth, the better it is, because it raises our quality of life and the potential for economic growth is unlimited.
  - A healthy environment depends upon a healthy economy.
  - The success of mankind depends upon how good managers we are for deriving benefits for us from nature.
- **Eco-centric Worldview**

  This is based on earth-wisdom. The basic beliefs are as follows-
  - Nature exists not for human beings alone, but for all the species.
  - The earth resources are limited and they do not belong only to human beings.
  - Economic growth is good till it encourages earth-sustaining development and discourages earth-degrading development.
  - A healthy economy depends upon a healthy environment.
  - The success of mankind depends upon how best we can cooperate with the rest of the nature while trying to use the resources of nature for our benefit.

Environmental ethics can provide us the guidelines for putting our beliefs into action and help us decide what to do when faced with crucial situations. Some important ethical guidelines known as Earth ethics or Environmental Ethics are as follows-

- One should love and honour the earth since it has blessed you with life and governs your survival.
- One should keep each day sacred to earth and celebrate the turning of its seasons.
- One should not hold yourself above other living things and have no right to drive them to extinction.
- One should be grateful to the plants and animals which nourish you by giving you food.
- One should limit your offsprings because too many people will overburden the earth.
- One should not waste your resources on destructive weapons.
- One should not run after gains at the cost of nature, rather should strive to restore its damaged majesty.
- One should not conceal from others the effects you have caused by your actions on earth.
- One should not steal from future generations their right to live in a clean and safe planet by impoverishing or polluting it.

- One should consume the material goods in moderate amounts so that all may share the earth's precious treasure of resources.

If we critically go through the above Ten Commandments for earth ethics and reflect upon the same, we will find that various religions teach us the same things in one form or the other. The concept of ahimsa (non-violence) in Buddhism and Jainism ensure the protection and conservation of all forms of life, thereby keeping the ecological balance of the earth intact. Our teachings on having fewer wants ensure to put .limits to growth and thus, guide us to have an eco-centric life style.

4.10 TWELVE PRINCIPLES OF GREEN CHEMISTRY:

12 PRINCIPLES OF

GREEN CHEMISTRY

1. **Prevention**
   It is better to prevent waste than to treat or clean up waste after it has been created.

2. **Atom Economy**
   Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

3. **Less Hazardous Chemical Syntheses**
   Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.

4. **Designing Safer Chemicals**
   Chemical products should be designed to affect their desired function while minimizing their toxicity.

5. **Safer Solvents and Auxiliaries**
   The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.

6. **Design for Energy Efficiency**
   Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

7. **Use of Renewable Feedstocks**
   A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

8. **Reduce Derivatives**
   Unnecessary derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

9. **Catalysis**

Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

10. **Design for Degradation**

Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

11. **Real-time analysis for Pollution Prevention**

Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

12. **Inherently Safer Chemistry for Accident Prevention**

Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

4.11 NUCLEAR ACCIDENTS AND HOLOCAUST

Nuclear accidents can occur at any stage of the nuclear fuel cycle. However, the possibility of reactor accidents is viewed more seriously because the effects of reactor accidents are more drastic. Many estimates of hypothetical accidents in a nuclear power station are made taking into consideration various parameters like reactor safety measures which if fail would release large amount of reactor contents, that is, radioactive debris affecting a substantial portion of human population within a particular site in a Particular area.

The modern fusion bombs (nuclear bombs) are of the explosive force of 500 kilotons and 10 megatons. In case of a world war total nuclear exchange of more than 5,000 megatons can be expected. Nuclear bombardment will cause combustion of wood, plastics, petroleum, forests etc. Large quantity of black soot will be carried to the stratosphere. Black soot will absorb solar radiations and won't allow the radiations to reach the earth. Therefore, cooling will result.

The infrared radiations which are re-radiated from the atmosphere to the earth will have very less water vapors and carbon dioxide to absorb them. If they leave the lower atmosphere the greenhouse effect will be disturbed and cooling will occur.

Due to this cooling effect, water evaporation will also reduce. Therefore, infra-red radiations absorbing water vapors will reduce in the atmosphere. This will also cause cooling. In the stratosphere there won't be significant moisture to rainout the thick soot. So, due to nuclear explosions, a phenomenon opposite to global warming will occur. This is called nuclear winter. It may result in lower global temperature.

Even the summer time will experience freezing temperature and drastically affect crop production. Crop productivity will reduce substantially causing famines and human sufferings. The Chernobyl nuclear accident, 1986 has resulted in wide spread contamination by radioactive substances. The devastation caused by nuclear bombs is not only immediate but may be long lasting. Towards, the end of World War II, bombing of Dresden, Germany caused huge firestorms. This caused particle laden updrafts in the atmosphere.

Nuclear holocaust refers to a possible nearly complete annihilation of human civilization by nuclear warfare. Under such a scenario, all or most of the Earth is made uninhabitable by nuclear weapons in future world wars.

Nuclear physicists and others have speculated that nuclear holocaust could result in an end to human life, or at least to modern civilization on Earth due to the immediate effects of nuclear fallout, the temporary loss of much modern technology due to electromagnetic pulses, or nuclear winter and resulting extinctions.

Case study

Atomic bombings of Hiroshima and Nagasaki:

During the final stages of World War II in 1945, the United States conducted two atomic bombings against the Japanese cities of Hiroshima and Nagasaki, the first on August 6, 1945, and the second on August 9, 1945. These two events are the only use of nuclear weapons in war to date.

For six months before the atomic bombings, the United States intensely fire-bombed 67 Japanese cities. Together with the United Kingdom and the Republic of China, the United States called for the unconditional surrender of Japan in the Potsdam Declaration issued July 26, 1945.

The Japanese government ignored this ultimatum. By executive order of President Harry S. Truman, the U.S. employed the uranium-type nuclear weapon code named "Little Boy" on the city of Hiroshima on Monday, August 6, 1945, followed three days later by the detonation of the plutonium-type weapon code named "Fat Man" over the city of Nagasaki on August 9.

Within the first two to four months after the bombings, acute effects killed 90,000–166,000 people in Hiroshima and 60,000–80,000 in Nagasaki, with roughly half of the deaths in each city occurring in the first 24 hours. The Hiroshima prefectural health department estimates that - of the people who died on the day of the detonation - 60% died from flash or flame burns, 30% from falling or flying debris, and 10% from other causes.

During the following months, large numbers died from the chronic effects of burns, radiation sickness, and other injuries, compounded by illnesses. In a U.S. estimate of the total immediate and short-term causes of death, 15–20% died from radiation sickness, 20–30% from flash burns, and 50–60% from other injuries, compounded by illnesses. In both cities, most of the dead were civilians.

4.12 WASTELAND RECLAMATION

Economically unproductive lands suffering from environmental deterioration are known as wastelands. Eg: salt affected lands, sandy areas, gullied areas, undulating uplands, barren hill-ridge etc. Snow covered areas, glacial areas and areas rendered barren after Jhum cultivation.

More than half of our country's geographical area (about 175 million ha) is estimated to be wasteland, thus indicating the seriousness of the problem for a country like ours which has to support 1/6th of the world's population.

Maximum wasteland areas in our country lie in Rajasthan (36 million ha) followed by M.P. and Andhra Pradesh. Wastelands are formed by natural processes, which include undulating uplands, snow-covered lands, coastal saline areas, sandy areas etc. or by anthropogenic (man-made) activities leading to eroded, saline or waterlogged lands.

The major anthropogenic activities leading to waste land formation are deforestation, overgrazing, mining and erroneous agricultural practices. Although deserts are wastelands formed by natural process, but there are many human activities which accelerate the spreading of desert as we have already discussed. Wasteland reclamation and development in our country falls under the purview of Wasteland Development Board, which works to fulfil the following objectives-

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

Some important reclamation practices are discussed here-

- **Land development and leaching**
  - For reclamation of the salt affected soil, it is necessary to remove the salts from the root-zone which is usually achieved by leaching i.e. by applying excess amount of water to push down the salts.

- After levelling and ploughing, the field is bundled in small plots and leaching is done. In continuous leaching, 0.5 to 1.0 cm water is required to remove 90% of soluble salts from each cm of the soil depending upon texture.

❖ **Drainage**
- This is required for water-logged soil reclamation where excess water is removed by artificial drainage.

1. Surface drainage: This is used in areas where water stands on the fields after heavy rains by providing ditches to runoff the excess water. Usually 30-45 cm deep ditches lying parallel to each other at 20-60 m distance are able to remove 5 cm of water within 24 hours.

2. Sub-surface drainage: Horizontal sub-surface drainage is provided in the form of perforated corrugated PVC pipes or open-jointed pipes with an envelope of gravel 2-3 m below the land surface. Chancesof evaporation of water leading to accumulation of salts almost become nil in this method. The World Bank has funded sub-surface drainage system at Sampla, Rohtak (Haryana) for reducing soil salinity by this method.

❖ **Irrigation Practices**
- Surface irrigation with precise land levelling, smoothening and efficient hydraulic design help to reduce water logging and salinity. High frequency irrigation with controlled amount of water helps to maintain better water availability in the upper root zone.
- Thin and frequent irrigations have been found to be more useful for better crop yield when the irrigation water is saline as compared to little heavy irrigation.

❖ **Selection of tolerant crops and crop rotations**
- Tolerance of crops to salts is found to range from sensitive, semi-tolerant, tolerant to highly tolerant. Barley, sugar beet and date-palm are highly tolerant crops which do not suffer from any reduction in crop yield even at a high salinity with electrical conductivity (EC) of 10 dS/m.
- Wheat, sorghum, pearl millet, soyabean, mustard and coconut are salt-tolerant crops. Rice, millets, maize, pulses, sunflower, sugarcane and many vegetables like bottle gourd, brinjal etc. are semi-tolerant. These different crop combinations can be grown on saline soils.

❖ **Gypsum amendment**
- Amendment of sodic soils with gypsum is recommended for reducing soil sodicity as calcium of gypsum replaces sodium from the exchangeable sites.

❖ **Green-manures, fertilizers and Biofertilizers**
- Application of farm yard manure or nitrogen fertilizers have been found to improve saline soils. Green manuring with dhaincha (Sesbania aculeata) sunhemp or guar have also been reported to improve salt-affected soils.
- Blue green algae have been found to be quite promising as biofertilizers for improving salt-affected soils.

❖ **Afforestation Programmes**
- The National Commission on Agriculture (NCA) launched several afforestation schemes in the VI th plan to cope up with the problem of spreading wasteland.
- The National Wasteland Development Board, in the Ministry of Environment and Forests has set a target of bringing 5 million hacres of wasteland annually under firewood and fodder plantation.

❖ **Social Forestry Programmes**
- These programmes mostly involve strip plantation on road, rail and canal-sides, rehabilitation of degraded forest lands, farm-forestry, waste-land forest development etc.

4.13 CONSUMERISM AND WASTE PRODUCTS

Consumerism refers to the consumption of resources by the people. While early human societies used to consume much less resources, with the dawn of industrial era, consumerism has shown an exponential rise. It has been related both to the increase in the population size as well as increase in our demands due to change in life-style.

Earlier we used to live a much simpler life and used to have fewer wants. In the modern society our needs have multiplied and so consumerism of resources has also multiplied. Our population was less than 1 million for thousands of years ever since we evolved on this earth.

Today we have crossed the six billion mark and are likely to reach 11 billion by 2045 as per World Bank estimates. Let us see how the changing population trends influence consumerism of natural resources and generation of wastes. Two types of conditions of population and consumerism exist.

- **People over-population**
  - It occurs when there are more people than available supplies of food, water and other important resources in the area.
  - Excessive population pressure causes degradation of the limited resources, and there is absolute poverty, under-nourishment and premature deaths.
  - This occurs in less developed countries (LDCs). Here due to large number of people, adequate resources are not available for all. So there is less per capita consumption although overall consumption is high.
- **Consumption over-population**
  - This occurs in the more developed countries (MDCs). Here population size is smaller while resources are in abundance and due to luxurious life-style per capita consumption of resources is very high.
  - More the consumption of resources more is the waste generation and greater is the degradationof the environment.

