

CHAPTER-1
MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES
AND NATURAL RESOURCES

INTRODUCTION

- The word environment is derived from the French word ‘**environner**’ which means to ‘**encircle or surround**’.
- Thus our environment can be defined as “**the Social, Cultural and Physical conditions that surround, affect and influence the survival, growth and development of people, animals and plants**”.
- This broad definition includes the natural world and the technological environment as well as the cultural and social contexts that shape human lives.
- It includes all factors (living and nonliving) that affect an individual organism or population at any point in the life cycle; set of circumstances surrounding a particular occurrence and all the things that surrounds us.

SEGMENTS OF ENVIRONMENT

Environment consists of four segments.

1. **Atmosphere**- Blanket of gases surrounding the earth.
2. **Hydrosphere**- Various water bodies present on the earth.
3. **Lithosphere**- Contains various types of soils and rocks on the earth.
4. **Biosphere**- Composed of all living organisms and their interactions with the environment.

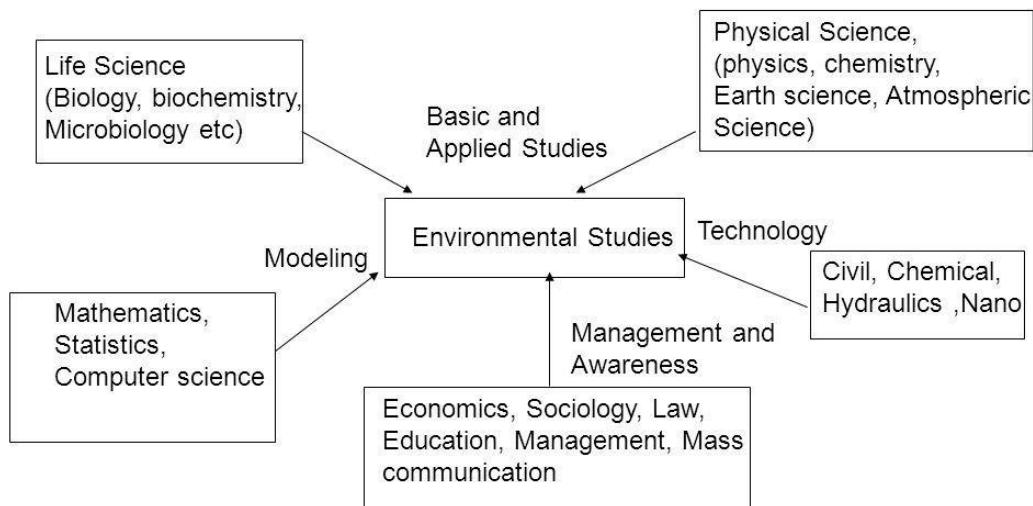
MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

- The Environment studies is a multi-disciplinary science because it comprises various branches of studies like chemistry, physics, medical science, life science, agriculture, public health, sanitary engineering etc.
- It is the science of physical phenomena in the environment. It studies about the sources, reactions, transport, effect and fate of physical and biological species in the air, water, soil and the effect of from human activity upon these.
- As the environment is complex and actually made up of many different environments like natural, constructed and cultural environments, environmental studies is inter

disciplinary in nature including the study of biology, geology, politics, policy studies, law, religion engineering, chemistry and economics to understand the humanity's effects on the natural world.

- This subject educates the students to appreciate the complexity of environmental issues and citizens and experts in many fields.
- By studying environmental science, students may develop a breadth of the interdisciplinary and methodological knowledge in the environmental fields that enables them to facilitate the definition and solution of environmental problems.

The multidisciplinary nature of environmental science is illustrated in following diagram



SCOPE OF ENVIRONMENTAL STUDIES

Environmental studies as a subject has a wide scope. It includes a large number of areas and aspects, which may be summarized as follows:

- **Natural resources**- their conservation and management
- **Ecology and Biodiversity**
- **Environmental pollution and control**
- **Human population** and environment
- **Social issues** in relation to development and environment

IMPORTANCE OF ENVIRONMENTAL STUDIES

- The importance of environmental studies is that, the current trend of environmental degradation can be reversed if people of educated communities are organized, empowered and experts are involved in sustainable development.
- Environmental factors greatly influence every organism and their activities.
- At present a great number of environmental issues, have grown in size and complexity day by day, threatening the survival of mankind on earth. These issues are studied besides giving effective suggestions in the environment studies.
- The environment studies enlighten us, about the importance of protection and conservation of our natural resources, indiscriminate release of pollution into the environment etc.

Environment studies have become significant for the following reasons:

1. Environment Issues being of International Importance:

It has been well recognized that environment issues like global warming, ozone depletion, acid rain, marine pollution and loss of biodiversity are not merely national issues but are global issues and hence must be tackled with international efforts and cooperation.

2. Problems Cropped in The Wake of Development:

Development, in its wake gave birth to Urbanization, Industrial Growth, Transportation Systems, Agriculture and Housing etc. However, it has become phased out in the developed world. The North, to cleanse their own environment has, fact fully, managed to move 'dirty' factories to South. When the West developed, it did so perhaps in ignorance of the environmental impact of its activities. Evidently such a path is neither practicable nor desirable, even if developing world follows that.

3. Explosively Increase in Pollution:

World census reflects that one in every seven persons in this planet lives in India. Evidently with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land. Agricultural experts have recognized soils health problems like deficiency of micronutrients and organic matter, soil salinity and damage of soil structure.

4. Need for An Alternative Solution:

It is essential, specially for developing countries to find alternative paths to an alternative goal. We need a goal as under:

- (1) A goal, which ultimately is the true goal of development an environmentally sound and sustainable development.
- (2) A goal common to all citizens of our earth
- (3) A goal distant from the developing world in the manner it is from the over-consuming wasteful societies of the “developed” world.

5. Need To Save Humanity From Extinction:

It is incumbent upon us to save the humanity from extinction. Consequences to our activities cause destructing the environment and depleting the biosphere, in the name of development.

6. Need For Wise Planning of Development:

Our survival and sustenance depend. Resources withdraw, processing and use of the product have all to be synchronized with the ecological cycles in any plan of development. Our actions should be planned ecologically for the sustenance of the environment and development.

NEED FOR PUBLIC AWARENESS

1. Growing Population:

A population of over thousands of millions is growing at 2.11 per cent every year. Over 17 million people are added each year. It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although population control does automatically lead to development, yet the development leads to a decrease in population growth rates.

2. Poverty:

India has often been described a rich land with poor people. The poverty and environmental degradation are mixed with one another. The vast majority of our people are directly dependent on the nature resources of the country for their basic

needs of food, fuel shelter and fodder. About 40% of our people are still below the poverty line.

3. Environment degradation:

Environment degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge of environment degradation are two facets of the same challenge.

4. Agricultural Growth:

The people must be made familiar with the methods to sustain and increase agricultural growth without damaging the environment. High yielding varieties have caused soil salinity and damage to physical structure of soil.

5. Need to Increase Ground water:

It is essential of rationalizing the use of groundwater. Factors like community wastes, industrial effluents, chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater. It is essential to restore the water quality of our rivers and other water bodies. Suitable strategies for conservation of water, provision of safe drinking water and keeping water bodies clean should be developed.

6. Development and Forests:

Forests serve catchments for the rivers. With increasing demand of water, plan to harness the mighty river through large irrigation projects were made. Certainly, these would submerge forests; displace local people, damage flora and fauna. As such, the dams on the river Narmada, Bhagirathi and elsewhere have become areas of political and scientific debate.

Forests in India have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas that were once green stand today as waste lands. These areas are to be brought back under vegetative cover. The tribal communities inhabiting forests, respects the trees, birds and animals give them sustenance. We must recognize the role of these people in restoring and conserving forests.

The modern knowledge and skills of the forest department should be integrated with the traditional knowledge and experience of the local communities. The strategies for the joint management of forests should be evolved in a well planned way.

7. Degradation of Land:

At present out of the total 329 mha of land, only 266 mha possess any potential for production. Of this, 143 mha is agricultural land nearly and 85 suffers from varying degrees of soil degradation. Of the remaining 123 mha, 40 are completely unproductive. The remaining 83 mha is classified as forest land, of which over half is denuded to various degrees. Nearly 406 million head of livestock have to be supported on 13 mha, or less than 4 per cent of the land classified as pasture land, most of which is overgrazed. Thus, out of 226 mha, about 175 mha or 66 per cent is degraded to varying degrees. Water and wind erosion causes further degradation of almost 150 mha. This degradation is to be avoided.

8. Evil Consequences of Urbanization:

Nearly 27% of Indians live in urban areas. Urbanization and industrialization has given birth to a great number of environmental problems. Over 30 percent of urban Indians live in slums. Out of India's 3,245 towns and cities, only 21 have partial or full sewerage and treatment facilities. Hence, coping with rapid urbanization is a major challenge.

9. Air and water Pollution:

Majority of our industrial plants are using outdated and pollution causing technologies and makeshift facilities devoid of any provision of treating their wastes. A great number of cities and industrial areas have been identified as the worst in terms of air and water pollution. Acts are enforced in the country, but their implement is not so easy.

The reason is their implementation needs great resources, technical expertise, political and social will. Again the people are to be made aware of these rules. Their support is indispensable to implement these rules.

CHAPTER-2 NATURAL RESOURCES

INTRODUCTION

- Natural resources can be defined as 'variety of goods and services provided by nature which are necessary for our day-to-day lives'.
Ex: **Living or biotic:** Plants, animals and microbes
Non-living or abiotic: Air, water, soil, minerals, climate and solar energy
- They are essential for the fulfillment of physiological, social, economical and cultural needs at the individual and community levels.

TYPES OF NATURAL RESOURCES

They are of two types of resources namely Renewable and Non-Renewable Resources.

- 1. Renewable resources:** The resources that can be replenished through rapid natural cycles are known as renewable resource. These resources are able to increase their abundance through reproduction and utilization of simple substances.
Ex: Plants (crops and forests) and animals.
 - Some examples of renewable resources though they do not have life cycle but can be recycled.
Ex: Wood and wood-products, pulp products, natural rubber, fibers (e.g. Cotton, jute, animal wool, silk and synthetic fibers) and leather.
 - In addition to these resources, water and soil are also classified as renewable resources.
 - Solar energy although having a finite life, as a special case, is considered as a renewable resource in as much as solar stocks is inexhaustible on the human scale.
- 2. Non renewable resources:** The resources that cannot be replenished through natural processes are known as non-renewable resources. These are available in limited amounts, which cannot be increased.
Ex: These resources include fossil fuels (petrol, coal etc.), metals (iron, copper, gold, silver, lead, zinc etc.), minerals and salts (carbonates, phosphates, nitrates etc.).
Once a non-renewable resource is consumed, it is gone forever.

Non-renewable resources can further be divided into two categories, viz.

- A) Recyclable and
- B) Non-recyclable

A) Recyclable: These are non-renewable resources, which can be collected after they are used and can be recycled. These are mainly the non-energy mineral resources, which occur in the earth's crust (Ex: Ores of aluminum, copper, mercury etc.) and deposits of fertilizer nutrients (e.g. Phosphate rock and potassium and minerals used in their natural state (asbestos, clay, mica etc.)

B) Non-recyclable: These are non-renewable resources, which cannot be recycled in any way.

Ex: Fossil fuels and uranium, which provide 90 per cent of our energy requirements.

NATURAL RESOURCES AND ASSOCIATED PROBLEMS:

- The main problem associated with natural resources is unequal consumption.
- A major part of natural resources are consumed in the 'developed' world. The 'developing nations' also over use many resources because of their greater human population. However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries.
- Advanced countries produce over 75% of global industrial waste and greenhouse gases.
- Energy from fossil fuels consumed in relatively much greater quantities in developed countries. Their per capita consumption of food too is much greater as well as their waste.

FOREST RESOURCES

A forest can be defined as a biotic community predominant of trees, shrubs or any other woody vegetation usually in a closed canopy. It is derived from latin word 'foris' means 'outside'. India's Forest Cover is 6,76,000 sq.km (20.55% of geographic area). Scientists estimate that India should ideally have 33% of its land under forests. Today we only have about 12% thus we need not only to protect our existing forests but also to increase our forest cover.

FUNCTIONS OF FOREST

1. It performs very important function both to human and to nature.
2. They are habitats to millions of plants, animals and wild life.
3. They recycle rain water.
4. They remove pollutant from air.
5. They control water quality.
6. They moderate temperature and weather.
7. They influence soil condition and prevent soil erosion.

USES OF FOREST

1. Commercial uses
2. Ecological uses

1. Commercial uses:

- i. Wood – used as a fuel
- ii. Supply wood for various industries – Raw materials as pulp, paper, furniture timber etc.
- iii. Minor forest products – gum, dyes, resins
- iv. Many plants – Medicines
- v. Supply variety of animal products – honey. Ivory, horns etc.
- vi. Many forest lands are used for - Mining, grazing, for dams and recreation.

2. Ecological uses: Forest provides number of environmental services.

- i. **Production of oxygen:** Photosynthesis produces large amount of oxygen which is essential for life.
- ii. **Reducing global warming:** Carbon dioxide is one of the main green house gases. It is absorbed by plants for photosynthesis. Therefore the problem of global warming caused by CO₂ is reduced.
- iii. **Soil conservation:** Roots of trees bind the soil tightly and prevent soil erosion. They also act as wind breaks.
- iv. **Regulation of hydrological cycle:** Watershed in forest acts like giant sponges and slowly releases the water for recharge of spring.
- v. **Pollution moderators:** Forest can absorb many toxic gases and noises and help in preventing air and noise pollution.
- vi. **Wild life habitat:** Forest is the home of millions of wild animals and plants.

REASON FOR DEFICIENCY OF FOREST:

In India the minimum area of forest required to maintain good ecological balance is about 33% of total area. But at present it is only about 12%. So over exploitation of forest material occurs.

1. OVER EXPLOITATION OF FOREST:

Due to overpopulation, the forest materials like food, medicine, shelter, wood & fuel are not sufficient to meet the people's demand. Hence exploitation of forest increases day by day.

REASON FOR OVER EXPLOITATION IN INDIA:

In India forest area required to maintain good ecological balance is 33% but at present is only 22% there. Hence over exploitation of forest occur.

CAUSES OF OVER EXPLOITATION:

1. Increasing agricultural production
2. Increasing industrial activities
3. Increase in demand of wood resources

EFFECTS OF OVER EXPLOITATION:

1. Led to migration of the farmers
2. Environment damage is heavy
3. Tropical forests are destroyed very fastly
4. Countless plants and animal species are endangered
5. Marine population will go into extinction
6. Dumping of wastes into land, water, & air is a severe problem

2. DEFORESTATION

It is process of removal of forest resources due to natural or manmade activities (i.e.) destruction of forests.

Deforestation in India:

Deforestation is a continuous process in India. About 1.3 hectares of forest land has been lost. The presence of waste land is a sign of deforestation in India.

CAUSES OF DEFORESTATION:

1. **Developmental projects:** Developmental projects causes deforestation through two ways.
 - Through submergence of forest area.
 - Destruction of forest area.Ex: big dams, hydro electric projects, road construction etc.
2. **Mining operations:** It reduces forest areas.

- Ex: Mica, coal, Manganese and lime stone.
3. **Raw materials for industries:** Wood is an important raw material for various purposes.
Ex: Making boxes, furniture and paper etc.
 4. **Fuel requirement:** Wood is the important fuel for rural and tribal population.
 5. **Shifting cultivation:** Replacement of natural forest ecosystem for mono specific tree plantation. Ex: Teak
 6. **Forest fires:** Forest fire destructs thousands of acres of forest.
 7. **Over grazing:** Over grazing by cattle reduces the cultivation land

EFFECTS OR CONSEQUENCES OF DEFORESTATION:

1. **Global Warming:** Cutting & burning of forest trees increase CO₂ content in atmosphere. This causes global warming and depletion of ozone layer.
2. **Soil erosion:** Forest trees act as natural barrier to reduce the wind velocity & reduce soil erosion. Deforestation causes soil erosion, floods, landslides, and drought.
3. **Loss of genetic diversity:** Destroy the genetic diversity on earth which provides food & medicines for entire world.
4. **Loss of Biodiversity:** When plants do not exist, animals that depend on them for food & habitat become extinct.
5. **Loss of Food grains:** Due to soil erosion, the countries loose the food grains.
6. **Flood & landslides:** Frequent floods, landslides in hilly areas and wind speed are heavy.
7. **Unemployment Problems:** People living around forest areas losses their livelihood.

PREVENTIVE MEASURES (OR) AVOID OF DEFORESTATION (OR) METHODS OF CONSERVATION OF FORESTS

1. New plants of more or less of the same variety should be planted to replace the trees cut down for timber
2. Use of wood for fuel should be discouraged.
3. Forest pests can be controlled by spraying pesticides by using aero planes
4. Forest fire must be controlled by modern techniques.
5. Over grazing by cattle must be controlled.
6. Steps should be taken by the government to discourage the migration of people into the islands from mainland.
7. Education and awareness programmes must be conducted.
8. Strict implementation of law of Forest conservation Act.

CASE STUDY:

Deforestation in the Himalayan region, involves clearing of natural forests and plantation of monoculture like Eucalyptus. Nutrient in the soil is poor; therefore soil losing their fertility, hence, Himalayan area facing the serious problem of desertification.

3. TIMBER EXTRACTION

- Wood used for engineering purposes like building houses, making furniture is called timber. The products derived from timber have been important to many civilizations, and thus it has acquired value within these civilizations.
- Timber extraction results in deforestation and in the fragmentation of the last remaining forests. It harms valuable species of trees, birds and wild animals.
- In spite of this, it is sometimes necessary to extract timber, so as to meet the needs of a developing country.
- During the extraction of timber, cutting, felling and handling should be done selectively, carefully and in a planned manner, in order to save the remaining forests and biodiversity.

Effects of Timber Extraction

The major effects of timber extraction on forest and tribal people include:

1. Poor logging results in a degraded forest.
2. Floods may be intensified by cutting of trees or upstream watersheds.
3. Loss of biodiversity.
4. Climatic changes such as less rain.
5. New logging roads permit shifting cultivators to gain access to logged areas and cut the remaining trees.
6. It results in forest fragmentation which promotes loss of biodiversity because some species of plants and animals require large continuous areas of similar habitat to survive.
7. Exploitation of tribal people by the contractors.
8. Soil erosion especially on slopes occurs extensively.
9. Sedimentation of irrigation systems, floods may be intensified by cutting of trees on upstream.

Case Study-Chipko Movement

- The world famous Chipko Movement, pioneered by Dasohli Gram Swarajya Mandal in Gopeshwar brought about a general awareness about conservation of forests.
- The first Chipko Movement dates back to 1731, when a village woman named Amrita Bai led the Bishnoi women against the Maharajas men to prevent them from cutting trees.
- In this attempt to save the trees, she sacrificed her life along with the lives of her husband, three daughters and 363 people. The movement was given this name because the village women embraced or hugged the trees to stop them from being cut.
- In 1972, in Uttar Pradesh, the Chipko Movement was led by Bachnoi Devi of Advani who protected the hill forests from the contractors axe men.

4. DAMS

- Dams are the massive artificial structures built across the rivers to store water for much beneficial purpose.
- Today there are more than 45,000 large dams around the world, which play an important role in communities and economies that harness these water resources for their economic development.
- Current estimates suggest some 30-40% of irrigated land worldwide relies on dams.
- Hydropower, another important the use of stored water, currently supplies 19% of the world's total electric power supply and is used in over 150 countries.
- The world's two most populous countries – China and India –have built around 57% of the world's large dams.
- **Dams are considered a “Temples of modern India”.** Dams destruct vast area of forest area.
- **India has more than 1600 large dams.**

Maharashtra = more than 600 dams

Gujarat = more than 250 dams

Madhya Pradesh = more than 130 dams

Benefits of Constructing Dams:

1. Control flood & store water
2. Divert water from river into a channel
3. Used for drinking & agricultural purposes
4. Built for generating electricity
5. Used for recreational purposes
6. Navigation & fishery can be developed in dam areas
7. Help for the socio economic development of the society
8. Used for irrigation during dry seasons
9. Prevent drought

Effects of dam on forest:

1. Thousands of hectares of forest are cleared for river valley projects
2. Forest is also cleared for residential, office, buildings, storing materials, laying roads etc
3. Hydro electric projects have led to loss of forest
4. Dam construction kills wild animals & aquatic life
5. Hydro electric projects spread water borne diseases
6. Water logging leads to salinity & reduces the fertility of land.

Examples:

Narmada Sagar Project = submerged 3.5 lakhs hectares of forest

Tehri dam = submerged 1000 hectares of forest

Effects of dam on tribal people:

1. Constructions of big dams lead to the displacement of tribal people.
2. Displacement and cultural change affects the tribal people both mentally and physically.
3. They do not accommodate the modern food habits and life style.
4. Tribal people are ill treated by the modern society.
5. Many of the displaced people were not recognised and resettled or compensated.
6. Body condition of tribal people will not suit with new areas and hence they will be affected by many diseases.

Problems of Constructing Dams:

Upstream Problem:

- Displacement of tribal people
- Loss of forests, flora & fauna
- Soil erosion, sedimentation, siltation occurs
- Water logging retards plant growth
- Spread of vector-borne & water borne diseases
- Reservoir Induced Seismicity (RIS) causes earthquake

Downstream problems:

- Water logging causes salinity

- Silt deposition in rivers
- Salt water intrusion in river
- As nutrients deposits in reservoir, land losses its fertility
- Structural defects of dam destroy many living organisms

Case study- Sardar Sarovar Project:

- The World Bank's withdrawal from the Sardar Sarovar Project in India in 1993 was a result of the demands of local people threatened with the loss of their livelihoods and homes in the submergence area.
- This dam in Gujarat on the Narmada has displaced thousands of tribal folk, whose lives and livelihoods were linked to the river, the forests and their agricultural lands. While they and the fishermen at the estuary have lost their homeland, rich farmers downstream will get water for agriculture.
- The question is why should the local tribals be made homeless, displaced and relocated to benefit other people? Why should the less fortunate be made to bear the costs of development for better off farmers?
- It is a question of social and economic equity as well as the enormous environmental losses, including loss of the biological diversity of the inundated forests in the Narmada valley.

5. MINING:

Definition: Mining is the process of extracting of metals from the mineral deposit. The process of extracting mineral resources and fossil fuels like coal from the earth is called as mining.

Types of mining

1. **Surface mining:** Mining of minerals from shallow deposits

It is process of extraction of raw materials from surface.

2. **Underground mining:** Mining of minerals from deep deposits.

It is the process of extraction of raw materials below the earth's surface

- **Open-Pit mining:** machines dig holes & remove the ores. (ex) Iron, copper, limestone, marble etc
- **Dredging:** Scraping the minerals from under-water mineral deposit by chained buckets & draglines.
- **Strip mining:** The ore is stripped off by using bulldozers, stripping wheels.

Steps involved in mining

1. Exploration
2. Development
3. Exploitation
4. Ore processing
5. Extraction and purification of minerals

The extent of damage by underground mining is more than that of surface mining, which needs enormous amount of land area for its operation and management.

Effects of over exploitation of mineral resources:

1. Pollute soil, water and air.
2. Destruction of natural habitat.
3. Continuous removal of minerals leads to the formation of trench where water is logged which contaminates the ground water.
4. Vibrations cause earth quakes.
5. Produces noise pollution
6. Reduces shape and size of the forest.
7. Increased risk of landslides.

8. Spoils the aesthetic beauty.
9. Rapid depletion of mineral deposits
10. Continuous mining causes landslides
11. Causes migration of tribal people.

Environmental Damage caused by mining activities:

1. De-vegetation & defacing of landscape	<ul style="list-style-type: none">• Topsoil & vegetation are removed from mining areas.• De-vegetation leads to severe ecological losses.
2. Groundwater contamination	<ul style="list-style-type: none">• Mining pollutes the ground water.• Sulphur present in many ores, is converted into sulphuric acid by microbial action. Hence water becomes acidic.• Some heavy metals also leach into ground water.
3. Surface water pollution	<ul style="list-style-type: none">• The drainage of acid mine contaminates streams & lakes.• Radioactive substances like Uranium contaminate the surface water & kill the aquatic animals.
4. Air pollution	<ul style="list-style-type: none">• Smelting & roasting done to purify the metal causes air pollution & affects the nearby vegetation.• The SPM (suspended particulate matter) like Arsenic, cadmium, lead etc. contaminate the atmosphere & affects public health.
5. Subsidence of Lands	<ul style="list-style-type: none">• Mining results in cracks in houses, tilting of buildings, bending of rail tracks etc.

CHAPTER-3
SYSTEMS

ECOSYSTEMS

INTRODUCTION

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ECOLOGY:

- The term was first coined by Hons Reiter and Haekel in 1869.
- The term ecology (Okekologie) is originated from two Greek words Oikos (eco) – means “house” (or) place of living and “ology” means “the science of (or) the study of. Hence, ecology is the branch of science that deals with the study of the pattern of relations between the organism and their environment.
- Ecology is the study of interactions among organisms (or) group of organisms with their environment.
- Ecology is the study of ecosystems.

ECO SYSTEM:

- In 1935, the British ecologist A.G.Tansley coined the term “eco system”.
- The term “**eco system**” is made up of two Greek words. “Eco” means ecological sphere (or) house (or) place of living (or) surroundings (or) Environment, w here living organism does exist while “**system**” means “group of organisms joined in regular and interdependent manner. Hence,
- A group of organisms interacting among them and with environment is known as ecosystem.
- A system of interaction of organisms with their surroundings (i.e., environment) is called as “ecosystem”. **Examples:** Pond, lake, ocean, forest and desert

CHARACTERISTICS OF ECOSYSTEM

- Eco system is the basic functional unit of ecology.
- It contains both biotic and abiotic components.
- The function of ecosystem is related to the cycling of matter (materials) and flow of energy.
- The amount of energy needed to maintain an ecosystem depends on its structure.
- Ecosystem passes from a less complex state to more complex state, which is called as **“Ecological succession”**.

CLASSIFICATION OF ECOSYSTEM:

- The ecosystem can be generally classified into two types:
 1. Natural Ecosystem
 2. Artificial Eco system

1. NATURAL ECOSYSTEM:

- A natural ecosystem is developed and governed by nature.
- These are capable of operating and maintaining themselves without any major interference by man.
- The following are the two types of natural ecosystem based on their habitat.
 1. Terrestrial Ecosystem.
 2. Aquatic Ecosystem.

1) Terrestrial Ecosystem:

- This ecosystem is related to land.
Examples: Grassland ecosystem
Forest ecosystem
Desert ecosystem

2) Aquatic Ecosystem:

- This ecosystem is related to water, it is further sub divided into two types based on salt content.

i. Fresh Water Ecosystem:

- a. Running Water Ecosystems
Examples: Rivers, streams (small narrow rivers)
- b. Standing Water Ecosystems
Examples: Pond, lake & well, etc

ii. Marine Ecosystem:

Examples: seas and sea shores (land along the edges of sea)

2. MAN MADE (OR) ARTIFICIAL ECOSYSTEM:

An artificial ecosystem is created and maintained by man for his different needs.

Examples: Reservoirs, Artificial lakes and gardens, etc.

STRUCTURE (OR) COMPONENTS OF AN ECOSYSTEM:

- The term structure refers to various components. So, the structure of an ecosystem explains the relationship between the abiotic (non-living) and the biotic (living) components.
- Each and every ecosystem has two major components are:
 1. Biotic (living) components.
 2. Abiotic (Non-living) components.

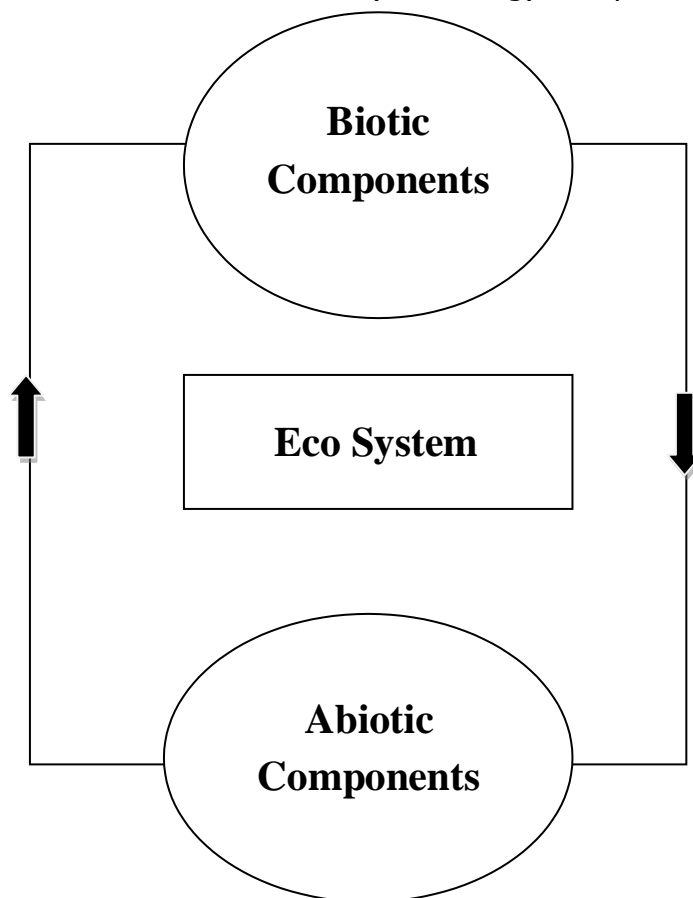


Fig: Components of Ecosystem

1. Biotic Components: The living component of an ecosystem is called “**Biotic component**”.

Examples: Plants (Producers)
Animals (Consumers) and
Micro Organisms (Decomposers)

- The biotic components of an ecosystem are classified into three types based on how they get their food.

A. Producers (Autotrophs): Plants

B. Consumers (Heterotrophs): Animals

C. Decomposers (Saprotrophs): Micro organisms.

A. Producers (or) Autotrophs (Auto=self, troph=feeder)

- Self food producing organisms are known as autotrophs.

Examples: All green plants and trees.

- Producers synthesize their food themselves through photosynthesis. Hence they are also called “**Photo autotrophs**”. (photo = light)

B. Consumers (or) Heterotrophs (Hetero = other, troph = feeder:

- Consumers are organisms, which cannot prepare their own food and depend directly (or) indirectly on the producers.

Examples: Plant Eating Species: Insects, rabbit, goat, deer, cow, etc.

Animals Eating Species: Fish, lions, tigers, etc.

- Depending upon the food habits the consumers are divided into four types.
 - i. Herbivores (or) Primary Consumers (Plant Eaters)
 - ii. Carnivores (or) Secondary Consumers (Meat Eaters)
 - iii. Omnivores (or) Tertiary Consumers (With plant & meat eaters)
 - iv. Detritivores (dead organism eaters)

i. Herbivores: (Herbi = the green plant & Vorare = to devour)

- Animals that eat only plants are called Herbivores.
- They directly depend on the plants for their food. So they are called Plant eaters.

Examples: Insects, goat, deer, cow, horse, etc.

ii. **Carnivores: (Carne = flesh meat & Vorare = to devour)**

- Animals that eat other animals are called carnivores.
- They directly depend on the herbivores for their food.

Examples: Frog, cat, snake & foxes, etc.

iii. **Omnivores: (Omni = whole comes from "ohm" & Vorare = to devour)**

- Animals that eat both plants and animals are called omnivores.
- They depend on both herbivores and carnivores for their food.

Examples: humans, tigers, lions, rats and fox etc.

iv. **Detritivores: (Detritifeeder)**

- Animals that eat dead organisms and waste of living are called detritivores.

Examples: beetles, termites, ants, crabs, earthworms, etc.

C. Decomposers (or) Saprotrophs: (Sapros = Rotten, trophos = feeder)

- Decomposers attack the dead bodies of producers and consumers and decompose them into simple compounds. During the decomposition inorganic nutrients are released.
- The organisms which break down the complex compounds into simple products are called decomposers (or) reducers.

Examples: micro-organisms such as bacteria and fungi, etc.