This concept can be explained by using the model of Paul Ehrlich and John Hodlren (1972)

Number of People	×	Per Capita use of resources	×	Waste generated per unit of resource used	=	Over all Environmental Impact

In LDC.s - No. of people is very high, but per capita use of resources and waste generated are less.
In MDC.s - No. of people is low, but per capita use of resources and wastes generated are very high.
The overall environmental impact of these two types of consumerism may be same or even greater in case of MDCs. Thus, consumerism varies with the country and USA is known for maximum consumerism.

The throw-away attitude and luxurious life-style of the west results in very high resource use as compared to less developed countries. With every unit of energy, mineral or any resource used there is waste generation and pollution in the environment.

A comparison of USA and India can illustrate this point more clearly with every unit of energy, mineral or any resource used there is waste generation and pollution in the environment.
Comparison of consumerism and waste generation Percent global values

Parameter	USA	India
Population	4.7%	16 %
Production of Goods	21%	1 %
Energy use	25%	3 %
Pollutants/wastes	25%	3 %
CFC.s Production	22%	0.7 %

The table shows that although the population of India is 3.4 times more than that of U.S.A. its overall energy use and waste generation are less than 1/8th that of USA. Thus more consumerism leads to more waste production

4.14 THE ENVIRONMENT (PROTECTION) ACT, 1986

The Act came into force on Nov 19, 1986, the birth anniversary of our Late Prime Minister Indira Gandhi, who was a pioneer of environmental protection issues in our country.

1. Environment includes water, air and land and the inter-relationships that exist among and between them and human beings, all other living organisms and property.
2. Environmental pollution means the presence of any solid, liquid or gaseous substance present in such concentration, as may be, or tend to be, injurious to environment.
3. Hazardous Substance means any substance or preparation which by its physico-chemical properties or handling is liable to cause harm to human beings, other living organisms, property or environment The Act has given powers to the Central Government to take measures to protect and improve environment while the state governments coordinate the actions. The most important functions of Central Govt. under this Act include setting up of-
    a. The standards of quality of air, water or soil for various areas and purposes.
    b. The maximum permissible limits of concentration of various environmental pollutants (including noise) for different areas.
    c. The procedures and safeguards for the handling of hazardous substances.
    d. The prohibition and restrictions on the handling of hazardous substances in different areas.
    e. The prohibition and restriction on the location of industries and to carry on process and operations in different areas.

The procedures and safeguards for the prevention of accidents which may cause environmental pollution and providing for remedial measures for such accidents.

For the purpose of protecting and improving the quality of the environment and preventing and abating pollution, standards have been specified under Schedule I- IV of Environment (Protection) Rules, 1986 for emission of gaseous pollutants and discharge of effluents/waste water from industries.

These standards vary from industry to industry and also vary with the medium into which the effluent in discharged or the area of emission. For instance, the maximum permissible limits of B.O.D. (Biochemical Oxygen Demand) of the waste water is 30 ppm if it is discharged into inland waters, 350 ppm if discharged into a public sewer and 100 ppm, if discharged onto land or coastal region.

Likewise, emission standards vary in residential, sensitive and industrial area. Naturally the standards for sensitive areas like hospitals are more stringent. It is the duty of the Pollution Control Board to check whether the industries are following the prescribed norms or not.

Under the Environmental (Protection) Rules, 1986 the State Pollution Control Boards have to follow the guidelines provided under Schedule VI, some of which are as follows-

1. They have to advise the Industries for treating the waste water and gases with the best available technology to achieve the prescribed standards.
2. The industries have to be encouraged for recycling and reusing the wastes.
3. They have to encourage the industries for recovery of biogas, energy and reusable materials.
4. While permitting the discharge of effluents and emissions into the environment, the State Boards have to take into account the assimilative capacity of the receiving water body.
5. The Central and State Boards have to emphasize on the implementation of clean technologies by the industries in order to increase fuel efficiency and reduce the generation of environmental pollutants.

Under the Environment (Protection) Rules, 1986 and amendment was made in 1994 for Environmental Impact Assessment (EIA) of Various Development Projects.

There are 29 types of projects listed under Schedule I of the rule which require clearance from the Central Government before establishing. Others require clearance from the State Pollution Control Board, when the proposed project or expansion activity is going to cause pollution load exceeding the existing levels. The project proponent has to provide EIA report, risk analysis report, NOC from State Pollution Control Board, Commitment regarding availability of water and electricity,

Summary of project report/feasibility report filled in a questionnaire for environmental appraisal of the project and comprehensive rehabilitation plan, if more than 1000 people are likely to be displaced due to the project. Under the Environment (Protection) Act, 1986 the Central Government also made the Hazardous Wastes (Management and Handling) Rules, 1989.

Under these rules, it is the responsibility of the occupier to take all practical steps to ensure that such wastes are properly handled and disposed off without any adverse effects. There are 18 Hazardous Waste

categories recognized under this rule and there are guidelines for their proper handling, storage, treatment, transport and disposal which should be strictly followed by the owner.

The Environment (Protection) Act, 1986 has also made provision for environmental Audit as a means of checking whether or not a company is complying with the environmental laws and regulations. Thus, ample provisions have been made in our country through law for improving the quality of our environment.

4.15 THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

Salient features of the act are as follows-

1. The Act provides for prevention, control and abatement of air pollution.
2. In the Act, air pollution has been defined as the presence of any solid, liquid or gaseous substance (including noise) in the atmosphere in such concentration as may be or tend to be harmful to human beings or any other living creatures or plants or property or environment.
3. Noise pollution has been inserted as pollution in the Act in 1987.
4. Pollution control boards at the central or state level have the regulatory authority to implement the Air Act. Just parallel to the functions related to Water (Prevention and Control of Pollution) Act, the board performs similar functions related to improvement of air quality. The boards have to check whether or not the industry strictly follows the norms or standards laid down by the Board under section 17, regarding the discharge of emission of any air pollutant. Based upon analysis report consent is granted or refused to the industry.
5. Just like the Water Act, the Air Act has provisions for defining the constitution, powers and function of Pollution Control Boards, funds, accounts, audit, penalties and procedures.
6. Section 20 of the Act has provision for ensuring emission standards from automobiles. Based upon it, the state govt. is empowered to issue instructions to the authority incharge of registration of motor vehicles (under Motor Vehicles Act, 1939) that is bound to comply with such instructions.
7. As per Section 19, in consultation with the State Pollution Control Board, the state government may declare an area within the state as .air pollution control area. and can prohibit the use of any fuel other than approved fuel in the area causing air pollution. No person shall, without prior consent of State Board operate or establish any industrial unit in the .air pollution control area. The Water and Air Acts have also made special provisions for appeals. Under Section 28 of Water Act and Section 31 of Air Act, a provision for appeals has been made. An Appellate Authority consisting of a single person or three persons appointed by the Head of the State, Governor is constituted to hear such appeals as filed by some grieved party (industry) due to some order made by the State Board within 30 days of passing the orders. The Appellate Authority after giving the appellant and the State Board an opportunity of being heard, disposes off the appeal as expeditiously as possible.

4.16 WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

It provides for maintaining and restoring the wholesomeness of water by preventing and controlling its pollution.

Pollution is defined as such contamination of water, or such alteration of the physical, chemical or biological properties of water, or such discharge as is likely to cause a nuisance or render the water harmful or injurious to public health and safety or harmful for any other use or to aquatic plants and other organisms or animal life.

The salient features and provisions of the Act are summed up as follows-

1. It provides for maintenance and restoration of quality of all types of surface and ground water.
2. It provides for the establishment of Central and State Boards for pollution control.
3. It confers them with powers and functions to control pollution. The Central and State Pollution Control Boards are widely represented and are given comprehensive powers to advise, coordinate and provide technical assistance for prevention and control of pollution of water.

4. The Act has provisions for funds, budgets, accounts and audit of the Central and State Pollution Control Boards.
5. The Act makes provisions for various penalties for the defaulters and procedure for the same.

4.17 WILDLIFE (PROTECTION) ACT, 1972

Wildlife was transferred from State list to concurrent list in 1976, thus giving power to the Central Govt. to enact the legislation.

The Indian Board of Wildlife **(IBWL)** was created in 1952 in our country, which after the enactment of the Wildlife (Protection) Act actively took up the task of setting up wildlife National Parks and sanctuaries. The major activities and provisions in the act can be summed up as follows

1. It defines the wild-life related terminology.
2. It provides for the appointment of wildlife advisory Board, Wildlife warden, their powers, duties etc.
3. Under the Act, comprehensive listing of endangered wild life species was done for the first time and prohibition of hunting of the endangered species was mentioned.
4. Protection to some endangered plants like Beddome cycad, Blue Vanda, Ladies Slipper Orchid, Pitcher plant etc. is also provided under the Act.
5. The Act provides for setting up of National Parks, Wildlife Sanctuaries etc.
6. The Act provides for the constitution of Central Zoo Authority.
7. There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.
8. The Act imposes a ban on the trade or commerce in scheduled animals.
9. It provides for legal powers to officers and punishment to offenders.
10. It provides for captive breeding programme for endangered species.

Several Conservation Projects for individual endangered species like lion (1972) Tiger (1973), Crocodile (1974) and Brown antlered Deer (1981) were started under this Act.

Some of the major drawbacks of the Act include mild penalty to offenders, illegal wild life trade in J & K, personal ownership certificate for animal articles like tiger and leopard skins, no coverage of foreign endangered wildlife, pitiable condition of wildlife in mobile zoos and little emphasis on protection of plant genetic resources.

4.18 FOREST (CONSERVATION) ACT, 1980

This act deals with the conservation of forests and related aspects. The Act covers under it all types of forests including reserved forests, protected forests or any forested land irrespective of its ownership.
The salient features of the Act are as follows-

1. The State Govt. has been empowered under this Act to use the forests only for forestry purposes. If at all it wants to use it in any other way, it has to take prior approval of central Government, after which it can pass orders for declaring some part of reserve forest for non-forest purposes (e.g mining) or for clearing some naturally growing trees and replacing them by economically important trees (reforestation).
2. It makes provision for conservation of all types of forests and for this purpose there is an Advisory committee which recommends funding for it to the Central Government.
3. Any illegal non-forest activity within a forest area can be immediately stopped under this Act. Non-forest activities include clearing of forest land for cultivation of any type of plants/crops or any other purpose (except re-afforestation). However, some construction work in the forest for wildlife or forest management is exempted from non-forest activity (e.g. fencing, making water-holes, trench, pipelines, check posts, wireless communication etc.)

1992 Amendment in the Forest Act

In 1992, some amendment was made in the Act which made provisions for allowing some non-forest activities in forests, without cutting trees or limited cutting with prior approval of Central Government.

These activities are setting of transmission lines, seismic surveys, exploration, drilling and hydroelectric projects. The last activity involves large scale destruction of forest, for which prior approval of the Centre is necessary.

Wildlife sanctuaries, National Parks etc. are totally prohibited for any exploration or survey under this Act without prior approval of Central Govt. even if no tree-felling is involved. Cultivation of tea, coffee, spices, rubber and plants which are cash-crops, are included under non-forestry activity and not allowed in reserve forests.

Even cultivation of fruit-bearing trees, oil-yielding plants or plants of medicinal value in forest area need to be first approved by the Central Government. This is because newly introduced species in the forest area may cause an imbalance in the ecology of the forest. If the species to be planted is a native species, then no prior clearance is required.

Tusser cultivation (a type of silk-yielding insect) in forest areas by tribal as a means of their livelihood is treated as a forestry activity as long as it does not involve some specific host tree like Asan or Arjun.

This is done in order to discourage monoculture practices in the forests which are otherwise rich in biodiversity.

Plantation of mulberry for rearing silkworm is considered a non-forest activity. Mining is a non- forestry activity and prior approval of Central Govt. is mandatory. The Supreme Court in a case T.N. Godavarman Thirumulkpad vs. Union of India (1997) directed all on-going mining activity to be ceased immediately in any forest area of India if it had not got prior approval of Central government.