2. Abiotic Components:

- The non-living component of an ecosystem is called "abiotic component"
- These non-living components enter the body of living organism, take part in metabolic activities and then return to the environment. The abiotic component of the ecosystems divided into three portions.
 1. Climate factors: Solar radiation, temperature, wind, water current, rainfall, etc.
 2. Physical factors: light, fire, soil, air, etc.
 3. Chemical factors: Organic and Inorganic substances.

FUNCTION OF AN ECOSYSTEM:

- The function of an ecosystem is related to the cycling of materials (matter) and flow of energy.

Types of functions:

- Functions of an ecosystem are of three types:

1. Primary Function: The producers (plants) can make their food themselves

through photosynthesis. This process is called primary function of eco system.

Examples: All green plants and trees.

2. Secondary Function: The consumers (animals and humans) cannot make their own food. They are always depending upon the producers for their energy. This is called secondary function of eco system.

3. Tertiary Function: Decomposers attack the dead bodies of consumers and producers and decompose them into simpler compounds. During the decomposition inorganic nutrients are released.

Examples: Micro organisms like bacteria and fungi, etc.

The functioning of an ecosystem may be understood by studying the following terms:

- A. Food chains
- B. Food webs
- C. Food pyramids (or) Energy pyramids
- D. Energy and material flow.

A. Food Chain:

- Anything which we eat to live is called food.
- Food contains energy.
- Food can be transferred from one organism to the other.
- The process of transfer of food (energy) from one organism to a series of organisms is called as **"food chain"**
- A food chain always starts with a plant life and end with animal life. Thus, a food chain is a picture (or) model that shows the flow of energy from autotrophs (producers) to series of organisms in an environment, as shown in the following figure.

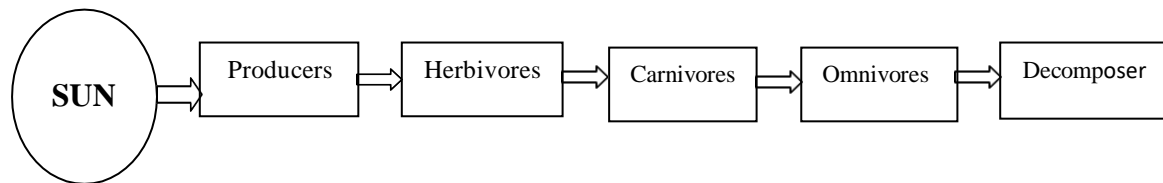


Figure: Schematic representation of food chain.

- Infact, all the food chains starts with the sun. The sun provides energy for plants.
- The producers (plants) can make their food themselves with the help of the sunlight, chlorophyll, water and air. The consumers, including animals and humans, cannot make their own food. They are always depending upon the producers for their energy.
- Decomposers are the micro-organisms that break down the dead animals and plants and release nutrients that become part of the soil, which are re-used by new plants, back to the starting point of the food chain.

Types of food chain:

Three basic types of **food chains** are found in a typical eco system. They are:

1. Grazing food chains.
2. Detritus food chains.
3. Parasitic food chains.

1. Grazing food chains:

- Grazing food chain starts with green plants (producers) and goes to decomposer food chain (or) detritus food chain through herbivores and carnivores.
- It has two types :
 - a. Terrestrial food chain and
 - b. Aquatic food chain

a. **Terrestrial food chain:** Food chain on land is called terrestrial food chain.

Example: Grassland food chain
Forest land food chain
Desert land food chain

Grass land food chain

Grasses → Grasshoppers → Frog → Snake → Eagles

Forest food chain

Green plants → Deer → Tiger (or) lion

- b. **Aquatic food chain:** This food chain is slightly different from terrestrial food chain. It is seen in aquatic (water) eco system. Food chain in water is called "Aquatic food chain".

Example: Marine food chain Example: Ocean

Fresh water food chain Example: Pond, lake, streams, etc.

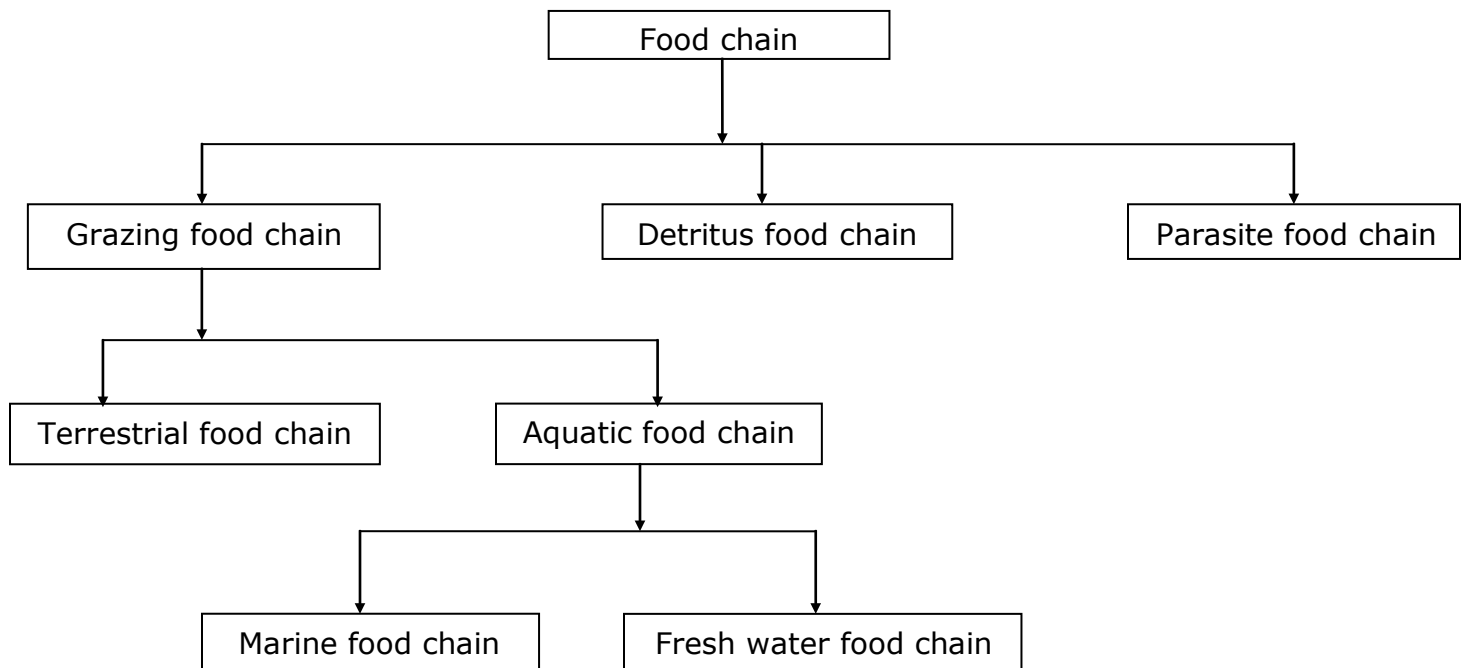
Food chain in a pond

Phytoplankton → Zoo Plankton → Small fish → Large fish → Man

Marine Food chain:

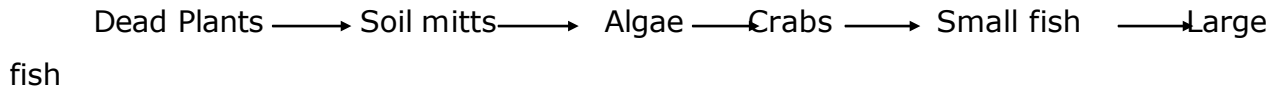
Sea Weeds → Small fish → Large fish → Sharks and other animals

Figure:

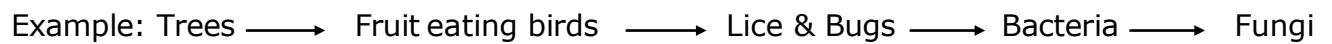


2. Detritus' food chain: Detritus food chain starts with dead organic matter (plants and animals) and goes to decomposer through consumers. Detritus food chains, independent of solar energy, but they depend on influx of dead organic matter.

Example:

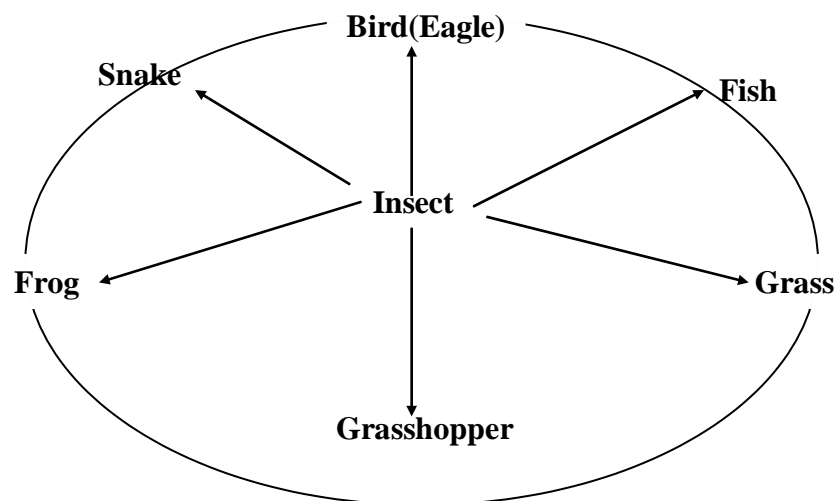


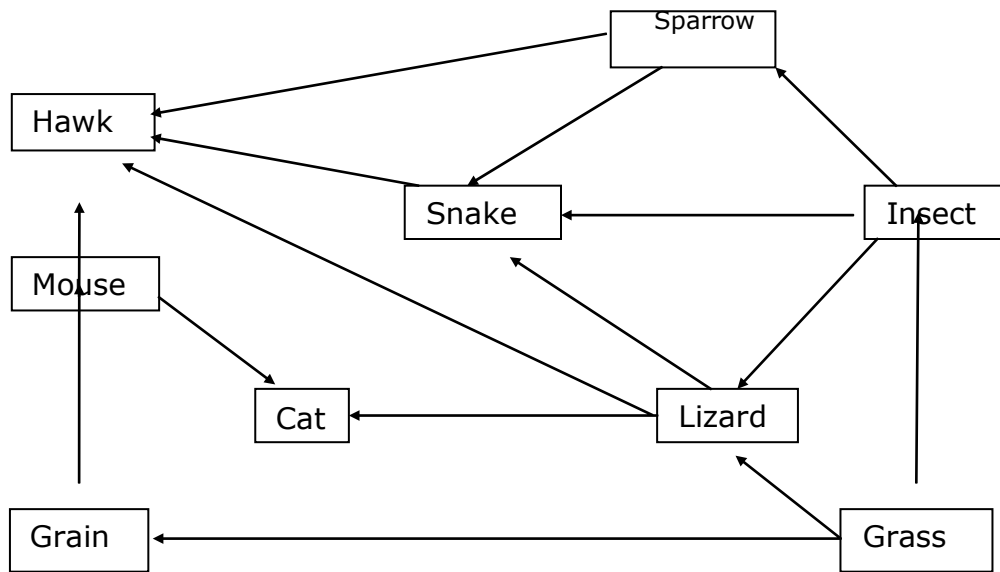
3. Parasitic food chain: Parasitic food chain operates in many ecosystems. In this food chain either consumer (or) producer is parasitized and the food passes to smaller organisms. A parasitic food chain involves host parasite hyper parasites' links.



B. Food Web:

- Web means "network" such as spider's web
- So, food web is a network of food chains.
- In a food web many food chains are inter connected, where different types of organisms are connected at different tropic levels, so that there are a number of options of eating and being eaten at each tropic level. Thus, there is a inter connecting of various food chains are called food webs and as shown in following figure.





This food web shows many linear food chains <as shown in figure>. These linear food chains are inter connected with other food chains operating in the eco system to form a food web.

The grazing food chains are as follows:

- Grains → Mouse → Cat
- Grains → Mouse → Hawk
- Grains → Mouse → Snake → Hawk
- Grains → Insect → Sparrow → Hawk
- Grass → Insect → Lizard → Snake → Hawk
- Grass → Insect → Sparrow → Snake → Hawk

The above food web is a simple one. Much more complex food webs do exist in nature.

C. Ecological Pyramids:

- The concept of ecological pyramids was first developed by British ecologist Charles Elton in 1927.
- Ecological pyramids are the diagrammatic representation of trophic structures in which the trophic levels (i.e., tiers) are depicted in successive stages.
- An ecological pyramid is shown in the following figure.

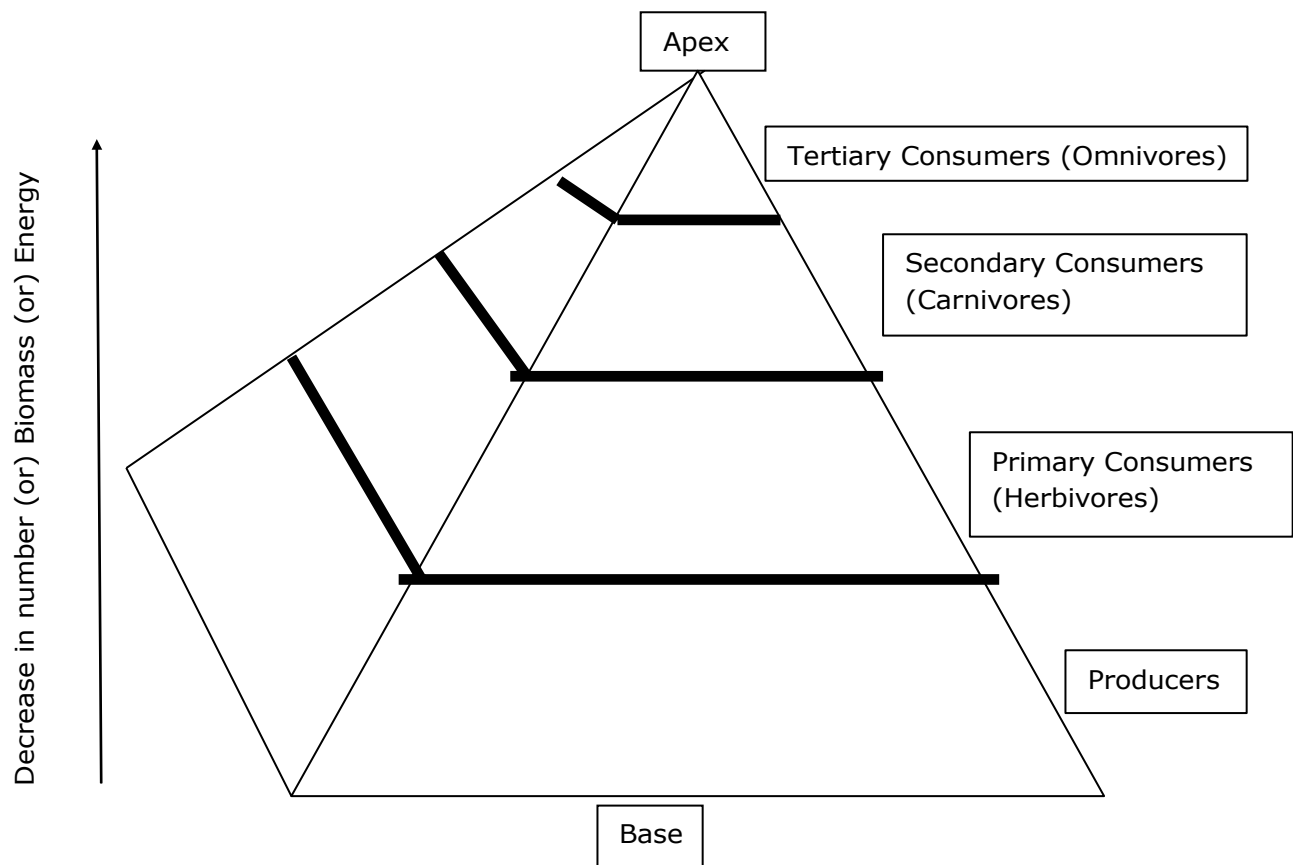


Figure: Formation of an Ecological Pyramid

- In ecological pyramids, trophic levels are shown in the following manner:
 - i. The producers represent first trophic level in the ecological pyramid.
 - ii. The herbivores (or) primary consumers represent second trophic level in the ecological pyramid.
 - iii. The carnivores (or) secondary consumers represent third trophic level in the ecological pyramid.
 - iv. The omnivores (or) tertiary consumers represent fourth trophic level in the ecological pyramid.
- On the basis of the number of organisms, the biomass of organisms and energy flow in population. Three types of ecological pyramids are:
 1. Pyramid of numbers.
 2. Pyramid of biomass
 3. Pyramid of energy.