Removal of stones, bajri, boulder etc., from river-beds located within the forest area fall under non- forest activity.

Any proposal sent to central govt. for non-forest activity must have a cost-benefit analysis and Environmental Impact statement (EIS) of the proposed activity with reference to its ecological and socio-economic impacts. Thus, the Forests (Conservation) Act has made ample provisions for conservation and protection of forests and prevents deforestation.

4.19 ECOMARK

It is the certificate issued by Bureau of Indian Standards. Its objective is to increase the environmental awareness among the consumers.

4.20 ENVIRONMENTAL LEGISLATION

India is the first country in the world to have made provisions for the protection and conservation of environment in its constitution. On 5th June, 1972, environment was first discussed as an item of international agenda in the U.N. Conference on Human Environment in Stockholm and thereafter 5th June is celebrated all over the world as World Environment Day.

Constitutional Provisions

Article 48-A of the constitution provides: .The state shall endeavour to protect and improve the environment and to safeguard forests and wildlife of the country.

Article 51A (g) provides: It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.

4.18 ENFORCEMENT OF ENVIRONMENTAL LEGISLATION

There are a number of important environmental laws in the form of Acts for safeguarding our environmental quality. But in spite of these acts, we find that we are not able to achieve the target of bringing 33% of our land cover under forests. Still we are losing our wild life.

The rivers have been turned into open sewers in many places and the air in our big cities is badly polluted. The status of environment shows that there are drawbacks in environmental legislations and problems in their effective implementation.

Let us examine some important issues related to our acts.

- **Drawbacks of the Wildlife (Protection) Act, (1972)**
  - The Act has been enacted just as fallout of Stockholm Conference held in 1972 and it has not included any locally evolved conservation measures.

- The ownership certificates for animal articles (tiger, leopard skins etc.) are permissible which very often serve as a tool for illegal trading.
- The wildlife traders in Jammu and Kashmir easily get illegal furs and skins from other states which after making caps, belts etc. are sold or smuggled to other countries. This is so happening because J & K has its own Wildlife Act and it does not follow the Central Wild Life Act.
- Moreover, hunting and trading of several endangered species prohibited in other states are allowed in J & K, thereby opening avenues for illegal trading in such animals and articles. The offender of the Act is not subject to very harsh penalties. It is just up to 3 years imprisonment or a fine of Rs. 25,000 or both.

❖ **Drawbacks of the Forest (Conservation) Act, 1980**

- This Act has inherited the exploitative and consumerist elements from the Forest laws of British period. It has just transferred the powers from state to centre, to decide the conversion of reserve forest lands to non-forest areas.
- Thus power has been centralized at the top. At the same time, the local communities have been completely kept out from the decision- making process regarding the nature of use of forest area. Very often, the tribals who lived in the forest and were totally dependent on forests retaliate when stopped from taking any resources from there and start criminal activities including smuggling, killing etc.
- The Act has failed to attract public support because it has infringed upon the human rights of the poor native people. They argue that the law is concerned about protecting the trees, birds and animals, but is treating the poor people as marginal. Very poor community participation in the Act remains
- One of the major drawbacks which affects proper execution of the Act. The forest-dwelling tribal communities have a rich knowledge about the forest resources, their importance and conservation. But, their role and contribution is neither acknowledged nor honoured. Efforts are now being made to make up for the gaps in laws by introducing the principles of Public trust or Human rights Protection.

CPCB (Central and state Pollution Control Board)

1. It advises the central govt. in matters related to prevention and control of water pollution.
2. Coordinates the activities of State Pollution Control Boards and provides them technical assistance and guidance.
3. Organizes training programs for prevention and control of pollution.
4. Organizes comprehensive programs on pollution related issues through mass media.
5. Collects, compiles and publishes technical and statistical data related to pollution.
6. Prepares manuals for treatment and disposal of sewage and trade effluents. Plans nation-wide programs for prevention, control or abatement of pollution.
7. Establishes and recognizes laboratories for analysis of water, sewage or trade effluent sample.
8. The State Pollution Control Boards also have similar functions to be executed at state level and are governed by the directions of CPCB.
9. The Board advises the state govt. with respect to the location of any industry that might pollute a stream or a well.
10. It lays down standards for effluents and is empowered to take samples from any stream, well or trade effluent or sewage passing through an industry.

The State Board is empowered to take legal samples of trade effluent in accordance with the procedure laid down in the Act. The sample taken in the presence of the occupier or his agent is divided into two parts, sealed, signed by both parties and sent for analysis to some recognized lab.

If the samples do not conform to the prescribed water quality standards (crossing maximum permissible limits), then consent is refused to the unit. Every industry has to obtain consent from the Board (granted for a fixed duration) by applying on a prescribed Performa providing all technical details, along with a prescribed fee following which analysis of the effluent is carried out.

The Board suggests efficient methods for utilization, treatment and disposal of trade effluents. The Act has made detailed provisions regarding the power of the Boards to obtain information, take trade samples,

restrict new outlets, restrict expansion, enter and inspect the units and sanction or refuse consent to the industry after effluent analysis.

While development is necessary, it is all the more important to prevent pollution, which can jeopardize the lives of the people. Installation and proper functioning of effluent treatment plants (ETP) in all polluting industries is a must for checking pollution of water and land.

Despite certain weaknesses in the Act, the Water Act has ample provisions for preventing and controlling water pollution through legal measures.

DRAWBACKS OF POLLUTION RELATED ACTS

The power and authority has been given to central government with little delegation of power to state government. Excessive centralization very often hinders efficient execution of the provisions of the Acts in the states. Illegal mining is taking place in many forest areas.

In Rajasthan alone, about 14000 cases of illegal mining have been reported. It becomes more difficult to check such activities at the central level. The provision of penalties in the Act is very insignificant as compared to the damage caused by the big industries due to pollution. The penalty is much less than the cost of the treatment pollution control equipments. This always gives a loose rope to the industries.

The Act has not included the right to information for the citizens. This greatly restricts the involvement or participation of the general public. The Environment (Protection) Act, 1986 regarded as an umbrella Act, encompassing the earlier two Acts often seems superfluous due to overlapping areas of jurisdiction. For instance Section 24 (2) of the new Act has made a provision that if the offender is punishable under the other Acts like Water Act or Air Act also, then he may be considered under their provisions.

Interestingly, the penalty under the older two Acts is much lighter than the new Act. So the offender easily gets away with a lighter punishment. Under Section 19, a person cannot directly file a petition in the court on a question of environment and has to give a notice of minimum 60 days to the central government. In case no action is taken by the latter, then alone the person can file a petition which certainly delays the remedial action.

Litigation, particularly related to environment is very expensive, tedious and difficult since it involves expert testimony, technical knowledge of the issues and terminologies, technical understanding of the unit process, lengthy prosecutions etc.

The State Boards very often lack adequate funds and expertise to pursue their objectives. A tendency to seek to exercise gentle pressure on the polluter and out of the court settlements usually hinders the implementation of legal measures. For small units it is very expensive to install Effluent Treatment Plant (ETP) or Air pollution control devices and sometimes they have no other option but to close the unit.

The Act should make some provision for providing subsidies for installing treatment plants or common effluent treatment plants for several small units. The pollution control laws are not backed by sound policy pronouncements or guiding principles. The position of chairman of the boards is usually occupied by political appointee. Hence it is difficult to keep political interference at bay.

The policy statement of the Ministry of Environment and Forests (1992) of involving public in decision-making and facilitating public monitoring of environmental issues has mostly remained on paper. Environmental policies and laws need to be aimed at democratic decentralization of power, community-state partnership, administrative transparency and accountability and more stringent penalties to the offender. There is also a need for environmental law education and capacity building in environmental issues for managers.

❖ **FLOOD**

DISASTER MANAGEMENT:

A flood occurs due to continuous heavy rainfall in an area, overflowing of rivers and submerging the surrounding areas damaging life and property.

Control

(i) Various preventive measures are proper embankment of water bodies, building check dams on flood-prone streams, prohibiting cultivation in flood plain of rivers and growing forests and perennial trees,

interlinking of river of the country and constructing houses on raised platforms and supported by reinforced stilts.

(ii) Floods can be controlled by collecting data from meteorological department and alerting the people of affecting area.

(iii) Educating the people about the steps to be taken in the event of disaster.

(iv) Hill slopes and catchment areas of rivers must be afforested and reforested.

- **EARTHQUAKE**

Sudden tremors of the earth's surface are produced due to movement of tectonic plates under the earth. This displacement of earth's crust releases energy stored within the earth's interior which produces vibratory waves.

The intensity of earthquake is measured by Richter, Scale which ranges from 0 to 9. The point from which the earthquake originates is called as epicenter.

Prevention, Control & Mitigation

(i) Constructing earthquake resistant building in the known earthquake prone zones e.g. wooden houses are preferred in Japan.

(ii) Installation of earthquake study centers studying seismic activities and analysis of seismic zones.

(iii) There must be insurance policies for earthquake victims rehabilitate them.

(iv) Creation of special task forces, fully trained and equipped, to manage such calamities within shortest possible time.

- **CYCLONE**.

A cyclone is powerful circular or oval swirling storm of high velocity wind in the coastal regions of Indian Ocean. It is called hurricane in Atlantic Ocean, typhoon in Western Pacific and Willy-willy in sea around Australia.

Control-

(i) Afforestation of coastal areas is the best measure.

(ii) Construction of dams, embankments, wind breakers etc.

(iii) Conservation of mangroves in coastal plains.

(iv) Better forecast, warning systems with the help of remote sensing satellites.

(v) Construction of cyclone proof houses and building in coastal areas.

- **LANDSLIDES**

Landslide is the sudden down slope movement of a mass of rock or soil due to gravitational pull, generally in the rainy season.

Control

(i) Afforestation and reforestation in the landslide prone areas is the best measure.

(ii) There should be no construction activity in slope areas.

(iii) Proper drainage of surface and sub surface water.

(iv) Making concrete support at the base of slope along the road.

(v) Construction of curved stone blocks in the risky areas.

4.19 PUBLIC ENVIRONMENTAL AWARENESS

Public awareness about environment is at a stage of infancy. Some awareness has taken place related to environmental degradation, pollution etc. but incomplete knowledge and information and ignorance about many aspects has often led to misconceptions.

Development has paved the path for rise in the levels or standards of living but it has simultaneously led to serious environmental disasters. Issues related to environment have often been branded as antidevelopment.

Some of the main reasons responsible for widespread of environmental ignorance can be summed up as follows

- Our courses in Science, technology, economics etc. have so far failed to integrate the knowledge in environmental aspects as an essential component of the curriculum.
- Our planners, decision-makers, politicians and administrators have not been trained so as to consider the environmental aspects associated with their plans.
- In zeal to go ahead with some ambitious development projects, quite often there is purposeful concealment of information about environmental aspects.
- (iv)There is greater consideration of economic gains and issues related to eliminating poverty by providing employment that overshadows the basic environmental issues.

Methods to Propagate Environmental Awareness-

Environmental awareness needs to be created through formal and informal education to all sections of the society. Everyone needs to understand it because environment belongs to all and every individual matters. When it comes to conservation and protection of environment various stages and methods that can be useful for raising environmental awareness in different sections of the society are as follows:

- **Among students through education**
  - Environmental education must be imparted to the students right from the childhood stage.
  - It is a welcome step that now all over the country we are introducing environmental studies as a subject at all stages including school and college level, following the directives of the Supreme Court.
- **Through mass-media**
  - Media can play an important role to educate the masses on environmental issues through articles, environmental rallies, plantation campaigns, street plays, real eco-disaster stories and success stories of conservation efforts.
- **Among the planners, decision-makers and leaders**
  - Since this elite section of the society plays the most important role in shaping the future of the society, it is very important to give them the necessary orientation and training through specially organized workshops and training programmers.
  - Publication of environment - related resource material in the form of pamphlets or booklets published by Ministry of Environment &Forests can also help in keeping this section abreast of the latest developments in the field.