1. Pyramid of numbers:

- It shows the number of individual organisms present in each trophic level.
- It is expressed in numbers per unit area.
- Depending upon the type of ecosystem, we have three types of pyramid of numbers.
 - a. Upright pyramid of numbers.
 - b. Partly upright pyramid of numbers.
 - c. Inverted pyramid of numbers.

1. Upright Pyramid of numbers:

- The number of individual organisms gradually decreases from lower trophic level to higher trophic level is called "**upright pyramid of numbers**". Example: A grassland ecosystem and a pond ecosystem show an upright pyramid of numbers.
- The producers in the grass lands are grasses, which are small in size and large in numbers. So, producers occupy lower trophic level (1st trophic level).
- The primary consumers (herbivores) are rats, which occupy the II trophic level. Since the numbers of rats are lower when compared to the grasses, the size of which is lower.
- The secondary consumers (carnivores) are snakes, which occupy the III trophic level. Since the numbers of snakes are lower when compared to the rats, the size of which is lower.
- The tertiary consumers (omnivores) are eagles, which occupy the IV trophic level. The number and size of the last trophic level is lowest <as shown in figure>.
- Similarly, in the case of pond ecosystem, producers, herbivores and carnivores are decreases from lower trophic level to the higher trophic level. Thus, these pyramids are upright.
- Therefore, the numbers of individual organisms per unit area, decreases from lower trophic level to higher trophic level as shown in figure.

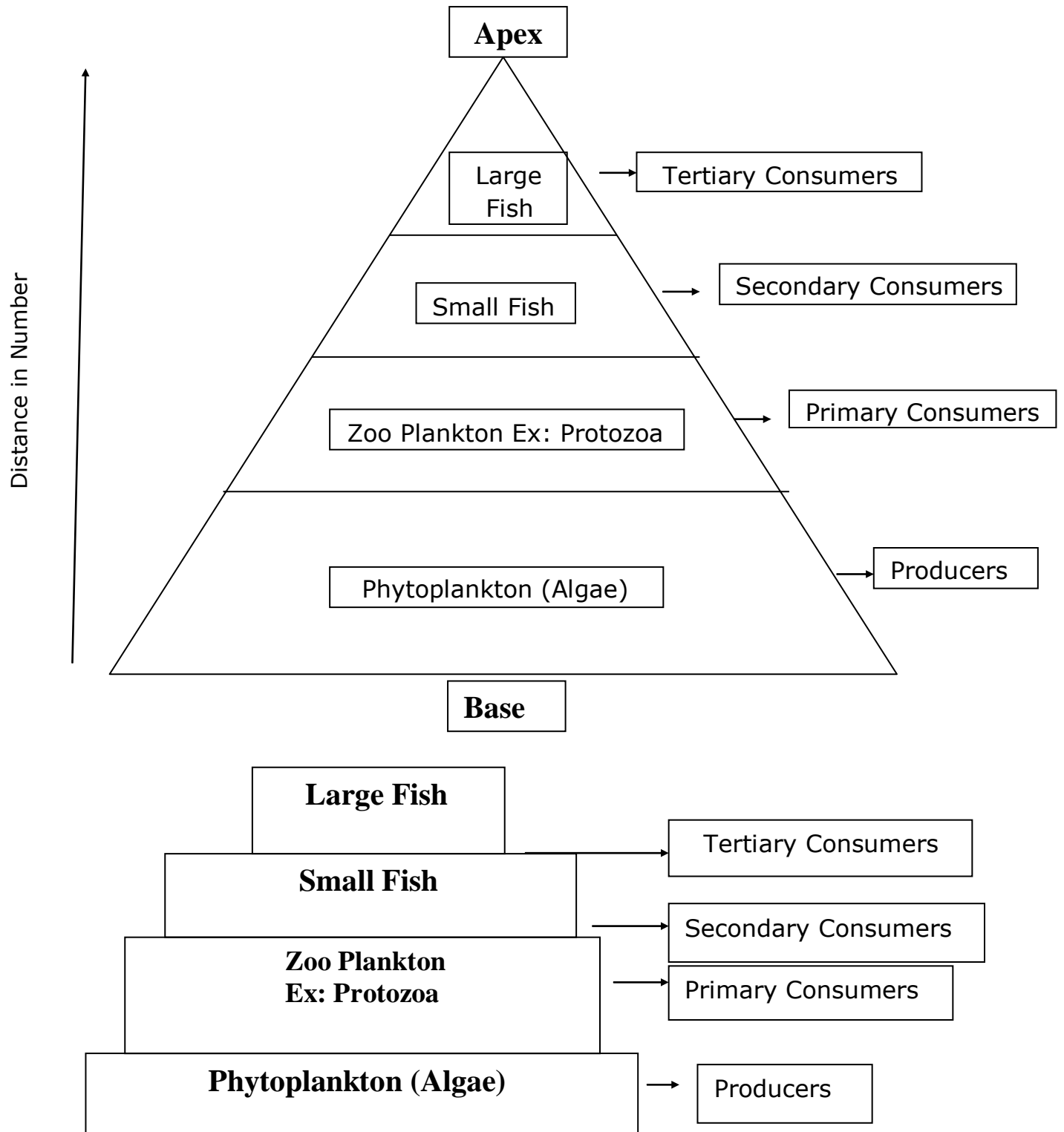
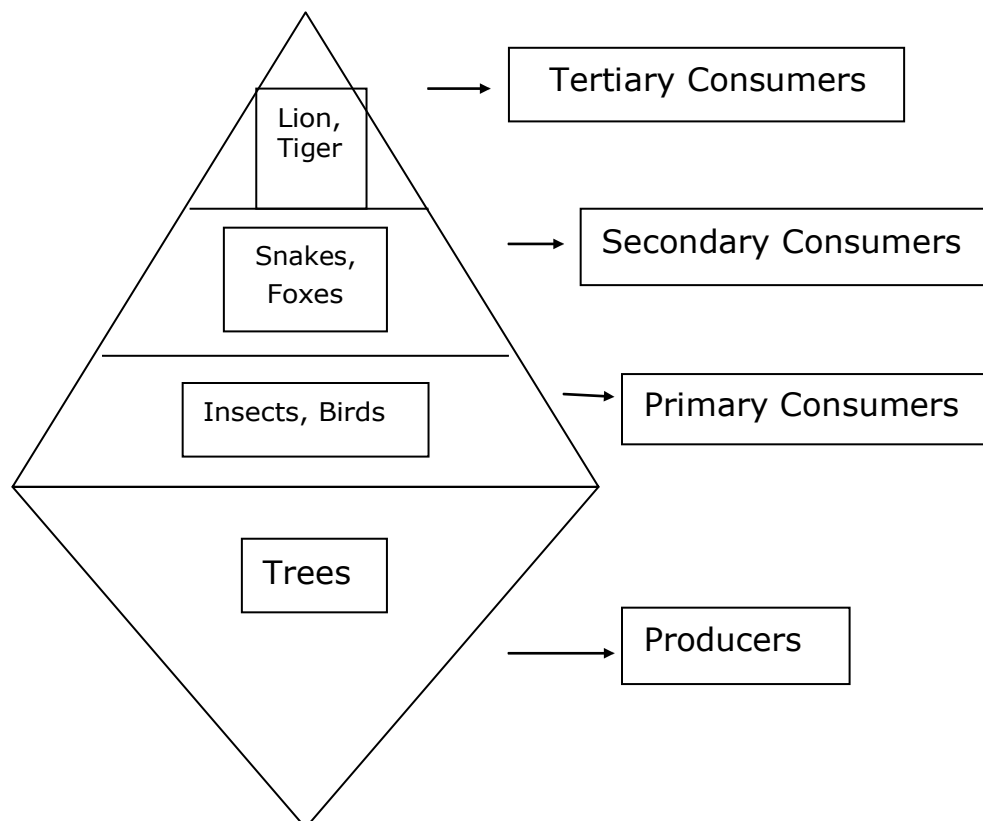


Figure: Pyramid of numbers in an aquatic (pond) ecosystem

2. Partially Upright Pyramid Of Numbers:

- A forest eco system is an example of partially upright pyramid.
- In a forest eco system, big trees are the producers, which are less number. So, these producers occupy the lower tropic level which is narrow base.
- The primary consumers (herbivores) are birds, insects, which occupy the II tropic level. Since the number of birds, insects and other species are higher when compared to the trees, the size of which is broader.
- The secondary consumers (Carnivores) are fox, snakes, lizards, which occupy the third tropic level. Since the number of fox, snakes are lower when compared to the birds, insects the size of which is lower.
- The tertiary consumers (omnivores) are lion, tiger, which occupy the IV tropic level. Since the number of lion, tiger are lower when compared to the fox and snakes the size of which is very (or) narrow lower. So the pyramid is narrow on both sides and broader in the middle and hence it is called partially upright of number as shown in figure.



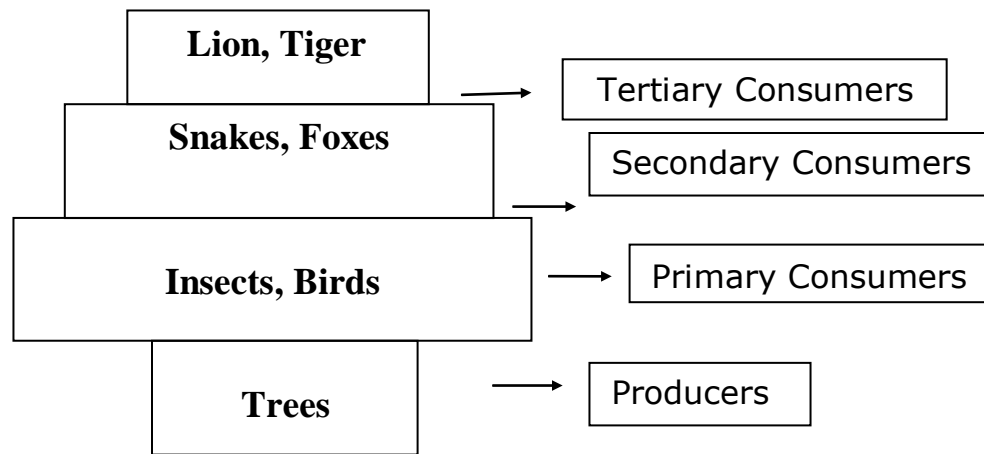
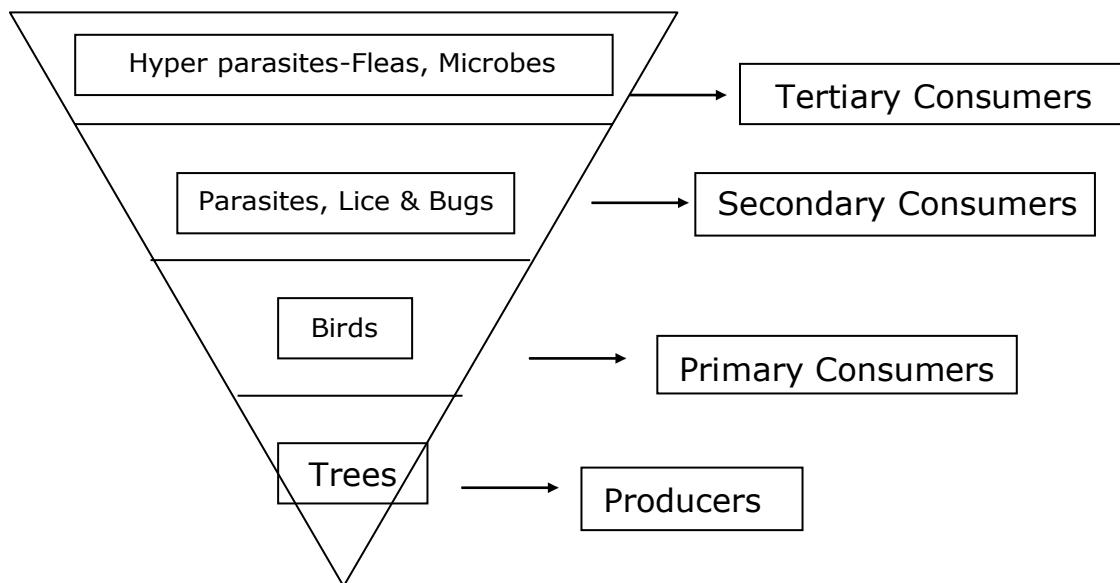


Figure: Pyramid of numbers in the forest ecosystem

3. Inverted Pyramid Of Numbers:

The number of individual organisms gradually increases from lower tropic level to higher tropic level, is known as "**inverted pyramid of numbers**".

Example: Parasitic food chain shows as inverted pyramid of number as shown in the following figure.



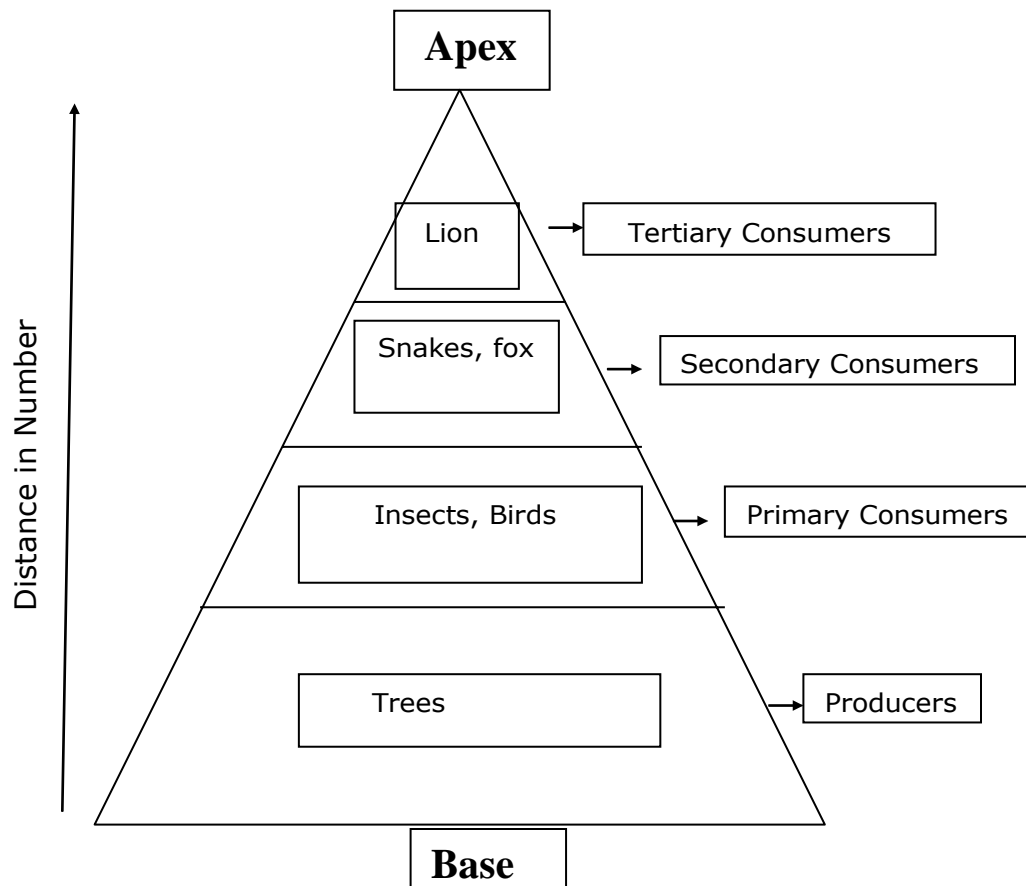
2. Pyramid of Biomass:

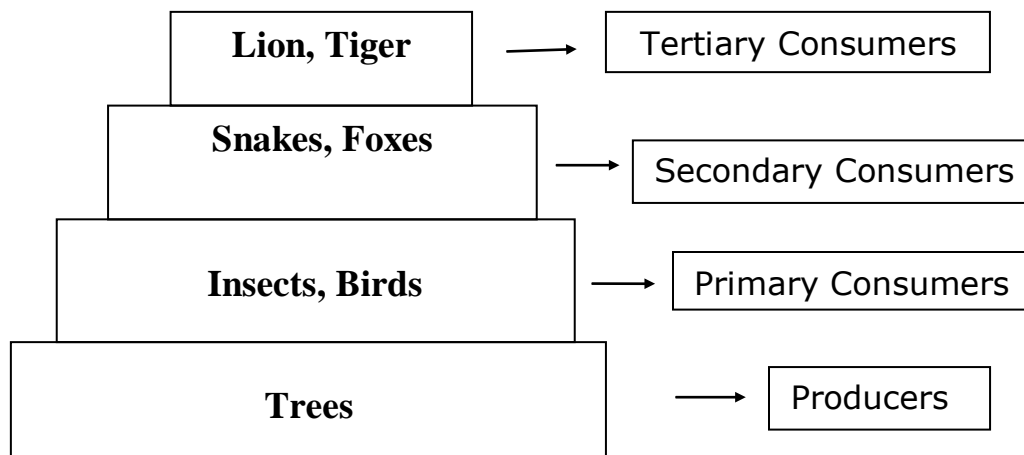
- It represents the total amount of biomass (mass (or) weight of biological material (or) organism) present in each tropic level.
- It is expressed in gram per unit area.

- Depending upon the type of ecosystem, we have two types of pyramid of biomass.
 - i. Upright pyramid of biomass.
 - ii. Inverted pyramid of biomass.

i. Upright Pyramid of Biomass:

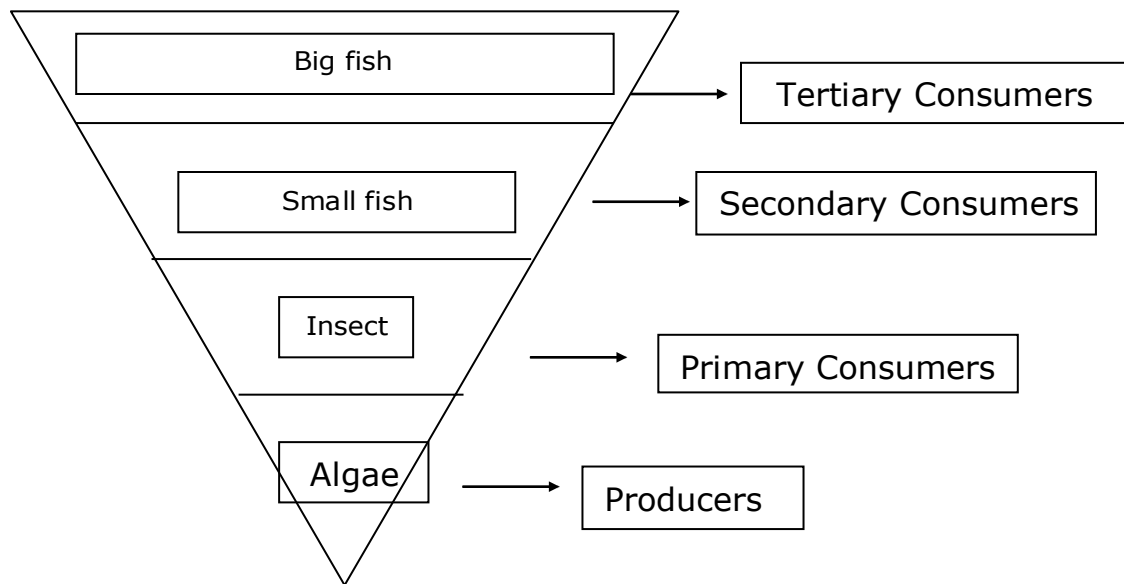
- The pyramid of biomass gradually decreases from the produce level (or) first tropic level to consumer level (higher tropic level) is called “upright pyramid of biomass”
- A forest ecosystem showed an upright pyramid of biomass.
- In this ecosystem, the biomass decreases from the producer level to consumer levels (as shown in figure)





ii. Inverted pyramid of biomass:

- The pyramid of biomass gradually increases from producer level to consumer level are called as Inverted pyramid of biomass.
- Example: The pond ecosystem shows an inverted pyramid of biomass.
- In this, ecosystem, the biomass increases from producer level to consumer levels as shown in the following figure.



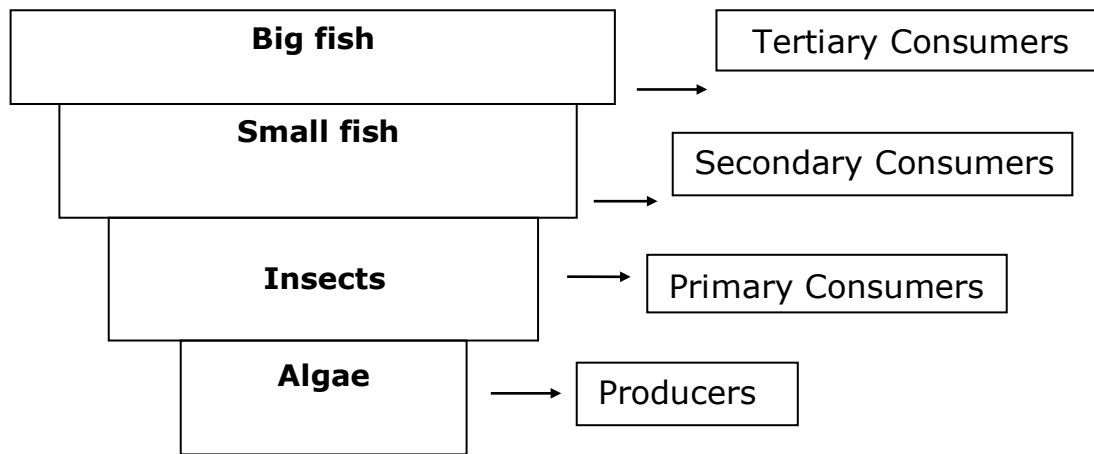
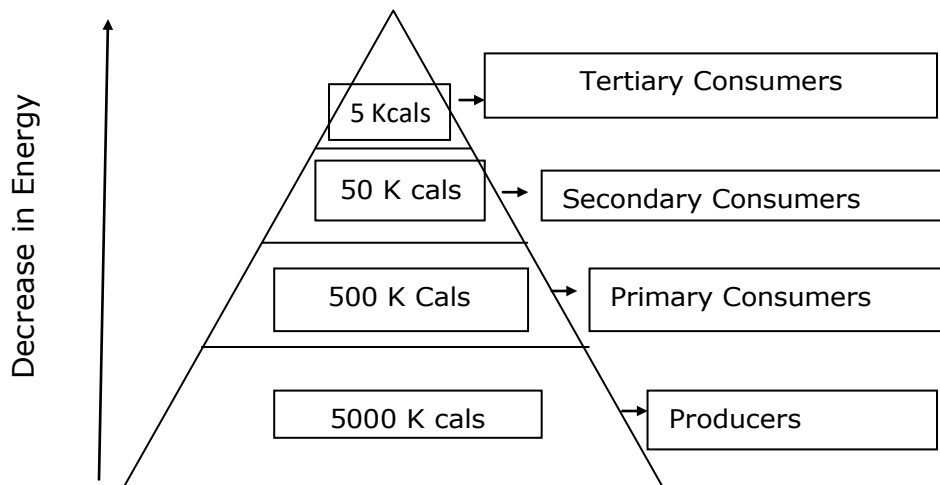


Figure: Pyramid of biomass in pond (eco system)

3. Pyramid of Energy:

- It represents the amount of flow of energy in each tropic level.
- It is expressed in calories per unit area per year.
- In an eco system, the energy flows from producer level to the consumer level. At each successive tropic level, there is a huge loss of energy (about 90%) in the form of heat, respiration, etc. Thus, at each next higher level only 10% of the energy passes on. Hence, there is a sharp decrease in energy at each and every producer to omnivores (or) top carnivores. Therefore, the pyramid of energy is always upright as shown in figure.

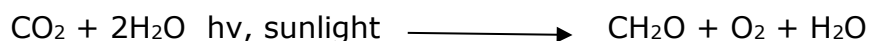


Energy flow through atmosphere to an ecosystem:

Sun the ultimate source of energy is absorbed by producers (plants) to produce organic matter through photosynthesis. The conversion of solar energy is governed by law of thermodynamics.

Ist Law of Thermodynamics:

Energy can neither be created, nor be destroyed, but it can be converted from one form to another. (Ex) photosynthesis- solar energy converted to chemical energy.

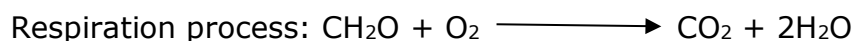
Photosynthesis Equation:

Plants are used by herbivores, herbivores are used by carnivores as their food.

Thus energy is transferred & conversion of solar energy is governed by law of thermodynamics

IIInd law of thermodynamics:

Whenever energy is transformed, there is a loss of energy through the release of energy in the form of heat. (Ex)

**Ten percent law:**

- According to this law, during the transfer of organic food energy from one trophic level to the next higher level, only ten percent of the energy will be passed on.
- In an every stage of food chain only the 10% of energy will transfer in the successive stage. eg. if plants are giving 99 joules of energy to deer because about 1% of energy is utilised by plants so Deer will get 10% of this 99 means 9.9 joules .

ECOLOGICAL SUCCESSION:**What is Ecological Succession?**

- Ecological succession is the steady and gradual change in a species of a given area with respect to the changing environment. It is a predictable change and is an inevitable process of nature.
- The ultimate aim of this process is to reach equilibrium in the ecosystem. The community that achieves this aim is called a **climax community**.
- In an area, the sequence of communities that undergo changes is called sere. Thus, each community that changes is called a seral stage or **seral community**.

- Ecological Succession: the series of changes in an ecosystem when one community is replaced by another community as a result of changes in biotic and abiotic factors.
- Can regenerate a damaged community
 - Can create a community in a previously uninhabited area
 - Occurs in all types of ecosystems (forests, ponds, coral reefs, etc)

Types of Ecological Succession

There are the following types of ecological succession:

- 1. Primary succession**
- 2. Secondary succession**
- 3. Cyclic succession**

Primary Succession

- Primary Succession: the process of creating and developing an ecosystem in an area that was previously uninhabited.
- Primary succession is the succession that starts in lifeless areas such as the regions devoid of soil or the areas where the soil is unable to sustain life.

Examples of uninhabited areas:

1. Sides of volcanoes
2. Sites of glacier recession

Process of Primary succession:

1. The process of primary succession starts with the arrival of living things such as lichens and mosses that do not need soil to survive. These first species are called **pioneer species**
2. Pioneer species move into an unoccupied area. The pioneers species help create soil by breaking down the rock particles into smaller and smaller pieces.
3. As lichen and mosses die, they decompose and add small amounts of nutrients to the rock particles, creating soil.
4. During this early stage of succession there are not many habitats so not many organisms are found in the environment.
5. Once there is enough soil and nutrients, small plants such as flowers, ferns, and grasses grow.
6. These plants help to further break down the rocks and add nutrients to the soil when they die and decompose.

7. The small plants create habitats for small animals like insects and small mammals.
8. Over time, as animals die and decompose, their bodies add nutrients to the soil allowing larger plant species to populate the area.
9. Larger animals follow the larger plants. Eventually, a mature community is formed; this mature community is called a **climax community**.
10. A climax community is a community that is able to maintain itself for long periods of time with few changes in the species that populate it.

Secondary Succession:

- Secondary Succession: the process of repairing a damaged ecosystem
- Occurs in areas where the soil was left intact

Examples of events that damage ecosystems:

1. Natural disasters
2. Human activities
3. Death of organisms

Secondary Succession:

- Is typically a much faster process than primary succession because there is already soil
- Secondary succession is a never ending process
- Any disturbance in an ecosystem results in secondary succession starting over
- Looks very similar to primary succession but does not require soil forming pioneer species
- If an ecosystem is frequently disturbed it will not be able to support large trees and animals so it will consist of the animals typical of the early stages of succession.
- It is obvious that primary succession is a rather slow process as life has to start from nothing whereas secondary succession is faster because it starts at a place which had already supported life before.

Cyclic Succession

This is only the change in the structure of an ecosystem on a cyclic basis. Some plants remain dormant for the rest of the year and emerge all at once. This drastically changes the structure of an ecosystem.

Seral Community

- A seral community is an intermediate stage of ecological succession advancing towards the climax community.
- A seral community is replaced by the subsequent community. It consists of simple food webs and food chains.

- It exhibits a very low degree of diversity. The individuals are less in number and the nutrients are also less.

There are seven different types of seres:

Types of Seres	Explanation
Hydrosere	Succession in aquatic habitat.
Xerosere	Succession in dry habitat.
Lithosere	Succession on a bare rock surface.
Psammosere	Succession initiating on sandy areas.
Halosere	Succession starting in saline soil or water.
Senile	Succession of microorganism on dead matter.
Eosere	Development of vegetation in an era.

Examples of Ecological Succession

1. Acadia National Park

This national park suffered a huge wildfire. Restoration of the forest was left on to nature. In the initial years, only small plants grew on the burnt soil. After several years, the forest showed diversity in tree species. However, the trees before the fire were mostly evergreen, while the trees that grew after the fire were deciduous in nature.

2. Ecological Succession of Coral Reefs

Small coral polyps colonize the rocks. These polyps grow and divide to form coral colonies. The shape of the coral reefs attracts small fish and crustaceans that are food for the larger fish. Thus, a fully functional coral reef exists.

MAJOR TYPES OF ECOSYSTEMS

FOREST ECOSYSTEM

Introduction: A forest ecosystem is the one in which a tall & dense trees grow which support many animals & birds. In India 19% occupies forest of total land area.

Types of Forest ecosystem:

1. Tropical rain forests → found near the equator, high temperature, have broad leaf trees like sandal, lion, tiger
2. Tropical deciduous forest → Found away from equator, warm climate, deciduous trees like maple, oak, deer, fox, rabbit etc.
3. Temperate rain forests → adequate rainfall areas, coniferous trees like pines, firs, squirrels, fox, cats, bear etc.
4. Temperate deciduous forest → found in moderate temp., trees like oak, hickory, animals – deer, fox, bear etc.
5. Tropical scrub forests → dry climate for longer time, small deciduous trees & shrubs, animals – deer, fox etc.

Characteristics of forest ecosystem:

- Characterized by warm temperature, adequate rainfall
- Maintain climate & rainfall
- Support many wild animals & protect biodiversity
- Soil is rich in minerals, so support growth of trees
- Penetration of light is poor so conversion of organic matter is very fast

Structure and Function of Forest Ecosystem

- I. Abiotic Components → abiotic components are physical components present in soil & atmosphere (Ex) temperature, light, rainfall, minerals
- II. Biotic Components
 1. Producers → plants absorbs sunlight & produce food by photosynthesis. Ex- trees, shrubs, plants
 2. Consumers
 - Primary consumers → Called herbivores/plant eaters- depend on plants for food. Ex. Insects, rat, goat, deer, cow, horse etc
 - Secondary consumers → Called primary carnivores/meat eaters. Depend on herbivores for food Ex. Frog, birds, cat, snakes, foxes etc.
 - Tertiary consumers → Called Secondary carnivores, feed on secondary consumers. Ex. Tigers, lions etc.
 3. Decomposers → Organisms which feed on dead organisms, plants & animals & decompose into simpler compounds like bacteria and fungi

AQUATIC ECOSYSTEM

Definition:

Deals with water bodies and biotic communities present in them-Classified as fresh water and marine ecosystems. Fresh water systems are classified as lentic and lotic ecosystems.

Types:

A. Pond ecosystem: Small fresh water ecosystem – seasonal in nature – organisms: algae, aquatic plants, insects, fishes etc. Ponds are very often exposed to anthropogenic pressure like cloth washing, bathing, cattle bathing, swimming etc.