4.20 CLIMATE CHANGE

Climate is the average weather of an area. It includes general weather conditions, seasonal variations and extremes of weather in a region. Such conditions which average over a long period- at least 30 years is called climate.

The Intergovernmental Panel on Climate Change (**IPCC**) in 1990 and 1992 published best available evidence about past climate change, the greenhouse effect and recent changes in global temperature. It is observed that earth's temperature has changed considerably during the geological times. It has experienced several glacial and interglacial periods.

During the past 10,000 years of the current interglacial period the mean average temperature has fluctuated by 0.5- 1°C over 100 to 200 year period. We have relatively stable climate for thousands of years due to which we have practiced agriculture and increased in population. Even small changes in climatic conditions may disturb agriculture that would lead to migration of animals including humans.

Anthropogenic (man-made) activities are upsetting the delicate balance that has established between various components of the environment. Greenhouse gases are increasing in the atmosphere resulting in increase in the average global temperature. This may upset the hydrological cycle, result in floods and droughts in different regions of the world, cause sea level rise, changes in agriculture productivity, famines and death of humans as well as live stock.

The global change in temperature will not be uniform everywhere and will fluctuate in different regions. The places at higher latitudes will be warmed up more during late autumn and winter than the places in tropics.

Poles may experience 2 to 3 times more warming than the global average, while warming in the tropics may be only 50 to 100% on an average. The increased warming at poles will reduce the thermal gradient between the equator and high latitude regions decreasing the energy available to the heat engine that drives the global weather machine.

This will disturb the global pattern of winds and ocean currents as well as the timing and distribution of rainfall. Shifting of ocean currents may change the climate of Iceland and Britain and may result in cooling at a time when rest of the world warms.

By a temperature increase of 1.5 to 4.5°C the global hydrological cycle is expected to intensify by 5 to 10%. Disturbed rainfall will result in some areas becoming wetter and the others drier. Although rainfall may increase, higher temperatures will result in more evapo-transpiration leading to annual water deficit in crop fields.

4.21 GLOBAL WARMING

Troposphere, the lowermost layer of the atmosphere, traps heat by a natural process due to the presence of certain gases. This effect is called **Greenhouse Effect** as it is similar to the warming effect observed in the horticultural greenhouse made of glass.

The amount of heat trapped in the atmosphere depends mostly on the concentrations of heat trapping or greenhouse gases and the length of time they stay in the atmosphere. The major greenhouse gases are carbon dioxide, ozone, methane, nitrous oxide, chlorofluorocarbons (CFCs) and water vapors.

The average global temperature is 15°C. In the absence of greenhouse gases this temperature would have been 18°C. Therefore, Greenhouse Effect contributes a temperature rise to the tune of 33°C. Heat trapped by greenhouse gases in the atmosphere keeps the planet warm enough to allow us and other species to exist.

The two predominant greenhouse gases are water vapors, which are controlled by hydrological cycle, and carbon dioxide, which is controlled mostly by the global carbon cycle. While the levels of water vapor in the troposphere have relatively remained constant, the levels of carbon dioxide have increased.

Other gases whose levels have increased due to human activities are methane, nitrous oxide and chlorofluorocarbons. Deforestation has further resulted in elevated levels of carbon dioxide due to non- removal of carbon dioxide by plants through photosynthesis.

Warming or cooling by more than 2°C over the past few decades may prove to be disastrous for various ecosystems on the earth including humans, as it would alter the conditions faster than some species could adapt or migrate. Some areas will become inhabitable because of drought or floods following a rise in average sea level.

❖ Greenhouse Gases

Due to anthropogenic activities there is an increase in the concentration of the greenhouse gases in the air that absorb infra-red light containing heat and results in the re-radiation of even more of the outgoing thermal infra-red energy, thereby increasing the average surface temperature beyond 15°C. The phenomenon is referred to as the **enhanced greenhouse effect** to distinguish its effect from the one that has been operating naturally for millennia. The greenhouse gases present in the troposphere and resulting in an increase in the temperature of air and the earth are discussed here-

1. **Carbon dioxide**
   - It contributes about 55% to global warming from greenhouse gases produced by human activity. Industrial countries account for about 76% of annual emissions.
   - The main sources are fossil fuel burning (67%) and deforestation, other forms of land clearing and burning (33%).

- CO2 stays in the atmosphere for about 500 years. CO2 concentration in the atmosphere was 355 ppm in 1990 that is increasing at a rate of 1.5 ppm every year

2. **Chlorofluorocarbons (CFCs)**
   - This is responsible for 24% of the human contribution to greenhouse gases.
   - They also deplete ozone in the stratosphere. The main sources of CFCs include leaking air conditioners and refrigerators, evaporation of industrial solvents, production of plastic foams, aerosols, propellants etc.
   - CFCs take 10-15 years to reach the stratosphere and generally trap 1500 to 7000 times more heat per molecule than CO2 while they are in the troposphere. This heating effect in the troposphere may be partially offset by the cooling caused when CFCs deplete ozone during their 65 to 110 years stay in the stratosphere.
   - Atmospheric concentration of CFC is 0.00225 ppm that is increasing at a rate of 0.5% annually.
3. **Methane (CH4)**
   - It accounts for 18% of the increased greenhouse gases.
   - Methane is produced when bacteria break down dead organic matter in moist places that lack oxygen such as swamps, natural wetlands, paddy fields, landfills and digestive tracts of cattle, sheep and termites. Production and use of oil and natural gas and incomplete burning of organic material are also significant sources of methane.
   - Methane stays in the atmosphere for 7-10 years. Each methane molecule traps about 25 times as much heat as a CO2 molecule.
   - Atmospheric concentration of methane is 1.675 ppm and it is increasing at a rate of 1% annually.
4. **Nitrous Oxide (N2O)**
   - It is responsible for 6% of the human input of greenhouse gases. Besides trapping heat in the troposphere it also depletes ozone in the stratosphere.
   - It is released from nylon products, from burning of biomass and nitrogen rich fuels (especially coal) and from the breakdown of nitrogen fertilizers in soil, livestock wastes and nitrate contaminated ground water.
   - Its life span in the troposphere is 140-190 years and it traps about 230 times as much heat per molecule as CO2. The atmospheric concentration of N_2O is 0.3 ppm and is increasing at a rate of 0.2% annually.

Impacts of Enhanced Greenhouse Effect

The enhanced greenhouse effect will not only cause global warming but will also affect various other climatic and natural processes.

- **Global temperature increase**
  - It is estimated that the earth's mean temperature will rise between 1.5 to 5.5°C by 2050 if input of greenhouse gases continues to rise at the present rate.
  - Even at the lower value, earth would be warmer than it has been for 10,000 years.
- **Rise in Sea Level**
  - With the increase in global temperature sea water will expand. Heating will melt the polar ice sheets and glaciers resulting in further rise in sea level.
  - Current models indicate that an increase in the average atmospheric temperature of 3°C would raise the average global sea level by 0.2.1.5 meters over the next 50.100 years.

One meter rise in sea level will inundate low lying areas of cities like Shanghai, Cairo, Bangkok, Sydney, Hamburg and Venice as well as agricultural lowlands and deltas in Egypt, Bangladesh, India, China and will affect rice productivity. This will also disturb many commercially important spawning grounds, and would probably increase the frequency of storm damage to lagoons, estuaries and coral reefs.

In India, the Lakshadweep Islands with a maximum height of 4 meters above the level may be vulnerable. Some of the most beautiful cities like Mumbai may be saved by heavy investment on embankment to prevent inundation.

Life of millions of people will be affected, by the sea level rise who have built homes in the deltas of the Ganges, the Nile, the Mekong, the Yangtze and the Mississippi rivers.

- **Effects on Human Health**
  - The global warming will lead to changes in the rainfall pattern in many areas, thereby affecting the distribution of vector-borne diseases like malaria, filariasis, elephantiasis etc.
  - Areas which are presently free from diseases like malaria, schistosomiasis etc. may become the breeding grounds for the vectors of such diseases. The areas likely to be affected in this manner are Ethiopia, Kenya and Indonesia.
  - Warmer temperature and more waste stagnation would favour the breeding of mosquitoes, snails and some insects, which are the vectors of such diseases. Higher temperature and humidity will increase/aggravate respiratory and skin diseases.
- **Effects on Agriculture**
  - The effect of global warming on agriculture may show positive or negative effects on various types of crops in different regions of the world.
  - Tropical and subtropical regions will be more affected since the average temperature in these regions is already on the higher side. Even a rise of 2°C may be quite harmful to crops.
  - Soil moisture will decrease and evapo-transpiration will increase, which may drastically affect wheat and maize production. Increase in temperature and humidity will increase pest growth like the growth of vectors for various diseases.
  - Pests will adapt to such changes better than the crops. To cope up with the changing situation drought resistant, heat resistant and pest resistant varieties of crops have to be developed.

Measures to Check Global Warming

To slow down enhanced global warming the following steps will be important-

- Cut down the current rate of use of CFCs and fossil fuel.
- Use energy more efficiently.
- Shift to renewable energy resources.
- Increase Nuclear Power Plants for electricity production.
- Shift from coal to natural gas.
- Trap and use methane as a fuel.
- Reduce beef production.
- Adopt sustainable agriculture.
- Stabilize population growth.
- Efficiently remove CO_2 from smoke stacks.
- Plant more trees.
- Remove atmospheric CO_2 by utilizing photosynthetic algae.

4.22 ACID RAIN

Oxides of sulphur and nitrogen originating from industrial operations and fossil fuel combustion are the major sources of acid forming gases. Acid forming gases are oxidized over several days by which time they travel several thousand kilometres.

In the atmosphere these gases are ultimately converted into sulfuric and nitric acids. Hydrogen chloride emission forms hydrochloric acid. These acids cause acidic rain. Acid rain is only one component of acidic deposition. Acidic deposition is the total of wet acidic deposition (acid rain) and dry deposition. Rain water is turned acidic when its pH falls below 5.6.

The clean or natural rain water has a pH of 5.6 at 20°C because of formation of carbonic acid due to dissolution of CO_2 in water. The Adirondack Lakes located in the state of New York are known to receive acid rains. The strong acids like sulphuric acid (H_2SO_4) and nitric acid(HNO_3) dissolved or formed in rainwater dissociate or release hydrogen ions thereby increasing the acidity in rain drops.

Generally sulfuric acid forms a major fraction of acid rain, followed by nitric acid and a very small fraction of other acids. However, in urban areas calcium (Ca^{2+}), Magnesium (Mg^{2+}) and ammonium (NH_4^+) ions help to neutralize the rain drops shifting the overall H^+ towards basic scale.

The overall pH of any raindrop is due to the net effect of carbonic acid, sulfuric acid, nitric acid and other acidic constituents or any neutralizers such as ammonia In the absence of rain, dry deposition of acid may occur.

Acid forming gases like oxides of sulphur and nitrogen and acid aerosols get deposited on the surface of water bodies, vegetation, soil and other materials. On moist surfaces or in liquids these acid forming gases can dissolve and form acids similar to that formed in acid rain. If the oxidizers are present on the liquid surfaces then these gases undergo oxidation to form acids.

Fine particles or acid droplets can act as nuclei for water to condense to form rain droplets. By such process sulfuric acid is incorporated into the droplets. In the clouds additional SO2 and NO2 contact the droplets and get absorbed which can be oxidized by the dissolved hydrogen peroxide (H2O2) or other oxidizers. In the droplets falling from the clouds additional acidic gases and aerosol particles get incorporated, further decreasing their pH.

A unit decrease in pH value causes 10 times increase in acidity. Average pH in rainfall over eastern United States from April 1979 to March 1980 was less than 5.0. In India acid rain is recorded from certain places:

Name of place	**pH of rainwater**
Kodaikanal	5.18
Minicoy	5.52
Mohanbari	5.50

Effects of acid rain

Acid rain causes a number of harmful effects below pH 5.1. The effects are visible in the aquatic system even at pH less than 5.5.l It causes deterioration of buildings especially made of marble e.g. monuments like Taj Mahal. Crystals of calcium and magnesium sulphate are formed as a result of corrosion caused by acid rain.