B. Lake ecosystem: Big fresh water ecosystem – Zonation or stratification, especially during summer is a common one.

Top layer – shallow, warm, prone to anthropogenic activities – Littoral zone

Second layer – enough sunlight, high primary productivity – Limnetic zone

Third layer – very poor or no sunlight – Profundal zone

Eg. Dal lake in Srinagar, Naini Lake in Nainital

Organisms:

1. Planktons – phytoplankton eg. Algae – zooplankton eg. Rotifers
2. Nektons – that swims in water eg. Fishes
3. Neustons – that float on the surface of water Benthos – that attached to sediments eg. Snails

Types of lakes: Many types

1. Oligotrophic lakes – with less nutrient content
2. Eutrophic lakes – with very high nutrient content due to fertilizer contamination
3. Desert salt lakes – that contains high saline water due to over evaporation
4. Volcanic lakes – formed by water emitted from magma due to volcanic eruptions
5. Dystrophic lakes – that contains highly acidic water (low pH)
6. Endemic lakes – lakes that contain many endemic species, etc.

C. Streams: Fresh water ecosystem where water current plays a major role. Oxygen and nutrient content are uniform. Stream organisms have to face extreme difference in climatic conditions but they do not suffer from oxygen deficiency as pond and lake organisms. This is because large surface area of running water provides more oxygen supply. The animals have very narrow range of tolerance towards oxygen deficiency. Thus stream are worst victims of industrial pollution.

D. River ecosystem: large streams flowing from mountain highlands are rivers.

- Three phases:
 1. Mountain highlands – rushing down water fall of water – large quantity of dissolved oxygen – plants attached to rocks and fishes that require more oxygen are found.
 2. Second phase – gentle slopes of hills – warmer – supports the growth of plants and fishes that require less oxygen are seen.
 3. Third phase: river shapes the land – lots of silts, nutrients are brought – deposited in plains and delta – very rich in biodiversity.

E. Oceans:

Gigantic reservoirs of water covering >70% of earth surface 2,50,000 species – huge variety of sea products, drugs etc. – provide Fe, Mg, oils, natural gas, sand etc. – major sinks of carbondioxide – regulate biochemical cycles.

- Two zones:
 1. Coastal zone – warm, nutrient rich, shallow – high sunlight – high primary productivity.
 2. Open sea – away from continental shelf – vertically divided in to 3 zones.
 - Euphotic zone – abundant sunlight
 - Bathyal zone – dim sunlight
 - Abyssal zone – dark zone – world’s largest ecological unit.

F. Estuary: coastal area where river meet ocean – strongly affected by tidal actions – very rich in nutrients – very rich in biodiversity also – organisms are highly tolerant – many species are endemic – high food productivity – however to be protected from pollution.

Characteristics:

Structural Components:

Abiotic: pH, nutrients, D.O, temp, climatic conditions, etc.

Biotic: Phytoplankton, fishes, snails' insects etc.

CHAPTER 4

BIODIVERSITY AND IT'S CONSERVATION

INTRODUCTION

- Biodiversity is the abbreviated word for —biological diversity (bio -life or living organisms, diversity-variety). Thus biodiversity is the total variety of life on our planet, the total number of races, varieties and species. The sum of total of various types of microbes, plants and animals (producers, consumers and decomposers) in a system.
- Biomes can be considered life zones, environment with similar climatic, topographic and soil conditions and roughly comparable biological communities (Eg. Grassland, forest).
- The biomes shelter an astounding variety of living organisms (from driest desert to dripping rain forest, from highest mountain to deepest ocean trenches, life occurs in a marvelous spectrum of size, shape, colour and inter relationship). The variety of living organisms, the biodiversity, makes the world beautiful.
- There are 1.4 million species known presently. But based on new discoveries, by research expeditions, mainly in tropics, taxonomists estimate there are in between 3-50 million different species may be alive today. Insects make up more than one half of all known species and may comprise more than 90% of all species on earth.

LEVELS OF BIODIVERSITY

- The concept of biodiversity may be analyzed in 3 different levels. They are

1. Genetic diversity
2. Species diversity
3. Ecosystem diversity

1. Genetic diversity

- A species with different genetic characteristics is known as a sub-species.
- Genetic diversity is a measure of the variety of versions of same gene within individual species.
- Within individual species, there are varieties that are slightly different from one other. These differences are due to differences in the combination of genes.

- Genes are the basic units of hereditary information transmitted from one generation to the other.

Ex: (i) Rice varieties - All rice varieties belong to the species "*Oryza sativa*". However there are thousands of rice varieties that show variation at the genetic level in the form of different size, shape, colour and nutrient content.

(ii) Teak wood varieties: The various teak wood varieties available are - Indian teak, Burma teak, Malaysian teak etc.

2. Species diversity

- A discrete group of organisms of the same kind is known as species.
- Species diversity is the diversity between different species.
- The sum of varieties of all living organisms at the species level is known as **species diversity**.
- Species diversity describes the number of kinds of organisms within individual communities or ecosystems.
- The biotic component is composed of a large number of species of plants, animals and microorganisms which interact with each other and with the abiotic component of the environment.

Ex: The total number of species living on earth is approximately more than 2 million. However, only around 1.5 million are found and assigned scientific names.

Plant species: Apple, Mango, Wheat, Grapes, Rice etc

Animal species: Lion, Tiger, Elephant, Deer etc

3. Community or Ecosystem diversity

- A set of biotic components (plants, animals and microorganisms) and abiotic components (soil, air, water, etc) interacting with each other is known as an **ecosystem**.
- Ecosystem or ecological diversity means the richness and complexity of a biological community, including trophic levels, ecological processes (which capture energy), food webs and material recycling.
- The diversity at an ecological level or habitat level is known as ecosystem diversity.

Ex: River ecosystem- Rivers include fish, aquatic insects, mussels and a variety of plants that have adapted.

- Ecosystem diversity is the aggregate of different environmental types in a region.
- It explains the interaction between living organisms and physical environment in an ecosystem.

FUNCTIONS OF BIODIVERSITY: Two main functions of biodiversity are

1. It is the source on which the entire human species depends on for food, fibre, shelter, fuel and medicine.
2. It depends on biosphere which in turn leads to stability in climate, water, soil, air and overall health of biosphere.

VALUE OF BIODIVERSITY

Definition and estimation of the value of biodiversity is not easy. The value of biodiversity is classified into:

1. Direct Value and
2. Indirect Value

1. Direct value of biodiversity: It is of two types

- a. Consumptive use value and
- b. Productive use value

a. Consumptive use value:

- The consumptive use value is the value placed on nature's products that are consumed directly, without passing through a market. Some of them are firewood, food, and meat.
- When direct consumption requires recreation, as in sport fishing and game viewing, the consumptive value is the whole recreational experience. Consumptive value seldom appears in national income accounts, but could be easily included in measures such as GDP. It is valued from the cost if resource was sold at market value, rather than being consumed.

High consumptive use values on resources may lead to the following problems:

- Over-exploitation of wildlife in developing countries
- Loss of traditional controls on hunting and
- Loss of wildlife populations at productive levels.

- Consumptive use value benefits the communities closest to the resource if harvested sustainably and managed efficiently.

b. Productive use value:

- Productive use value refers to products that are commercially harvested (sold in a market).
- Its value is estimated at the production end rather than retail end by adding an inflated cost to the finished product.
- Productive use value is often the only value of biological resource reflected in national income accounts and may have a major impact on the national economy.
- Timber, fish, honey, construction materials, mushrooms, fruits, medicinal plants and meat sold in a market have productive use value.

2. Indirect value of biodiversity

- Indirect values provide economic benefits without being harvested and do not appear in GDP. However, they are crucial to other natural products which influence the GDP.
- These values involve functions performed by biodiversity which are not of any use. Ex: Ecological Processes etc.
- Direct values are often derived from indirect values because plants and animals are supported by the services provided by their environments.
- Many classes of plant and animal species are consumed by tribal and non-tribal communities.

• **Examples:**

1. Ecological functions
2. Flood and storm protection
3. Waste assimilation
4. Microclimatic functions
5. Nutrient cycles
6. Photosynthesis
7. Carbon stores
8. Soil protection, etc.

Indirect values of biodiversity are of the following types:

1. Non-consumptive use value
2. Optional value
3. Existence or ethical value
4. Information value
5. Aesthetic Values

1. Non-consumptive use value:

- This indirect value deals with nature's functions and services.
- It includes photosynthesis of plants which provides support system for other species by maintaining water cycle, regulating climate, production and protection of the soil, absorption and breakdown of pollutants, recreational, aesthetic, socio-cultural, scientific, educational, spiritual and historic values of natural environments.
- Recreational value is important with regard to tourism and helps the national GDP.

2. Optional value:

- This refers to the potential of biodiversity that is currently known and needs to be explored.
- This refers to the idea that there may be several existing species that may prove to be important in future and their usefulness needs to be studied with reference to a specific problem currently plaguing the society.

Ex:

1. The growing biotechnology field is searching for the cure for diseases like cancer and AIDS.
2. Medicinal plants and herbs play a very important role in the economic growth of our country.

3. Existence value:

- This is the value gained from continuous knowledge of existence. Also, this is the value that people are willing to pay to keep a species /community /ecosystem from going extinct. Examples of this are high amounts being spent for animals like pandas, whales, lions etc.
- Our rich heritage teaches us to worship plants, animals, rivers and mountains. Examples

being the Ganga River, trees like Banyan and Peepal and plants like the Vambu, Tulsi and Vengai are worshipped.

4. **Information value:** This relates to the educational, scientific and aesthetic and tourism values of biodiversity in an ecosystem.
5. **Aesthetic Values:** Beautiful plants and animals inspire us to protect biodiversity. The most important aesthetic value of biodiversity is eco-tourism.

Ex:

1. People from distant places spend time and money to visit areas where they can enjoy aesthetic value of biodiversity. This is called eco-tourism.
2. The pleasant music of wild birds, beautifully coloured butterflies, colour of peacocks and colour of flowers are very important for their aesthetic value.

BIO-GEOGRAPHICAL CLASSIFICATION OF INDIA

- India has different climate and topography in different parts and hence is termed as a mega diversity country.
- India occupies **10th place among plant rich countries of the world.**
- It is essential to acquire knowledge about the distribution and environmental interaction of flora and fauna of India.
- Bio-geographers have classified India into ten bio-geographic zones with each zone having characteristic climate, soil and biodiversity.

These zones are described below:

1. **Trans-Himalayas:** The trans-Himalayas are an extension to the Tibetan plateau. This region harbors the high-altitude cold desert in Ladakh and Lahaul Spiti (Himachal Pradesh). It accounts for 5.7% of the country's landmass.
2. **Himalayas:** The Himalayas are the northern boundaries of India. The entire mountain chain is running from Kashmir in the North-west to Assam in the north-east. The Himalayas comprise of a diverse range of biotic provinces and biomes. The Himalayas cover 7.2% of the country's landmass

3. **Desert:** The extremely dry area west of the Aravalli hill range comprises both the salty desert of Gujarat and the sandy desert of Rajasthan. Deserts occupy around 6.9% of the country's land mass.

The kinds of deserts found in India are:

- a. The desert of western Rajasthan- sandy
 - b. The desert of Gujarat-salty
 - c. The high-altitude cold desert of Jammu & Kashmir and Himachal Pradesh. The Indian deserts have more diversified fauna.
4. **Semi-arid:** This zone lies between the desert and the Deccan plateau. It includes the Aravalli hill range. It covers approximately 15.6% of the country's landmass.
5. **Western Ghats:** The Western Ghats are a mountain range that runs along the western coast of India. They are a range extending north-south from southern tip of Gujarat in the north to Kanyakumari in the south. The mountains cover an area of about 160,000 sq. km. This ghat section covers an extremely diverse range of biotic provinces and biomes. It covers about 5.8% of the country's landmass.
6. **Deccan plateau:** It is a large triangular plateau south of the Narmada valley. Three sides of the plateau are covered by mountains slopes towards east. Satpura Mountains cover the north while Western Ghats cover the west side and Eastern Ghats cover the eastern side of the plateau. It is the one of largest zones covering the southern and south-central plateau with mostly deciduous trees. It covers 4.3% of the country's landmass.
7. **Gangetic plain:** This plain covers the area between the south Himalayas to the tropic of cancer. These plains were formed by the Ganges river system and are relatively homogeneous. This region experience 600 mm rainfall annually. Sunderbans forests are located in this region and it covers 11% of the country's land mass.
8. **North-east India:** These are plains and non-himalayan ranges of northeastern India and have a wide variety of vegetation. It covers around 5.2% of the country's land mass.

9. **Islands:** The Andaman and Nicobar Islands in the Bay of Bengal has almost 300 big and small islands. Among these, only five islands are inhabited. Only tribes are found in the island of Nicobar. These islands have a highly diverse set of biomes and occupy 0.03% of the country's biomass.
10. **Coasts:** India has a large coastline distributed both to the east and west with distinct differences between these two. The Lakshwadeep islands are included in this but the area of these islands is negligible.

INDIA AS MEGA-DIVERSITY NATION

- India's rich biological diversity - its immense range of ecosystems, species and genetic forms is by virtue of its tropical location, climate and physical features.
- India's bio-geographical composition is unique as it combines living forms from three major bio-geographical realms, namely –
 - Eurasian,
 - Agro-Tropical and
 - Indo-Malayan.
- India's fabulous biodiversity is estimated to be over 45,000 plant species representing about 7% of the world's flora; and its bewildering variety of animal life represents 6.5% of world's fauna.
 - 15,000 species of flowering plants
 - 53,430 species of insects
 - 5050 species of molluscs
 - 6,500 species of other invertebrates
 - 2,546 species of fishes
 - 1228 species of birds, 446 species of reptiles
 - 372 species of mammals
 - 204 species of amphibians have been identified
- In India about 1, 15,000 species of plants and animals have been identified and described.
- India stands 10th in 25 most plant-rich countries of the world. Plant richness means greater uniqueness of species present.
- India has been described as one of 12 mega-diversity countries possessing a rich means

of all living organisms when biodiversity is viewed as a whole. The greater the multidiversity of species, greater is the contribution to biodiversity. There are 25 clearly defined areas in the world called '**hot spots**' which support about 50,000 endemic plant species, comprising 20 per cent of the world's total flora. **India's defined location of 'hot spots' is the Western Ghats and the Northeastern regions.**

- Forests, which embrace a sizeable portion of biodiversity, now comprise about 64million hectares or about 19 per cent of the land area of the country, according to satellite imaging. Roughly 33 cent of this forest cover represents primary forest.
- Indian flora comprises about 15,000 flowering plants and bulk of our rich flora is to be found in the Northeast, Western Ghats, the Northwest and Eastern Himalayas, and the Andaman and Nicobar Islands. Likewise, Assam and the Western Ghats are home to several species of mammal fauna, birds, and reptilian and amphibian fauna.
- As one of the oldest and largest agriculture societies, India has also a striking variety of at least 166 species of crop plants and 320 species of wild relatives of cultivated crops. There is a vital, but often-neglected factor when we focus on biodiversity.
- It may be a matter of her surprise for many to understand that the tribals who officially constitute 7.5 per cent of India's population have preserved 90 per cent of the country's biocultural diversity. To a large extent, the survival of our biodiversity depends on how best the tribals are looked after.
- To preserve our rich biodiversity, **several biosphere reserves** are set up in specific biogeographic" zones:
 1. The biggest one is in the Deccan Peninsula in the Nilgiris covering Tamil Nadu, Andhra Pradesh and Karnataka.
 2. Nanda Devi in Uttar khand in the Western Himalayas
 3. The Nokrek in Meghalaya
 4. Manas and Dibru Saikhowa in Assam
 5. The Sunderban's in the Gangetic plain in West Bengal
 6. The Great Nicobar
 7. The Gulf of Mannar in Tamil Nadu.

ENDANGERED AND ENDEMIC SPECIES OF INDIA

ENDANGERED SPECIES OF INDIA: A plant, animal or microorganism that is in immediate risk of biological extinction is called **endangered species** or **threatened species**.

In India, 450 plant species have been identified as endangered species. 100 mammals and 150 birds are estimated to be endangered.

India's biodiversity is threatened primarily due to:

1. Habitat destruction
 2. Degradation and
 3. Over exploitation of resources
- The **RED-data book** contains a list of endangered species of plants and animals. It contains a list of species of that are endangered but might become extinct in the near future if not protected.
 - Some of the rarest animals found in India are:
 1. Asiatic cheetah
 2. Asiatic Lion
 3. Asiatic Wild Ass
 4. Bengal Fox
 5. Gaur
 6. Indian Elephant
 7. Indian Rhinoceros
 8. Marbled Cat
 9. Markhor
 - ✓ **Extinct species** is no longer found in the world.
 - ✓ **Endangered or threatened species** is one whose number has been reduced to a critical number. Unless it is protected and conserved, it is in immediate danger of extinction.
 - ✓ **Vulnerable species** is one whose population is facing continuous decline due to

habitat destruction or over exploitation. However, it is still abundant.

- ✓ **Rare species** is localized within a restricted area or is thinly scattered over an extensive area. Such species are not endangered or vulnerable.

A few endangered species in the world are listed below:

1. West Virginia Spring Salamander (U.S.A)
2. Giant Panda (China)
3. Golden Lion Tamarin (Brazil)
4. Siberian Tiger (Siberia)
5. Mountain Gorilla (Africa)
6. Pine Barrens Tree Frog (Male)
7. Arabian Oryx (Middle East)
8. African Elephant (Africa)

Other important endangered species are:

1. Tortoise, Green sea Turtle , Gharial, Python (Reptiles)
2. Peacock, Siberian White Crane, Pelican, Indian Bustard (Birds)
3. Hoolock gibbin, Lion-tailed Macaque, Capped mokey, Golden monkey (Primates)
4. *Rauvolfia serpentina* (medicinal plant), Sandal wood tree, etc

Factors affecting endangered species:

1. Human beings dispose wastes indiscriminately in nature thereby polluting the air, land and water. These pollutants enter the food chain and accumulate in living creatures resulting in death.
2. Over-exploitation of natural resources and poaching of wild animals also leads to their extinction.
3. Climate change brought about by accumulation of green houses gases in the atmosphere. Climate change threatens organisms and ecosystems and they cannot adjust to the changing environmental conditions leading to their death and extinction.

- An international treaty to help protect endangered wildlife is, "**Convention on International Trade in Endangered Species 1975**" (CITES). This treaty is now signed by 160 countries.
1. CITES lists 900 species that cannot be commercially traded as live specimens or wildlife products as they are in danger of extinction.
 2. CITES restricts trade of 2900 other species as they are endangered.

ENDEMIC SPECIES OF INDIA

Species that are found only in a particular region are known as **endemic species**. Almost 60% the endemic species in India are found in Himalayas and the Western Ghats.

Endemic species are mainly concentrated in:

1. North-East India
2. North-West Himalayas
3. Western Ghats and
4. Andaman & Nicobar Islands.

Examples of endemic Flora species are

1. *Sapria Himalayana*
2. *Ovaria Lurida*
3. *Nepenthis khasiana* etc

Endemic fauna of significance in the western ghats are:

1. Lion tailed macaque
2. Nilgiri langur
3. Brown palm civet and
4. Nilgiri tahr

Factors affecting endemic species:

1. Habitat loss and fragmentation due to draining and filling of inland wetlands.
2. Pollution also plays an important role.

Ex: Frog eggs, tadpoles and adults are extremely sensitive to pollutants especially pesticides.

3. Over-hunting
4. Populations can be adversely affected by introduction of non active predators and competitors. Disease producing organisms also play an important adversary in reducing populations of endemic species.

THREATS TO BIODIVERSITY

- Any disturbance in a natural ecosystem tends to reduce its biodiversity.
- Waste generated due to increase in human population and industrialization spoils the environment and leads to decreased diversity in biological species.
- Any change in the system leads to a major imbalance and threatens the normal ecological cycle.

Causes for loss of biodiversity are:

1. Habitat loss
2. Poaching of wildlife
3. Man-wildlife conflicts

1. Habitat loss: The loss of populations of interbreeding organisms is caused by habitat loss. Factors influencing habitat loss are:

- a) **Deforestation:** Loss of habitat is mainly caused by deforestation activities. Forests and grasslands are cleared for conversion into agriculture lands or settlement areas or developmental projects. Forests and grasslands are natural home to thousands of species which disintegrate due to loss of their natural habitat.
- b) **Destruction of wetlands:** Wetlands, estuaries and mangroves are destroyed due to farming, filling and pollution that cause loss of biodiversity.
- c) **Habitat fragmentation:** When the habitat is divided into small and scattered patches the phenomenon is called habitat fragmentation. This leads to the disappearance of most wildlife.
- d) **Raw material:** To produce hybrid seeds, wild plants are used as raw materials leading to extinction of many wild plant species.

e) **Production of drugs:** Pharmaceutical companies collect wild plants for the production of drugs leading to extinction of several medicinal plant species.

Medicinal plants:

Penicillin-	fungus is the source	Antibiotic
Quinine-	Chincona bark	Malaria treatment
Morphine-	Poppy bark	Analgesic

f) **Illegal trade:** Illegal trade of wildlife reduces biodiversity leading to habitat loss.

g) **Developmental activities:** Construction of dams in forest areas coupled with the discharge of industrial effluents kills birds and other aquatic life.

2. Poaching of wildlife: Poaching refers to killing animals or commercial hunting. It contributes to loss of biodiversity.

Poaching can be of two types listed below:

1. **Subsistence poaching:** This refers to killing animals for survival.
2. **Commercial poaching:** This refers to hunting animals in order to sell their products.

Factors influencing poaching:

1. **Human population:** Increased human population in India has led to pressure on forest resources, leading to degradation of wildlife habitats.
2. **Commercial activities:**
 - Although a ban has been imposed internationally on the trade of products of endangered species, there is a continued smuggling of wildlife products. Since trading of such products is highly profitable, poachers continue to hunt endangered animals and smuggle their fur, skin and tusks to other countries.

Eg:

1. Tiger, Deer for hides
2. Rhinoceros – for horns
3. Male gorilla for its body parts
4. Blue morpho butterfly – making attractive trays
5. Snowy large egret – used for white feather in ladies hat
6. Elephant feet – for making Ash trays
7. Elephant – for ivory tusk

8. Bengal tiger – soled for \$1,00,000 in foreign market
9. Dynamite fishing – high tech fishing, exhaust marine life- Sea horses, Sea turtles

- Wildlife products include furs, horns, tusks, live specimens and herbal products. Richest source of biodiversity lies in developing nations in Asia, Africa and Latin America.
 - Eg. The American passenger pigeon was the world's most abundant bird. In spite of this vast population, market hunting and habitat destruction caused the entire population to crash within 20 years.
- Advanced countries like Europe, North America, Japan, Taiwan, Hong Kong are the major importers of wildlife products.

3. **Man-Wildlife Conflicts:** Man-wildlife conflicts arise, when wildlife starts causing immense damage and danger to man. Under such conditions it is very difficult for the forest department officials to convince the affected villagers to gain the villagers support for wildlife conservation.

Ex:

1. In Sambalpur, Orissa, several people were killed by elephants. In retaliation, the villagers killed and injured several elephants.
2. In Mysore, elephants were killed by farmers in retaliation to the damage done by elephants to their cotton and sugarcane fields.
3. Villagers sometimes hide explosives in their fields to ward-off animals which explode when the elephants enter the fields.
4. Several people were killed when leopards attacked them in Sanjay Gandhi National Park, Mumbai.

Factors influencing man-animal conflicts

1. Shrinking forest cover compels wildlife to move outside the forest
2. Human encroachment into forest area induces a man-wildlife conflict
3. Injured animals have a tendency to attack man
4. Wild animals venture out of the forest area in search of food

5. Villagers' set-up electric wiring around their fields. This injures animals (Elephants) who suffer pain and get violent.
6. Cash compensation paid by the government is not enough.
7. Garbage near human settlements or food crops attracts wild animals.

CONSERVATION OF BIODIVERSITY

The following measures should be taken to conserve biodiversity

1. Illegal hunting and trade of animals and animal products should be stopped immediately
2. People-at-large should boycott purchasing coats, purse or bags made of animal skin
3. Bio-diversity laws should be strengthened.
4. Adequate crop and cattle compensation schemes must be started
5. Solar powered fencing must be provided with electric current proof trenches to prevent animals from entering fields.
6. Cropping pattern should be changed near the forest borders
7. Adequate food and water should be made available for wild animals within forest zones.
8. Development and construction work in and around forest region must be stopped.

Types of conservation:

There are two types of biodiversity conservation:

1. In-situ conservation and
2. Ex-situ conservation

1. IN-SITU CONSERVATION

In-situ conservation involves protection of flora and fauna within its natural habitat. The natural habitats or ecosystems under in-situ conservation are called "**protected areas**".

- a. Biosphere reserves
- b. National parks
- c. Wildlife sanctuaries
- d. Gene sanctuaries

a. Biosphere reserves: They cover large areas (>5000 sq.km.) They are normally used to protect species for a long time.

The roles of biosphere reserves are listed below:

- i. Long-term survival of evolving ecosystem
- ii. Protect endangered species
- iii. Protect maximum number of species and communities
- iv. Serve as site of recreation and tourism
- v. May also be used for educational and research purposes
- vi. Biosphere reserves function as an open system and changes in land use are not allowed. No tourism and explosive activities are allowed in biosphere reserves.

There are 18 biosphere reserve are in India.

Sl.No	Name	States/ UT
1	Nilgiri Biosphere Reserve	Tamil Nadu, Kerala and Karnataka
2	Gulf of Mannar Biosphere Reserve	Tamil Nadu
3	Sundarbans Biosphere Reserve	West Bengal
4	Nanda Devi Biosphere Reserve	Uttarakhand
5	Nokrek Biosphere Reserve	Meghalaya
6	Pachmarhi Biosphere Reserve	Madhya Pradesh
7	Simlipal Biosphere Reserve	Odisha
8	Great Nicobar Biosphere Reserve	Andaman & Nicobar Islands
9	Achanakmar-Amarkantak Biosphere	Chhattisgarh, Madhya Pradesh
10	Agasthyamalai Biosphere Reserve	Kerala and Tamil Nadu
11	Khangchendzonga	Sikkim
12	Manas Biosphere reserve	Assam

Sl.No	Name	States/ UT
13	Dihang- Dibang	Arunachal Pradesh
14	Great Rann of kutch	Gujrat
15	Cold desert (Pin Valley National Park and surroundings; Chandratal and Sarchu & Kibber Wildlife Sanctuary)	Himachal Pradesh
16	Dibru-Saikhowa	Assam
17	Seshachalam hills	Andhra Pradesh
18	Panna	Madhya Pradesh

b. A national park:

- It is an area dedicated for the conservation of wildlife along with its environment.
- It covers an area ranging from 100-500 sq.km.
- One or more national parks may exist within a biosphere reserve.
- A national park is used for enjoyment through tourism, without affecting the environment.
- It is used to protect, propagate and develop wildlife.
- Grazing domestic animals inside national parks is prohibited
- All private rights and forestry activities are prohibited inside a national park
- As of May 2020, there are 105 national parks situated in India.

Some of the National Parks in India are:

1. Gir National Park Gujarat
2. Periyar Kerala
3. Dudwa Uttar Pradesh
4. Sariska Rajasthan
5. Ranthambore Rajasthan
6. Kaziranga Assam

c. Wildlife sanctuary is an area that is reserved for the conservation of animals only.

- It protects animals only.
- It allows operations such as harvesting of timber, collection of forest products, private ownership rights and forestry operations, provided it does not affect animals adversely.
- There are 553 existing **wildlife sanctuaries in India** covering an area of 119776.00 km², which is 3.64 % of the geographical area of the country (National **Wildlife** Database, December, 2019).

Some of the Wildlife sanctuary present in India:

- | | |
|---------------------------------|-----------|
| 1. Mudumalai wildlife sanctuary | Tamilnadu |
| 2. Vedanthangal Bird sanctuary | Tamilnadu |
| 3. Sultanpur Bird sanctuary | Haryana |
| 4. Ghana Bird sanctuary | Rajasthan |
| 5. Wild Ass sanctuary | Gurajat |

d. Gene sanctuary is an area where plants are conserved.

e. Other projects for the conservation of animals are Project Tiger, Gir Lion Project, Crocodile breeding project, project elephant etc.

Advantages of in-situ conservation

- i. It is cheap and convenient
- ii. Species get adjusted to natural disasters like drought, floods, forest fires etc.

Disadvantages of in-situ conservation

- i. A large surface area of earth is required to preserve biodiversity
- ii. Maintenance is not proper due to shortage of staff and pollution

2. EX-SITU CONSERVATION

Ex-situ conservation involves protection of flora and fauna outside their natural habitats. This type of conservation is mainly done for conservation of crop varieties and wild relatives of crops.

1. Ex-situ conservation involves maintenance and breeding of endangered plant and animal species under controlled conditions
2. It identifies those species that are at a high risk of extinction
3. It prefers species that are important for man in the near future among the endangered species.

Important centers of ex-situ conservation:

1. Botanical gardens
2. Seed banks
3. Microbial culture collections
4. Tissue and cell cultures
5. Museums and
6. Zoological gardens

Institutes for ex-situ conservation:

1. **National Bureau of Plant Genetic Resources (NPBGR):** It is located in New Delhi and uses the Cryopreservation Technique to preserve agricultural and horticultural crops. Cryopreservation technique involves using liquid nitrogen at $-196\text{ }^{\circ}\text{C}$. Varieties of rice, turnip, radish, tomato, onion, carrot, chilli, tobacco have been successfully preserved for years using this technique.
2. **National Bureau of Animal Genetic Resources (NPAGR):** It is located in Karnal, Haryana and preserves the semen of domesticated bovine animals.
3. **National Facility for Plant Tissue Culture Repository (NFPTCR):** In this facility, conservation of varieties of crop plants or trees is done using tissue culture. This facility has been created within the NPBGR.

Advantages of Ex-situ conservation

1. Survival of endangered species is increasing due to special care and attention
2. In captive breeding the animals are assured of food, water, shelter and security thereby have a longer life span
3. It is carried-out in cases of endangered species that do not have any chance of survival in the wild

Disadvantages of Ex-situ conservation

1. It is an expensive method
2. Freedom of wildlife is lost
3. Animals cannot survive after they release to their natural environment.

CHAPTER 5

ENVIRONMENTAL POLLUTION

INTRODUCTION

- **Pollution** may be defined as an undesirable change in the physical, chemical or biological characteristics of air, water and land that may be harmful to human life and other animals, living conditions, industrial processes and cultural assets.
- Pollution can be natural or manmade.
- The agents that pollute are called pollutants.

POLLUTANTS

Pollutants are by-products of man's action. The important pollutants are summarized below:

1. **Deposited matter**—Soot, smoke, tar or dust and domestic wastes.
2. **Gases**—CO, nitrogen oxides, sulphur oxides, halogens (chlorine, bromine and iodine).
3. **Metals**—Lead, zinc, iron and chromium.
4. **Industrial pollutants**—Benzene, ether, acetic acid and cyanide compounds.
5. **Agriculture pollutants**—Pesticides, herbicides, fungicides and fertilizers
6. **Photochemical pollutants**—Ozone, oxides of nitrogen, ethylene, photochemical smog, and proxy acetyl nitrate
7. **Radiation pollutants**—Radioactive substances and radioactive fall-outs of the nuclear test.

CLASSIFICATION OF POLLUTANTS

Nature of disposal: On the basis of natural disposal, pollutants are of two types:

1. **Non-degradable pollutants:**

- These are the pollutants, which degrade at a very slow pace by the natural biological processes.

- These are inorganic compounds such as salts (chlorides), metallic oxides waste producing materials and materials like, aluminum cans, mercuric salts and even DDT.
- These continue to accumulate in the environment.

2. **Biodegradable pollutants:**

- These include domestic sewage that easily decomposes under natural processes and can be rapidly decomposed by natural/ artificial methods.
- These cause serious problems when accumulated in large amounts as the pace of deposition exceeds the pace of decomposition of disposal.