It damages stone statues. Priceless stone statues in Greece and Italy have been partially dissolved by acid rain. It damages metals and car finishes. Aquatic life especially fish are badly affected by lake acidification. Aquatic animals suffer from toxicity of metals such as aluminium, mercury, manganese, zinc and lead which leak from the surrounding rocks due to acid rain. It results in reproductive failure, and killing of fish.

Many lakes of Sweden, Norway, Canada have become fishless due to acid rain. It damages foliage and weakens trees. It makes trees more susceptible to stresses like cold temperature, drought, etc. Many insects and fungi are more tolerant to acidic conditions and hence they can attack the susceptible trees and cause diseases.

Control of Acid Rain

Emission of SO2 and NO2 from industries and power plants should be reduced by using pollution control equipments. Liming of lakes and soils should be done to correct the ad- verse effects of acid rain. A coating of protective layer of inert polymer should be given in the interior of water pipes for drinking water.

4.23 OZONE LAYER DEPLETION

For the last 450 million years the earth has had a natural sunscreen in the stratosphere called the ozone layer. This layer filters out harmful ultraviolet radiations from the sunlight and thus protects various life forms on the earth. Ozone is a form of oxygen.

The molecule of oxygen contains two atoms whereas that of ozone contains three (O3). In the stratosphere ozone is continuously being created by the absorption of short wave- length ultraviolet (UV) radiations. Ultraviolet radiations less than 242 nanometres decompose molecular oxygen into atomic oxygen (O) by photolytic decomposition.

$$O_2 + hv = O + O$$

The atomic oxygen rapidly reacts with molecular oxygen to form ozone.

$$O + O_2 + M = O_3 + M$$

(M is a third body necessary to carry away the energy released in the reaction). Ozone thus formed distributes itself in the stratosphere and absorbs harmful ultraviolet radiations (200 to 320 nm) and is continuously being converted back to molecular oxygen.

$$O_3 + hv = O_2 + O$$

Absorption of UV radiations results in heating of the stratosphere. The net result of the above reactions is an equilibrium concentration of ozone.

Ozone concentration in about 24 km of the stratosphere i.e. from 16 km to 40 Km away from earth is about 10 ppm (as compared to 0.05 ppm concentration of harmful troposphere ozone). This equilibrium is disturbed by reactive atoms of chlorine, bromine etc. which destroy ozone molecules and result is thinning of ozone layer generally called ozone hole.

The amount of atmospheric ozone is measured by **Dobson Spectrometer** and is expressed in **Dobson units (DU).** One DU is equivalent to a 0.01 mm thickness of pure ozone at the density it would possess if it were brought to ground level (1atm) pressure.

Normally over temperate latitude concentration is about 350 DU, over tropics it is 250 DU whereas at sub polar regions (except when ozone thinning occurs) it is on an average 450 DU. It is because of the stratospheric winds which transport ozone from tropical towards polar regions.

Thinning of Ozone Layer

The Antarctic ozone hole was discovered by Dr Joe C. Farman and his colleagues in the British Antarctic Survey who had been recording ozone levels over this region since 1957. During spring season of south pole i.e. September to November each year ozone depletion is observed. Steep decline has been observed since mid 1970s with a record low concentration of 90 DU in early October of 1993.

Chlorofluorocarbons (CFC) are mainly responsible for ozone depletion in the stratosphere. CFCs are a group of synthetic chemicals first discovered by Thomas Midgley Jr. in 1930. CFC-11 and CFC-12 are the CFCs most commonly used. CFCs are used as coolants in refrigerators and air conditioners, as propellants, cleaning solvents, sterilant and in styrofoam etc. CFCs released in the troposphere reach the stratosphere and remain there for 65-110 years destroying O3 molecules.

In 1974, Rowland and Molina warned that CFC are lowering the concentration of ozone in the stratosphere and predicted severe consequences. It was in 1985 that scientists discovered that 50% (98% in some areas) of upper stratospheric ozone over Antarctica was destroyed during the Antarctic spring and early summer (September-December). At Antarctic region the temperature during winter drops to 90°C. The winds blowing in a circular pattern over earth's poles create polar vortices.

Water droplets in clouds when enter these vortices form ice crystals. CFCs get collected on the surfaces of these ice crystals and destroy ozone much faster. Similar destruction of ozone over North Pole occurs during Arctic spring and early summer (February-June). The depletion is 10-25% and it is less than that observed at South Pole. Nitrous oxide emitted by supersonic aircrafts, during combustion of fossil fuel and use of nitrogen fertilizers breaks ozone molecules.

Chlorine liberated from chlorofluorocarbons also break ozone molecules. The chain reaction started in Antarctic spring i.e. August/ September continues till nitrogen dioxide is liberated from nitric acid formed in the stratosphere by photolysis (breakdown by sunlight). Nitrogen dioxide combines with chlorine and stops further destruction of ozone.

Effects of Ozone Depletion

Ozone depletion in the stratosphere will result in more UV radiation reaching the earth especially UV-B (290-320 nm). The UV-B radiations affect DNA and the photosynthetic chemicals. Any change in DNA can result in mutation and cancer. Cases of skin cancer (basal and squamous cell carcinoma) which do not cause death but cause disfigurement will increase.

Easy absorption of UV rays by the lens and cornea of eye will result in increase in incidents of cataract. Melanin producing cells of the epidermis (important for human immune system) will be destroyed by UV-rays resulting in immuno-suppression.

Fair people (can't produce enough melanin) will be at a greater risk of UV exposure. Phytoplanktons are sensitive to UV exposure. Ozone depletion will result in decrease in their population thereby affecting the population of zooplankton, fish, marine animals, in fact the whole aquatic food chain.

Yield of vital crops like corn, rice, soybean, cotton, bean, pea, sorghum and wheat will decrease. Degradation of paints, plastics and other polymer material will result in economic loss due to effects of UV radiation resulting from ozone depletion.

UNIT-5 HUMAN POPULATION AND THE ENVIRONMENT

Population:

The group of individuals belonging to the same species living in an area at a given time is called as population.

Population Density

It is expressed as the number of individuals of the population per unit area. This varies in response to changes in the environment and introduction with other living organism.

Parameters affecting population size

1. Birth rate or natality

It is the number of live birth per 1000 people in a population in a given year.

2. Death rate or Mortality

It is the number of death per 1000 people in a population in a given year.

3. Immigration

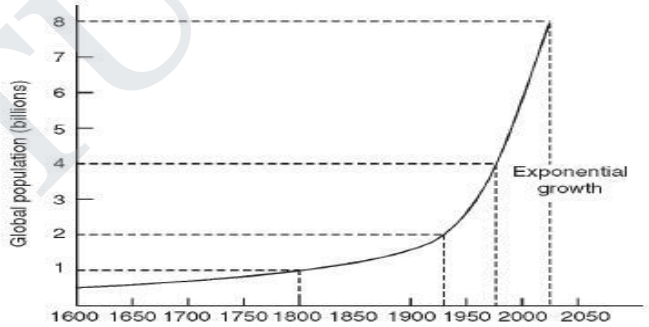
It denotes the arrival of individuals from neighboring population.

4. Emigration

It denotes the dispersal of individuals from native area to a new area.

Population Growth

- In 1800, the earth was home to about 1 billion people.
- It took about 39,000 years of human history to reach 1 billion, 130 years to reach the second billion, 45 years to reach 4 billion and the next doubling is likely within a span of a few decades.
- Population had already crossed 6 billion and may reach 10 billion by 2050 as per the World Bank estimates. The dramatic way in which global human population grew thereafter is shown in Figure



Global population growth trends in the last four centuries.

Reasons of this trend of human population growth:

During the Stone Age, population was quite stable. Environmental conditions were hostile and humans had not yet developed adequate artificial means for adaptations to these stresses.

Droughts and outbreak of diseases used to be quite common leading to mass deaths. 14th century A.D. experienced large scale mortality due to bubonic plague when about 50% of people in Asia and Europe died due to the disease.

With scientific and technological advancement, life expectancy of humans improved. People started living in definite settlements leading a more stable life with better sanitation, food and medical facilities. Victory over famine-related deaths and infant mortality became instrumental for a rapid increase in population size.

Effects:

The rapid increase of human population is putting an incredible strain on our environment. While developed countries continue to pollute the environment and deplete its resources, developing countries are under increasing pressure to compete economically and their industrial advancements are damaging as well.

The demands that this growth places on our global environment are threatening the future of sustainable life on earth. As the world's population grows, improving living standards without destroying the environment is a global challenge.

Many basic resources that are strained by our current population are given below:

1. **Water Scarcity:**

It is the lack of sufficient available water resources to meet the demands of water usage (water for consumption, agriculture and sanitation) within a region.

Aquifers are being depleted faster than they can be replenished. Melting glaciers threaten the water supply for billions. More than 1.2 billion people lack access to clean drinking water.

The supply of freshwater is finite, but demand is soaring as population grows and uses per capita rises. Depending on future rates of population growth, between 2.6 billion and 3.1 billion people may be living in either water-scarce or water-stressed conditions by 2025.

2. **Food supply:**

In 64 of 105 developing countries studied by the UN Food and Agriculture Organization, the population has been growing faster than food supplies.

Population pressures have degraded some 2 billion hectares of arable land, one billion people, one out of every seven people alive, go to bed hungry. Every day 25,000 people die of malnutrition and hunger related diseases.

Almost 18,000 of them are children under 5 years old. The number of people living in countries where cultivated land is critically scarce is projected to increase to between 600 million and 986 million in 2025.

Food production and distribution could catch up if our population stopped growing and dropped to a sustainable level.

3. **Coastlines and oceans:**

Half of all coastal ecosystems are pressured by high population densities and urban development. A tide of pollution is rising in the world's seas. Ocean fisheries are being overexploited, and fishery is down.

Most of the world's ocean fisheries are already being fished to their maximum capacities and are in decline**.**

4. **Forests**:

Over 1.8 billion people live in 36 countries with less than 0.1 hectare of forested land per capita, an indicator of critically low levels of forest cover. Based on the medium population projection and current deforestation trends, by 2025 the number of people living in forest-

scarce countries could nearly double to 3 billion. Nearly half of the world's original forest cover has been lost, and each year another 16 million hectares are cut, bulldozed, or burned. Forests provide over US$400 billion to the world economy annually and are vital to maintaining healthy ecosystems. Yet, current demand for forest products may exceed the limit of sustainable consumption by 25%.

5. Global Warming:

The earth's surface is warming due to greenhouse gas emissions, largely from burning fossil fuels. If the global temperature rises as projected, sea levels would rise by several meters, causing widespread flooding. Global warming also could cause droughts and disrupt agriculture.

In 1998, global data are available for both population and heat-trapping carbon dioxide emissions, per capita emissions of CO_2 continued the upward trend that dominated the middle 1990s. When combined with growing world population, these increased per capita emissions accelerated the accumulation of greenhouse gases in the global atmosphere and, thus, future global warming.

6. **Species Extinction:**

More than 1.1 billion people live in areas that conservationists consider the richest in non-human species and the most threatened by human activities. While these areas comprise about 12 percent of the planet's land surface, they hold nearly 20 percent of its human population.

The population in these biodiversity hotspots is growing at a collective rate of 1.8 percent annually, compared to the world's population's annual growth rate of 1.3 percent.

Human population growth is the number one threat to the world's environment. Each person requires energy, space and resources to survive, which results in environmental losses. If the human population were maintained at sustainable levels, it would be possible to balance these environmental losses with renewable resources and regeneration. But our population is rapidly rising beyond the earth's ability to regenerate and sustain us with a reasonable quality of life. We are exceeding the carrying capacity of our planet. We need to limit our growth voluntarily, and promote contraceptive use, before Nature controls our population for us with famines, drought and plagues.

<u>Population characteristics:</u>

1. Exponential growth:

When a quantity increases by a constant amount per unit time e.g. 1, 3, 5, 7 etc. it is called **linear growth.** And when it increases by a fixed percentage it is known as exponential growth e.g. 10, 102, 103, 104, or 2, 4, 8, 16, 32 etc.

2. Doubling time:

The time needed for a population to double its size at a constant annual rate is known as doubling time. It is calculated as follow-

$$Td = 70/r$$

Td = Doubling time in years r
= annual growth rate

3. Total Fertility rates (TFR) :

The average number of children that would be born to a woman in her lifetime if the age specific birth rates remain constant. The value of TFR varies from 1.9 in developed nations to 4.7 in developing nations.

4. Infant mortality rate (IMR) :

It is the percentage of infants died out of those born in a year. Although this rate has declined in the last 50 years, but the pattern differs widely in developed and developing countries.

5. Replacement level:

This is an important concept in population dynamics or demography. Two parents bearing two children will be replaced by their offspring. But, due to infant mortality this replacement level is usually changed.

For developing nations, where infant mortality is high and life expectancy is low, the replacement level is approx 2.7, whereas in developed nations it is 2.1.

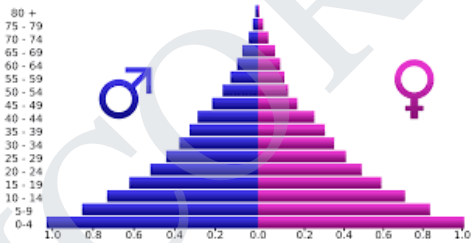
6. Age Structure:

Based upon people belonging to different age classes like pre-reproductive (0-14 years), reproductive (15-44 years) and post reproductive (45 years and above) Age structure of population of a nation can be represented by age pyramids,

a. Pyramid shaped:

The very young population is more, making a broad base and old people are less. This indicates growing population such as India, Bangladesh, Ethiopia, and Nigeria.

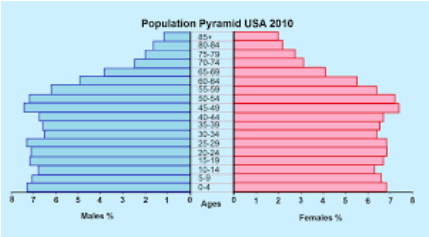
The large number of individuals in very young age will soon enter into reproductive age, thus causing an increase in population, whereas less number of people in old age indicates less loss of population due to death.



b. Bell shaped:

In Countries like France, USA and Canada where birth rates have in the past one or two decades declined resulting in people of almost equal number in age group 0-35 years.

So in the next 10 years, the people entering into reproductive age group is not going to change much and such age-pyramids indicate stable populations.



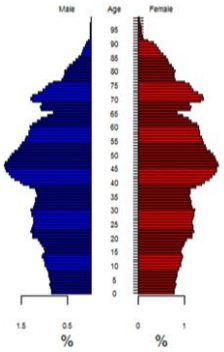
c. Urn shaped:

In Countries like Germany, Italy, Hungary, Sweden and Japan number of individuals in very young class is smaller than the middle reproductive age class.

In the next 10 years the number in reproductive age class will thus become less than before

resulting in a decline of population growth.

The TFR, age structure, infant mortality and replacement level are all important parameters determining population growth. But population will not stop growing even when all couples have only 2 children.



7. Zero population growth (ZPG):

When birth plus immigration in a population are just equal to deaths plus emigration, it is said to be zero population growth.

8. Male-Female ratio:

The ratio of boys and girls should be fairly balanced in a society to flourish. However, due to female infanticides and gender-based abortions, the ratio has been upset in many countries including India.

In China, the ratio of boys to girls became 140:100 in many regions which led to scarcity of brides.

9. Life expectancy:

It is the average age that a newborn infant is expected to attain in a given country. The average life expectancy, over the globe, has risen from 40 to 65.5 years over the past century.

In India, life expectancy of males and females was only 22.6 years and 23.3 years, respectively in 1900. In the last 100 years improved medical facilities and technological advancement has increased the life expectancy to 60.3 years and 60.5 years, respectively for the Indian males and females.

10. Demographic transition:

Population growth is usually related to economic development. There occurs a typical fall in death rates and birth rates due to improved living conditions leading to low population growth, a phenomenon called demographic transition. It is associated with urbanization and growth and occurs in four phases:

i. **Pre industrial phase** - high growth and death rates and net population growth is low.
ii. **Transitional phase** - advent of industrialization providing better hygiene and medical facilities and adequate food, thereby reducing deaths.
Birth rates, however, remain high and the population shows 2.5-3% growth rate.
iii. **Industrial phase** - fall in birth rates thereby lowering growth rate.
iv. **Post industrial phase** - zero population growth is achieved.

Demographic transition is already observed in most developing nations. As a result of demographic transition the developed nations are now growing at a rate of about 0.5% with a doubling time of 118 years.

However more than 90% of the global population is concentrated in developing nations

which have a growth rate a little more than 2%, and a doubling time of less than 35 years.

POPULATION EXPLOSION

The enormous increase in population due to low death rate (mortality) and high birth rate (natality) is termed as population explosion.

The population clock:

Every second, on an average 4-5 child are born and 2 people die, thus resulting in net gain of nearly 2.5 people every second. This means that every hour we are growing by about 9000 and every day by about 2, 14,000.

The Indian Scenario:

a. For the developing countries like India, population explosion is a curse and is damaging to the development of the country and its society. The developing countries already facing a lack in their resources, and with the rapidly increasing population, the resources available per person are reduced further, leading to increased poverty, malnutrition, and other large population-related problems.

b. India is the second most populous country of the world with 1.27 billion people. Currently, there are about 51 births in India in a minute. India represents almost 17.31% of the world's population, which means one out of six people on this planet live in India.

c. Although, China leads in population for decades, India is all set to take the number one position by 2030. With the population growth rate at 1.58%, India is predicted to have more than 1.53 billion people by the end of 2030.

Causes:

1. Decline in the Death Rate:

Until recently, birth rates and death rates were about the same, keeping the population stable. The success in reducing death rates was attributable to several factors like

1. increase in food production and distribution
2. improvement in public health (water and sanitation)
3. medical technology (vaccines and antibiotics)
4. awareness education and standards of living

The fall in death rates that is decline in mortality rate is one fundamental causes of overpopulation. This has resulted in an increase in the life expectancy of individuals. Mortality rate has declined leading to an increase in population. Thus the overall death rate has gone down same time as brought with it, the curse of overpopulation.

2. Rise in the Birth Rate:

With the new discoveries in nutritional science, we are able to bring in increase in the fertility rates of human beings.

Medicines of today can boost the reproductive rate in human beings.

There are medicines and treatments, which can help in conception. Thus, science has led to an increase in birth rate.

3. Migration:

The inhabitants of various countries migrate to a particular part of the world and settle over there, the area is bound to suffer from the ill effects of overpopulation.

If the rates of emigration from a certain nation do not match the rates of immigration to that country, overpopulation makes its way.

Crowding of immigrants in certain parts of the world, results in an imbalance in the density of population.

4. Lack of Education:

Illiteracy is another important cause of overpopulation. Those lacking education fail to understand the need to prevent excessive growth of population. They are unable to understand the harmful effects that overpopulation has.

They are unaware of the ways to control population. Lack of family planning is commonly seen in the illiterate lot of the world. This is one of the major factors leading to overpopulation.

Consequences:

Population grows fastest in the world's poorest countries. Overpopulation and poverty have long been associated with increased death and disease.

The world's current and projected population growth calls for an increase in efforts to meet the needs for food, water, health care, technology and education.

In the poorest countries, massive efforts are needed to keep social and economic conditions from deteriorating further; any real advances in well-being and the quality of life are negated by further population growth.

Many countries lack adequate supplies of basic materials needed to support their current population. Not every nation is capable of providing its people with the adequate amount of resources.

The ever-increasing population will eventually leave no nation capable of providing its people with the resources they need to thrive. When the environment fails to accommodate the living beings that inhabit it, overpopulation becomes a disaster.

Measures:

Alarmed by its swelling population, India started taking measures to stem the growth rate quite early. India launched the National Family Planning program in 1952 and became the first country in the world to have a population policy.

The family planning program yielded some noticeable results, bringing down significantly the country's fertility rate. In 1965-2009 the contraceptive usage more than tripled and the fertility rate more than halved.

The efforts did produce positive results, however, failed to achieve the ultimate goal and the population of India since getting independence from Britain in 1947 increased almost three times.

Whereas India has missed almost all its targets to bring the rate of population growth under control, China's 'One Child Policy' in 1978, has brought tremendous results for the latter. The policy claims to have prevented between 250 and 300 million births from 1978 to 2000 and 400 million births from 1979 to 2010.

Problem with implementing measures:

Population explosion is causing severe resource depletion and environmental degradation. Our resources like land, water, fossil fuels, minerals etc. are limited and due to over exploitation these resources are getting exhausted.

Even many of the renewable resources like forests, grasslands etc. are under tremendous pressure. Industrial and economic growth are raising our quality of life but adding toxic pollutants into the air, water and soil. As a result, the ecological life-support systems are getting jeopardized. The two very important views on population growth are-

1. Malthusian Theory:

According to Malthus, human populations tend to grow at an exponential or compound

rate whereas food production increases very slowly or remains stable. Therefore, starvation, poverty, disease, crime and misery are invariably associated with population explosion.

He believes positive checks like famines, disease outbreak and violence as well as preventive checks like birth control need to stabilize population growth.

2. Marxian Theory:

According to Karl Marx, population growth is a symptom rather than the cause of poverty, resource depletion, pollution and other social ills.

He believed that social exploitation and oppression of the less privileged people leads to poverty, overcrowding, unemployment, environmental degradation that in turn, causes over population.

FAMILY WELFARE PROGRAMS

It was implemented by the government of india as a voluntary programme. It is an integral part of overall national policy of growth covering human health, family welfare child care and womens rights.

Family planning:

Family planning allows couples to decide their family size and also the time spacing of their offspring. Almost every culture in the past used to practice some traditional fertility control methods through some traditions, taboos and folk medicine.

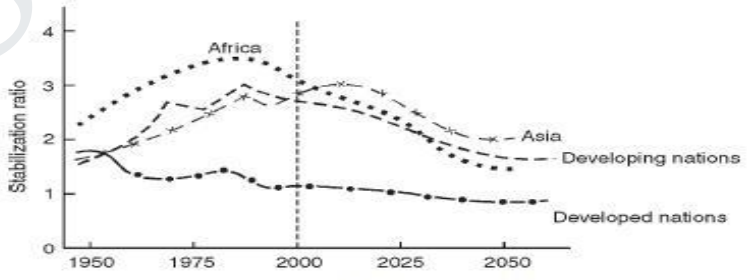
Modern science has provided several birth control techniques including mechanical barriers, surgical methods, chemical pills and physical barriers to implantation. More than a hundred contraceptive methods are on trial.

The United Nations Family Planning Agency provides funds to 135 countries. Many of these countries include abortion as a part of the population control programme which very often encourages female infanticide thereby disturbing the optimal male and female ratio in a society.

The birth control programmes have often faced strong opposition from religious groups. Nonetheless, World Health Organization (WHO) estimates that today about 50 percent of the worlds married couples adopt some family planning measures as compared to just 10% about 30 years back. Still some 300 million couples do not have access to family planning.

India started the family planning programme in 1951 with the objective of "reducing the birthrate to the extent necessary to stabilize the population at a level consistent with the requirements of national economy."

Evolution:



Stabilization ratio of developing & developed nations, Africa and Asia. A ratio of 1 achieved in developed nations around 2000 indicates zero population growth in developed nations while Africa is presently having the highest ratio.

The United Nations projections about population stabilization of developed and developing nations and that of Asia are shown in above Figure.

The ratio is derived by dividing crude birth rate by crude death rate. As evident, developed nations have already achieved a stabilization ratio of 1 around the year 2000, which is more or less stabilized indicating zero population growth.

Developing nations including Asia, on the other hand, is yet having a high stabilization ratio nearing 3, which is however, on a decline and is expected to lower down substantially by 025.

Stabilization in developing nations is possible only through various family welfare programmes.

ENVIRONMENT AND HUMAN HEALTH

A physically fit person not suffering from any disease is called a healthy person. According to World Health Organization (WHO) health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Human health is influenced by many factors like nutritional, biological, chemical or psychological. These factors may cause harmful changes in the body's conditions called disease.

Infectious organisms:

Disease causing organisms pose greater environmental threats to health, more severely in the developing countries especially the tropical ones.

High temperature and moisture along with malnutrition help many diseases to spread in these countries. Microbes especially bacteria can cause food poisoning by producing toxins in the contaminated food.

Some molds grow on food and produce poisonous toxins. Infectious organisms can also cause respiratory diseases (pneumonia, tuberculosis, influenza etc.) and gastrointestinal diseases (diarrhoea, dysentery, cholera etc.) There are various types of parasites that cause diseases like malaria, schistosomiasis, filariasis etc. Most of these infections take place when the environmental conditions are unclean and unhygienic.

Chemicals:

A large number of chemicals are introduced in the environment by anthropogenic activities. Industrial effluents containing various chemicals are of major concern. Chemicals can be divided into two categories i.e. hazardous and toxic chemicals. Hazardous are the dangerous chemicals like explosives, inflammable chemicals etc and toxic chemicals (toxins) are poisonous chemicals which kill cells and can cause death.

Many other chemicals can cause cancer (carcinogenic), affect genetic material (DNA) in cells (mutagenic) or cause abnormalities during embryonic growth and development (teratogenic), while there are others that affect nervous system (neurotoxins) and the reproductive system.

Some of the pesticides and other industrial pollutants may act as hormone analogs in humans and other species. These environmental hormones affect reproduction, development and cause various types of ailments including tumors.

Many chemicals like DDT and other chlorinated pesticides bio-accumulate in food-chain and show deleterious effects at the top of the food chain. Many chemical substances present in wastewaters like heavy metals (mercury, cadmium, lead etc.) fluoride and nitrate can affect human health.

Metals can contaminate food while cooking in various types of utensils including alloys like steel. Containers for canned food, especially which are acidic in nature, contaminate the

food with lead. Lead also comes in water from the water-pipes where it is added for plumbing purposes.

Various alcoholic beverages contain lead while tobacco contains cadmium that goes in the body and affects human health. Various chemicals, gases and particulates laden with chemicals, spewed into the environment from various industries cause air pollution and affect human health.

Noise:

Although human ear is capable of tolerating a range of sound levels, yet if sound levels beyond the permissible level exist for certain duration, it becomes painful and sometimes irreparable damage occurs.

Radiations:

Radiations are known to cause short-term and long term changes in various organs. Cosmic rays and ultra-violet rays cause harmful effects on human health which may include cancer.

Diet:

Diet has a very important role in maintaining health. Malnutrition makes humans prone to other diseases. There is a strong correlation between cardiovascular diseases and the amount of salt and fat in one's diet. Food contamination can cause various ill effects. There had been cases of Dropsy in India, a disease which occurred due to contamination of mustard oil with the poisonous seeds of Argemonemexicana.

Settlement:

Proper environment, availability of basic necessities of life like, water, sanitation etc. are essential for healthy living. Improper settlement and poor physical environment may cause various psychological problems which affect various vital physiological processes in the body.

HUMAN RIGHTS:

Human beings are born equal in dignity and rights. These are moral claims which are inalienable and inherent in all individuals by virtue of their humanity alone, irrespective of caste, colour, creed, and place of birth, sex, cultural difference or any other consideration.

These claims are articulated and formulated in what is today known as human rights. Human rights are sometimes referred to as fundamental rights, basic rights, inherent rights, natural rights and birth rights.

Definition:

The Universal Declaration of Human Rights (UDHR) 1948 defines human rights as "Rights derived from the inherent dignity of the human person." Human rights when they are guaranteed by a written constitution are known as "Fundamental Rights" because a written constitution is the fundamental law of the state.

Human rights are essential for the overall development of individuals. The Constitution of India makes provisions for basic rights also known as Fundamental Rights for its citizens as well as for aliens. A distinction is made between Specific Fundamental Rights and Unspecified Fundamental Rights.

Draft Declaration of Human Rights and Environment:

The draft declaration describes the rights as well as duties that apply to individuals, governments, international organizations and transnational corporations.

The preamble envisages a deep concern regarding the consequences of environmental harm caused by poverty, debt programmes and international trade. Environmental damages are often irreversible.

Human rights violations may lead to further environmental degradation on a long-term basis and the environmental degradation, in turn would lead to further human rights violation.
The principles of the draft declaration are divided into five parts.

- **Part I:** It deals with human rights for an ecologically sound environment, sustainable development and peace for all. It also emphasizes the present generation's rights to fulfill its needs to lead a dignified and good quality life. But, at the same time it lays stress on the fact that it should be without impairing the rights of the future generations to meet their needs.
- **Part II:** It mainly deals with human rights related to an environment free from pollution and degradation. It also emphasizes the rights to enjoyment of natural ecosystems with their rich biodiversity. It defines right to own native land or home. No one can be evicted from one's native place except in emergency or due to a compelling purpose benefitting the society as a whole which is not attainable by other means. All persons have the right to timely assistance in the event of any natural or technological disaster.
- **Part III:** It deals with right of every person to environmental information, education, awareness and also public participation in environmental decision making.
- **Part IV**: It deals with the duties to protect and preserve the environment and prevent environmental harm. It includes all remedies for environmental degradation and measures to be taken for sustainable resource use. It emphasizes that states shall avoid using environment as a means of war and shall respect international law for protection of environment.
- **Part V:** This lays stress on social justice and equity with respect to use of natural resources and sustainable development. Right to development has to be linked to right to safe and clean environment which has to be considered not only at the level of individual but at community, national and global level.

VALUE EDUCATION:

Education:

It is one of the most important tools in bringing about socioeconomic and cultural progress of a country. However, the objective should not merely be imparting coaching to the students that they get through the examinations with good results and get some good job.

Education does not simply mean acquiring a lot of information but also its righteousness and use within the framework of a spectrum of ethical values.

Current scenario:

The rapid strides of scientific and technological advancements have no doubt, brought revolutionary changes in our everyday life and information technology has shrunk the whole world into a global village with access to very information sitting in one corner over the internet.

But, in this frenzy for development and mad race for progress perhaps man has become too materialistic, self-centered and over ambitious and the desired ideals of a real good life have been pushed to the background.

Objective of value education:

1. It has a very significant role in providing proper direction to inculcate a positive

attitude and to teach the distinction between right and wrong.

2. It teaches one to be compassionate, helpful, peace loving, generous and tolerant so that they can move towards a more harmonious, peaceful, enjoyable and sustainable future.
3. It helps in arriving at value-based judgments in life based on practical understanding of various natural principles rather than acquiring certain prejudices.
4. It encompasses human values, social values, professional values, religious values, national values, aesthetic values and environmental values.
5. It increases awareness about our national history, our cultural heritage, national pride, constitutional rights and duties, national integration, community development and environment.

Different phases:

Phases include value awareness, value orientation, value appraisal, value selection, value commitment and value action. The basic aim is to create and develop awareness about the values, their significance and role.

After knowing them mindset of students would get oriented towards those values and they will try to critically analyze the same and then select the values which really appeal to him.

Value-based Environmental Education:

Following the Supreme Court directives (in M.C. Mehta's Union of India, 1988) environmental education has been included in the curriculum right from the school stage to college/university level. The prime objective of it is to make everyone environment literate.

Environmental education can be made value based by,

1. Preparing text-books and resource materials about environmental education that play an important role in building positive attitudes about environment. The basic human value is man in nature rather than nature for man needs to be infused through the same.
2. Including Social values like love, compassion, tolerance and justice which are the basic teachings of most of our religions into environmental education. These are the values to be nurtured so that all forms of life and the biodiversity on this earth are protected.
3. Cultural and religious values enshrined in Vedas emphasize that man should not exploit nature without nurturing her. Our cultural customs and rituals in many ways teach us to perform such functions as would protect and nurture nature and respect every aspect of nature, treating them as sacred, are it rivers, earth, mountains or forests.
4. Encompassing the Environmental education with the ethical values of earth-centric rather than human-centric world-view. The educational system should promote the earth-citizenship thinking. Instead of considering human being as supreme we have to think of the welfare of the earth.
5. Global values stress upon the concept that the human civilization is a part of the planet as a whole and similarly nature and various natural phenomena over the earth are interconnected and inter-linked with special bonds of harmony. Disturbing this harmony anywhere will be an ecological imbalance leading to catastrophic results.
6. Spiritual values highlight the principles of self-restraint, self discipline, contentment, reduction of wants, freedom from greed and austerity. All these values promote conservationism and transform our consumerist approach.

Value-based environmental education can bring in a total transformation of our mindset, our attitudes and our lifestyles. The above mentioned human values will go a long way in

attaining the goals of sustainable development and environmental conservation. The value elements in environmental education alone can succeed in achieving the real goals of environmental literacy.

HIV/AIDS

Dr. Robert Gallo at National Institute of Health, USA and Luc Montagnier at Pasteur Institute, Paris isolated the virus, HIV which causes AIDS.

HIV stands for **H**-Human: This particular virus can only infect human beings. **I**-Immunodeficiency: HIV weakens your immune system by destroying important cells that fight disease and infection. **V**-Virus: A virus can only reproduce itself by taking over a cell in the body of its host.

AIDS stands for **A**-Acquired: AIDS is not something you inherit from your parents. You acquire AIDS after birth. **I**-Immuno: our body's immune system includes all the organs and cells that work to fight off infection or disease. **D**-Deficiency: one get AIDS when your immune system is deficient. **S**-Syndrome: A syndrome is a collection of symptoms and signs of disease.

The terms "HIV" refers to the virus itself and "AIDS" refers to the late stage of HIV infection.

Function of HIV inside human body:

HIV is like other viruses that cause the flu or the common cold. But an important difference over time is that our immune system can clear most viruses out of our body. That is not the same in case of HIV, the human immune system can't seem to get rid of it i.e., once you have HIV, you have it for life.

HIV can hide for long periods of time in the cells of your body and that it attacks a key part of immune system. White Blood Cells are responsible in the formation of antibodies are called T-helper cells.

Our body has to have these cells to fight infections and disease, but HIV invades them, uses them to make more copies of it, and then destroys them. Over time, HIV can destroy so many of your CD4 cells that your body can't fight infections and diseases anymore.

When that happens, HIV infection can lead to AIDS, the final infection. No safe and effective cure currently exists, but scientists are working hard to find one. But with proper medical care, HIV can be controlled.

Treatment for HIV is often called antiretroviral therapy or ART. This can dramatically prolong the lives of many people infected with HIV and lower their chance of infecting others.

Origin:

Though sufficient knowledge about the disease has been gained, yet a definite source of this virus could not be identified. But it is believed that it is transferred to humans from African monkey, through contaminated polio vaccine prepared from monkey's kidney, through Hepatitis- B viral vaccine, through small pox vaccine programme of Africa.

Transmission:

1. It is transmitted through certain body fluids from an HIV-infected person-Blood, Semen, Rectal fluids, vaginal fluids, Breast milk. These body fluids when come into contact with a mucous membrane or damaged tissue or when directly injected into bloodstream (by a needle or syringe) the transmission is possible.
2. Having unprotected sex with someone who has HIV.
3. Sharing needles, syringes, rinse water, or other equipment used to prepare injection drugs with someone who is infected with HIV.
4. Being born to an infected mother. (HIV can be passed from mother to child during pregnancy, birth, or breastfeeding).

5. Receiving blood transfusions, blood products, or organ/tissue transplants that are contaminated with HIV.
6. Contact between broken skin, wounds, or mucous membranes and HIV-infected blood or blood-contaminated body fluids.

HIV is NOT spread by:

- Air or water
- Insects, including mosquitoes or ticks
- Saliva, tears, or sweat
- Casual contact, like shaking hands, hugging or sharing dishes/drinking glasses

Symptoms:

1. Early Stage of HIV

Within 2-4 weeks after HIV infection, many people experience flu-like symptoms often described as the 'worst flu ever'. This is called "acute retroviral syndrome" (ARS) or "primary HIV infection," and it is the body's natural response to the HIV infection.

Symptoms include Fever, Swollen glands, Sore throat, Rash, Fatigue, Headache, Muscle and joint aches.

2. The Clinical Latency Stage

Latency means a period where a virus is living or developing in a person without producing symptoms. During the clinical latency stage, people who are infected with HIV experience no HIV-related symptoms, or only mild ones. This stage is sometimes called "asymptomatic HIV infection" or "chronic HIV infection."

During the clinical latency stage, the HIV virus reproduces at very low levels, although it is still active. If one takes antiretroviral therapy (ART), they may live with clinical latency for several decades because treatment helps keep the virus in check.

It is important to remember that people in this symptom-free period are still able to transmit HIV to others even if they are on ART, although ART greatly reduces the risk of transmission.

3. Progression to AIDS

If one have HIV and you are not taking HIV medication (antiretroviral therapy), eventually the HIV virus will weaken your body's immune system. The onset of symptoms signals the transition from the clinical latency stage to AIDS.

During this late stage of HIV infection, people infected with HIV may have the following symptoms:

- Rapid weight loss
- Recurring fever or profuse night sweats
- Extreme and unexplained tiredness
- Prolonged swelling of the lymph glands in the armpits, groin, or neck
- Diarrhea that lasts for more than a week
- Sores of the mouth, anus, or genitals
- Pneumonia
- Red, brown, pink, or purplish blotches on or under the skin or inside the mouth, nose, or eyelids
- Memory loss, depression, and other neurologic disorders.

Many of the severe symptoms and illnesses of HIV disease come from the opportunistic infections that occur because your body's immune system has been damaged.

Diagnosis:

1. ELISA test (Enzyme Linked Immuno Sorbent Assay) is a sensitive preliminary blood test used to detect HIV antibodies.
2. Western Blot is the confirmatory test, which is highly specific and based on specific antibodies to viral core proteins

Control and Management:

- Education to people about protected sexual behavior and practices, the do's and don'ts in AIDS contraction and bringing more awareness among the public.
- Protected sexual behavior.
- Screening of blood and blood products before blood transfusion.
- Usage of disposable syringes in the hospitals.
- Not sharing the razors / blades in the saloon.
- Avoid tattooing using common needle.
- Making the antiretroviral drugs such as AZTs (Azidothymidine/Zidovudin) and saquinovir available to patients.

WOMEN WELFARE

Women and children are usually the soft targets, who suffer in a number of ways mainly because they are weaker, helpless and economically dependent. The main aim is to improve the status of women by providing opportunities in education, employment and economic independence.

Need:

Women usually suffer gender discrimination and devaluation at home, at workplace, in matrimony, in inheritance, in public life and power, particularly in developing countries. The gender violence, victimization and harassment take many forms across culture, race or nation.

The exceptionally high number of cases of abduction, dowry deaths, rape, domestic violence, criminal offences and mental torture to women is something that needs immediate attention and reforms in the interest of the women.

Women are often the worst victims of communal enmities. The human rights of women are violated too often in a male dominated patriarchal society. Thus, there is an urgent need for policy reforms and more stringent legislation as well as educational and legal awareness amongst women for checking the atrocities and injustice towards her.

There is a full-fledged Ministry for Women and Child development whose sole aim is to work for the welfare and upliftment of women encompassing family planning, health care, education and awareness.

Environmental degradation:

Women are also the victims of capitalism, development and environment. The exploitative nature of capitalist development not only affects the natural environment but the traditional, social, cultural and family life of women.

After losing the forests and getting rehabilitated from their native places, men folk usually migrate to towns in search of some job while the women are left behind to look after the family and household with little resources.

Development projects like mining very often play havoc with the life of women. Men can still work in the mines or migrate to towns after getting compensation from the government. The National Network for Women and Mining (NNWM) with about 20 groups in different mining

states of India is rightly fighting for a .gender audit of India's mining companies.

The displaced women are the worst affected as they do not get any compensation and are totally dependent upon the males for wages. The displaced women driven out from their land- based work are forced to take up marginalized work which is highly un-organized and often socially humiliating. Issues related to their dignity and honor has not yet received any attention.

The NNWM is now working for rights of women over natural resources, resettlement and compensation issues. Besides the government initiatives there are now a number of nongovernment organizations mostly as Mahila Mandals.

To create awareness amongst women of remote villages even to empower them, train them, educate them and help them to become economically self-dependent On an international level, the United Nations Decade for Women (1975-85) witnessed inclusion of several women welfare related issues on international agenda.

The CEDAW (International Convention on the Elimination of all forms of Discrimination Against Women, 1979) has been a landmark outcome of the decade to be accepted as an international standard for the protection and promotion of women's human rights and socio-economic upliftment. It is, however, most important for all women in the mainstream, tribal's, refugees and the down-trodden to be educated about these issues.

National commission for women:

It has been created by government of India and its objectives are

- To examine constitutional and legal rights for women
- To review existing legislations
- To sensitize the enforcement and administrative machinery to women's causes.

CHILD WELFARE

Children are considered to be the assets of a society. They nearly occupy 40% of total population. But the statistical figures tell us that about a million babies, out of 21 million born every year in India are abandoned soon after their birth due to different socio-economic reasons.

Around 20 million children in our country are estimated to be working as child labours, some of them in various hazardous industries like the match industry, firework industry, brassware industry and pottery industry.

Child labours:

Poverty is the main reason to drive these children into long hours of work in miserable, unhealthy conditions and yet they do not get the minimum nutritive food, what to talk of educational and recreational facilities, which are their childhood rights.

Various organizations towards child welfare:

The UN General Assembly in 1959 adopted the Declaration of the Rights of a child. After the UN convention on Rights of Child, it became International Law in the year 1990, consisting of 54 articles and a set of international standards and measures to promote and protect the well being of children in a society. The law defines right of the child to survival, protection, development and participation.

-The right to survival emphasizes on adequately good standards of living, good nutrition and health.

-The right to protection means freedom from exploitation, abuse, inhuman treatment and neglect.

- -The right to development ensures access to education, early childhood care and support, social security and right to leisure and recreation.

-The right to participation means freedom of thought, conscience and religion and appropriate information to the child.

The World Summit on Children, held on September 30, 1990 had a focused agenda for the wellbeing of the children targeted to be achieved in the beginning of the new millennium.

India is also a signatory to the World Declaration on Survival, protection and development of children.

A national plan of action for children has been formulated by the Ministry of Human Resource Development (MHRD), Government of India in which a strategic plan has been formulated for children's welfare in the priority areas of health, education, nutrition, clean and safe drinking water, sanitation and environment.

Universalisation of effective access to at least primary level schooling, special emphasis on girl child's education including health and nutrition, up gradation of home-based skills, mid-day meals scheme, expansion of early childhood development activities including low-cost family based involvements are some of the important actions envisaged.

Children are also the most affected due to environmental pollution. .They consume more water, food and air than adults, hence more susceptible to any environmental contamination.- says one of the scientific reports of Center for Science and Environment (CSE), New Delhi. It is high time to work together for a secure and cleaner environment so as to give our children a cleaner and safer world to live in.

ROLE OF IT IN HUMAN HEALTH AND ENVIRONMENT

Information technology has tremendous potential in the field of environmental education and health as in any other field like business, economics, politics or culture. Development of internet facilities, worldwide web, geographical information system (GIS) and information through satellites has generated a wealth of up-to-date information on various aspects of environment and health.

A number of soft-wares have been developed for environment and health studies which are user friendly and can help an early learner in knowing and understanding the subject.

a. **Database:**

Database is the collection of inter-related data on various subjects. It is usually in computerized form and can be retrieved whenever required. In the computer the information of database is arranged in a systematic manner that is easily manageable and can be very quickly retrieved.

Application includes

- **The Ministry of Environment and Forests**, Government of India has taken up the task of compiling a database on various biotic communities. The comprehensive database includes wildlife database, conservation database, forest cover database etc. Database is also available for diseases like HIV/AIDS, Malaria, Fluorosis, etc.
- **National Management Information System (NMIS)** of the Department of Science and Technology has compiled a database on Research and Development Projects along with information about research scientists and personnel involved.
- **Environmental Information System (ENVIS)** The Ministry of Environment and Forests, Government of India has created an Information System called Environmental Information System (ENVIS).
    - Headquarters: Delhi, it functions in 25 different centers all over the country.
    - The ENVIS centers work for generating a network of database in areas like pollution control, clean technologies, remote sensing, coastal ecology,

biodiversity, western Ghats and eastern Ghats, environmental management, media related to environment, renewable energy, desertification, mangroves, wildlife, Himalayan ecology, mining, etc.

- **The National Institute of Occupational Health** provides computerized information on occupational health i.e. the health aspects of people working in various hazardous and nonhazardous industries, safety measures etc.

a. Remote sensing:

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to in situ observation.

In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (surface, in the atmosphere and oceans) by means of propagated signals (electromagnetic radiation). It may be split into active remote sensing or passive. It is applied in following fields-

In agriculture: provide valuable information about land and water management.
In forestry: provide valuable information for sustainable forest management.
In land cover: spatial information on land use is required at different scale depending on usage.

In water resources: for surface water mapping, ground water targeting, wetland, flood monitoring runoff modeling etc,.

Satellite imageries provide us actual information about various physical and biological resources and also to some extent about their state of degradation in a digital form through remote sensing. We are able to gather digital information on environmental aspects like water logging, desertification, deforestation, urban sprawl, river and canal network, mineral and energy reserves and so on.

c. Geographical Information System (GIS):

It has proved to be a very effective tool in environmental management.

GIS is a technique of superimposing various thematic maps using digital data on a large number of inter related or interdependent aspects.
Its applications include

1. Different thematic maps containing digital information on a number of aspects like water resources, industrial growth, human settlements, road network, soil type, forest land, crop land or grassland etc. are superimposed in a layered form in computer using software. Such information is very useful for future land-use planning.
2. Even interpretations of polluted zones, degraded lands or diseased cropland etc. can be made based on GIS. Planning for locating suitable areas for industrial growth is now being done using GIS by preparing Zoning Atlas.
3. GIS serves to check unplanned growth and related environmental problems.

d. Satellite data:

It helps in providing correct, reliable and verifiable information about forest cover, success of conservation efforts etc.

They also provide information of atmospheric phenomena like approach of monsoon, ozone layer depletion, inversion phenomena, smog etc. We are able to discover many new reserves of oil, minerals etc. with the help of information generated by remote sensing satellites.

e. World Wide Web:

A vast quantum of current data is available on World Wide Web.
Important on-line learning center:

1. www.mhhe.com/environmental science
2. Multimedia Digital Content Manager (DCM) in the form of CD-ROM

Provides the most current and relevant information on principles of environmental science, various problems, queries, applications and solutions.

The World Wide Web with resource material on every aspect, class-room activities, digital files of photos, power-point lecture presentations, animations, web-exercises and quiz has proved to be extremely useful both for the students and the teachers of environmental studies.

Features:

1. Student friendly features:

These include practice quiz, how-to study tips and hyperlinks on every chapter topics with detailed information, web exercises, case studies, environment maps, key-terms, career information, current articles, interactive encyclopedia and how to contact your elected officials.

2. Teacher-friendly features:

In addition to above it include supplement resource charts, additional case studies, answers to web exercises, solutions to critical thinking questions, editing facility to add or delete questions and create multiple versions of same test etc.

Thus remote sensing and GIS play a key role in resource mapping, environmental conservation, management, planning and environmental impact assessment. It also helps in identifying several disease infested areas which are prone to some vector-borne diseases like malaria, schistosomiasis etc. based upon mapping of such areas. There are several Distribution Information Centers (DICs) in our country that are linked with each other and with the central information network having access to international database.

Information technology is expanding rapidly with increasing applications and new avenues are being opened with effective role in education, management and planning in the field of environment and health.