Nature of form: On the basis of the form in which they persist after their release into the environment, pollutants can be categorized under two types:

(i) Primary pollutants: These include those substances, which are emitted directly from some identifiable sources. This include-

- a. **Sulphur compounds:** SO_2 , SO_3 , H_2S produced by the oxidation of fuel.
- b. **Carbon compounds:** Oxides of carbon ($\text{CO}+\text{CO}_2$) and hydrocarbons.
- c. **Nitrogen compounds:** NO_2 and NH_3 .
- d. **Halogen compounds:** Hydrogen fluoride (HF) and hydrochloric acid (HCl).
- e. **Particles of different size and substances:** These are found suspended in air. The fine particles below the diameter of 100μ are more abundant and include particles of metals, carbon, tar, pollen, fungi, bacteria, silicates and others.

(ii) Secondary pollutants: The secondary pollutants are produced by the combination of primary emitted pollutants in the atmosphere.

Ex: In bright sunlight, a photochemical reaction occurs between nitrogen oxides; oxygen and waste hydrocarbons from gasoline that forms peroxy-acetylene nitrate (PAN) and ozone (O_3), both of them are toxic components of smog and cause smarting eyes and lung damage.

TYPES OF POLLUTION

AIR POLLUTION

INTRODUCTION

Air pollution is one such form that refers to the contamination of the air, irrespective of indoors or outside. A physical, biological or chemical alteration to the air in the atmosphere can be termed as pollution.

It occurs when any harmful gases, dust, smoke enters into the atmosphere and makes it difficult for plants, animals and humans to survive as the air becomes dirty.

The WHO defines **air pollution** as the presence of materials in the air in such concentration which are harmful to man and his environment. A number of ingredients find their way in the air and these are mostly gases, which rapidly spread over wide areas.

CAUSES OF AIR POLLUTION

1. **Burning of Fossil Fuels:** Sulfur dioxide emitted from the combustion of fossil fuels like coal, petroleum and other factory combustibles is one of the major causes of air pollution. Pollutants emitting from vehicles cause immense amount of pollution. Carbon Monoxide produced by improper or incomplete combustion emitted from vehicles is another major pollutant along with Nitrogen Oxides that is produced from both natural and manmade processes.
2. **Agricultural activities:** Ammonia is a very common by product from agriculture related activities and is one of the most hazardous gases in the atmosphere. Use of insecticides, pesticides and fertilizers in agricultural activities emit harmful chemicals into the air and cause water pollution.
3. **Exhaust from factories and industries:** Manufacturing industries release large amount of carbon monoxide, hydrocarbons, organic compounds, and chemicals into the air thereby depleting the quality of air. Petroleum refineries also release hydrocarbons and various other chemicals that pollute the air and also cause land pollution.

4. **Mining operations:** Mining is a process wherein minerals below the earth are extracted using large equipments. During the process dust and chemicals are released in the air causing massive air pollution.
5. **Indoor air pollution:** Household cleaning products, painting supplies emit toxic chemicals in the air and cause air pollution.
6. **Suspended Particulate matter:** Suspended particulate matter popular by its acronym SPM, is another cause of pollution.

TYPES OF AIR POLLUTANTS

- **Primarily air pollutants** can be caused by primary sources or secondary sources. The pollutants that are a direct result of the process can be called primary pollutants. A classic example of a primary pollutant would be the sulfur-dioxide emitted from factories
- **Secondary pollutants** are the ones that are caused by the inter mingling and reactions of primary pollutants. Smog created by the interactions of several primary pollutants is known to be as secondary pollutant.

COMMON AIR POLLUTANTS

1. **Carbon Dioxide:** CO₂ content of air has increased by 20% during the last century. CO₂ causes nausea and headache. Its increase in the air may cause green house effect, rise in the atmospheric temperature. This may melt the polar ice resulting in rise in level of oceans and flooding of coastal regions.
2. **Carbon Monoxide:** It is a very poisonous gas and is produced by incomplete combustion of fuel. If inhaled it combines with hemoglobin and reduces its oxygen-carrying capacity. This leads to laziness, reduced vision and death.
3. **Oxides of Nitrogen:** These include NO and NO₂, which are released by automobiles and chemical industries as waste gases and also by burning of materials. These are

- harmful and lower the oxygen carrying capacity of blood.
4. **Oxides of Sulphur:** SO_2 and SO_3 are produced by burning of coal and petroleum and are harmful to buildings, clothing, plants and animals. High concentration of SO_2 causes chlorosis (yellowing of leaves), plasmolysis, damage to mucous membrane and metabolic inhibition. SO_2 and SO_3 react with water to form Sulphuric and sulphurous acids. These may precipitate as rain or snow producing acid rain or acid precipitation.
 5. **Photochemical Oxidants:** Formed by the photochemical reactions between primary pollutants, viz. oxides of nitrogen and hydrocarbons. Nitrogen oxides in the presence of sunlight react with un-burnt hydrocarbons to form peroxyacyl nitrate (PAN), Ozone, aldehydes and some other complex organic compounds in the air.
 6. **Hydrocarbons:** These are un-burnt discharges from incomplete combustion of fuel in automobiles. These forms PAN with nitrogen oxides, which is highly toxic.
 7. **Particulate Matter:** Industries and automobiles release fine solid and liquid particles into the air. Fly ash and soot from burning of coal, metal dust containing lead, chromium, nickel, cadmium, zinc and mercury from metallurgical processes; cotton dust from textile mills; and pesticides sprayed on crops are examples of particulate pollutants in the air. These are injurious to respiratory tract.
 8. **Aerosols:** Aerosols are chemicals released in the air in vapor form. These include fluorocarbon (carbon compound having fluorine) present in emissions from the Jet aero planes. Aerosols deplete the ozone layer. Thinning of ozone layer results in more harmful ultraviolet rays reaching the earth, which are harmful to skin, and can lead to skin cancer also.
 9. **Radioactive Substances:** These are released by nuclear explosions and explosives. These are extremely harmful for health.
 10. **Fluorides:** Rocks, soils and minerals containing fluorides release an extremely

toxic gas called hydrogen fluoride on heating. This gas is highly injurious to livestock and cattle.

CONTROL MEASURES

The atmosphere has several built-in self cleaning processes such as dispersion, gravitational settling, flocculation, absorption, rain-washout, etc to cleanse the atmosphere. However, control of contaminants at their source level is a desirable and effective method through preventive or control technologies.

1. **Source control:** Some measures that can be adopted in this direction are
 - a) Using unleaded petrol
 - b) Using fuels with low sulphur and ash content
 - c) Encouraging people to use public transport, walk or use a cycle as opposed to private vehicles
 - d) Ensure that houses, schools, restaurants and playgrounds are not located on busy streets
 - e) Plant trees along busy streets as they remove particulates, carbon dioxide and absorb noise
 - f) Industries and waste disposal sites should be situated outside the city preferably on the downwind of the city.
 - g) Catalytic converters should be used to help control emissions of carbon monoxide and hydrocarbons

2. **Control measures in industrial centers:**
 - a) Emission rates should be restricted to permissible levels by each and every industry
 - b) Incorporation of air pollution control equipment in design of plant layout must be made mandatory
 - c) Continuous monitoring of the atmosphere for pollutants should be carried out to know the emission levels.

EQUIPMENT USED TO CONTROL AIR POLLUTION:

Air pollution can be reduced by adopting the following approaches:

- 1) Ensuring sufficient supply of oxygen to the combustion chamber and adequate temperature so that the combustion is complete thereby eliminating much of the smoke consisting of partly burnt ashes and dust.
- 2) To use mechanical devices such as scrubbers, cyclones, bag houses and electro- static precipitators in manufacturing processes. The equipment used to remove particulates from the exhaust gases of electric power and industrial plants are shown below.
- 3) All methods retain hazardous materials that must be disposed safely. Wet scrubber can additionally reduce sulphur dioxide emissions. The air pollutants collected must be carefully disposed. The factory fumes are dealt with chemical treatment.

CASE STUDY: Bhopal Gas Tragedy

On night of 3rd December 1984 in Bhopal city of Madhya Pradesh at Union carbide India Ltd, which manufacture carbonate pesticides using methyl isocyanate (MIC) Due to failure of coolant, the reactor got exploded & 40 tons of MIC leaked over 40 sq.km area.

Nature of MIC: It is a toxic gas, affects lungs, eyes and causes skin irritation, remove oxygen from lungs and cause death.

Effects in Bhopal: About 5000 persons died, 1000 became blind, 65,000 people suffered from eye, respiratory and neuromuscular problems.

WATER POLLUTION

INTRODUCTION

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.”

SOURCES OF WATER POLLUTION

1. **Point sources:** These are pollutants that are discharged at specific locations through pipes, ditches or sewers into bodies of surface waters.
Ex: Factories, sewage treatment plants, abandoned underground mines and oil tankers.

2. **Non point sources:** These pollutants cannot be traced to a single point of discharge. They are large land areas or air-sheds that pollute water by runoff, subsurface flow or deposition from the atmosphere.
Ex: Acid deposition, runoff of chemicals into surface water from croplands, livestock feedlots, logged forests, urban streets, lawns, golf courses and parking lots.

TYPES, EFFECTS AND SOURCES OF WATER POLLUTION:

Water pollution is any chemical, biological or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses.

Sl. No.	Pollutants	Human sources	Health Effects
1	Infectious agents Ex: Bacteria, Viruses, Protozoa, and parasitic worms.	Human and animal wastes	Variety of diseases
2	Oxygen demanding wastes (Dissolved oxygen) Ex: Organic wastes such as animal manure and plant debris	Sewage, Animal feedlots, paper mills and food processing facilities	Degrade water quality by depleting water of dissolved oxygen. This causes fish and other forms of oxygen consuming aquatic life to die.

3	Inorganic chemicals Ex: Water soluble inorganic chemicals: Acids, Compounds of toxic metals such as lead (Pb), arsenic (As) and selenium (Se) and Salts such as NaCl in oceans and fluoride (F-) found in some soils.	Surface runoff, industrial effluents and household cleansers	<ul style="list-style-type: none"> • Make freshwater unusable for drinking and irrigation • Cause skin cancer and neck damage, Damage to nervous system, liver and kidneys • Harm fish and other aquatic life • Lower crop yields • Accelerate corrosion of metals exposed to such water
4	Organic chemicals Ex: Oil, Gasoline, Plastics, Pesticides, Cleaning solvents and Detergents.	Industrial effluents, household cleansers and surface runoff from farms.	<ul style="list-style-type: none"> • Can threaten human health by causing nervous system damage and some cancers. • Harm fish and wildlife.
5	Plant nutrients Ex: Water soluble compounds containing nitrate, Phosphate and Ammonium ions.	Sewage, manure and runoff of agricultural and urban fertilizers	<ul style="list-style-type: none"> • Can cause excessive growth of algae and other aquatic plants, which die, decay, deplete dissolved oxygen in water thereby killing fish • Drinking water with excessive levels of nitrates lower the oxygen carrying capacity of the blood and can kill urban children and infants.
6	Sediment Ex: Soil, silt, etc.	Land erosion	<ul style="list-style-type: none"> • Causes cloudy water thereby reducing photosynthetic activity • Disruption of aquatic food chain
			<ul style="list-style-type: none"> • Carries pesticides, bacteria and other harmful substances • Settles and destroys feeding and spawning grounds of fish

			<ul style="list-style-type: none"> • Clogs and fills lakes, artificial reservoirs, stream channels and harbors
7	<p>Radioactive materials: Ex: Radioactive isotopes of: Iodine, Radon, Uranium, Cesium and Thorium.</p>	<p>Nuclear power plants, mining and processing of uranium and other ores, nuclear weapon production and natural sources</p>	<ul style="list-style-type: none"> • Genetic mutations, birth defects and certain cancers.
8	<p>Heat (Thermal pollution) Ex: Excessive heat</p>	<p>Water cooling of electric power plants and some types of industrial plants.</p>	<ul style="list-style-type: none"> • Low dissolved oxygen levels thereby making aquatic organisms more vulnerable to disease, parasites and toxic chemicals. • When a power plant starts or shuts down for repair, fish and other organisms adapted to a particular temperature range, can be killed by an abrupt temperature change known as thermal shock.

TESTING OF RIVER WATER

- **Dissolved oxygen (DO)** = It is the amount of oxygen dissolved in a given quantity of water at a particular pressure & temperature.
- **Biochemical Oxygen Demand (BOD)** = It is the amount of oxygen required for the biological decomposition of organic matter present in the water.
- **Chemical Oxygen Demand (COD)** = It is the amount of oxygen required for chemical oxidation of organic matter using oxidizing agent like $K_2Cr_2O_7$ & $KMnO_4$

CONTROL MEASURES OF WATER POLLUTION

1. Administration of water pollution control should be in the hands of state or central government
2. Scientific techniques should be adopted for environmental control of catchment areas of rivers, ponds or streams
3. Industrial plants should be based on recycling operations as it helps prevent disposal of wastes into natural waters but also extraction of products from waste.
4. Plants, trees and forests control pollution as they act as natural air conditioners.
5. Trees are capable of reducing sulphur dioxide and nitric oxide pollutants and hence more trees should be planted.
6. No type of waste (treated, partially treated or untreated) should be discharged into any natural water body. Industries should develop closed loop water supply schemes and domestic sewage must be used for irrigation.
7. Qualified and experienced people must be consulted from time to time for effective control of water pollution.
8. Public awareness must be initiated regarding adverse effects of water pollution using the media.
9. Laws, standards and practices should be established to prevent water pollution and these laws should be modified from time to time based on current requirements and technological advancements.
10. Basic and applied research in public health engineering should be encouraged.

SOIL POLLUTION

INTRODUCTION

Soil pollution is defined as, "contamination of soil by human and natural activities which may cause harmful effect on living organisms".

TYPES, EFFECTS AND SOURCES OF WATER POLLUTION

Sl No.	Pollutants	Sources	Health Effects
1	Industrial wastes	<ul style="list-style-type: none"> Industrial pollutants are mainly discharged from various origins such as pulp and paper mills, chemical fertilizers, oil refineries, sugar factories, tanneries, textiles, steel, distilleries, fertilizers, pesticides, coal and mineral mining industries, drugs, glass, cement, petroleum and engineering industries etc. 	<ul style="list-style-type: none"> These pollutants affect and alter the chemical and biological properties of soil. As a result, hazardous chemicals can enter into human food chain from the soil or water, disturb the biochemical process and finally lead to serious effects on living organisms.
2	Urban wastes	<ul style="list-style-type: none"> Plastics, glasses, metallic cans, fibers, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products. 	<ul style="list-style-type: none"> Alter the constitution of soil Cause Water logging Cause biomagnifications of toxic materials through food chain
3	Agricultural practices	<ul style="list-style-type: none"> fertilizers, pesticides, weedicides, farm wastes, manure debris, soil erosion 	<ul style="list-style-type: none"> Water logging, Salinisation, micronutrient imbalance, loss of fertile soil

4	Radioactive pollutants	<ul style="list-style-type: none"> • Atomic reactor, nuclear radioactive devices, • Explosion of hydrogen weapons and cosmic radiations 	<ul style="list-style-type: none"> • Mutations, changes functions of living beings, Biomagnifications, cancers, Infant mortality
5	Biological agents	<ul style="list-style-type: none"> • The human and animal wastes, garbage, waste water 	<ul style="list-style-type: none"> • Variety of diseases • Cause nutrient imbalance
6	Pesticides	<ul style="list-style-type: none"> • Chlorinated hydrocarbon insecticide • Organic phosphorous pesticides 	<ul style="list-style-type: none"> • Reduces the activity of sex hormones of male and female. • Causes diseases to human beings.
7	Fertilizers	<ul style="list-style-type: none"> • Different fertilizers discharge N, Na, K, S, Nitrates etc 	<ul style="list-style-type: none"> • The nitrate causes cancer, blue baby syndrome in infants.
8	Polymer, Plastics & other water	<ul style="list-style-type: none"> • Waste from different sources 	<ul style="list-style-type: none"> • Biomagnifications, • water logging, • create cancers in animals and human beings.

CONTROL MEASURES OF WATER POLLUTION

1. Soil erosion can be controlled by a variety of forestry and farm practices. Ex: Planting trees on barren slopes
2. Contour cultivation and strip cropping may be practiced instead of shifting cultivation
3. Terracing and building diversion channels may be undertaken.
4. Reducing deforestation and substituting chemical manures by animal wastes also helps arrest soil erosion in the long term.
5. **Proper dumping of unwanted materials:** Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal. The surface so obtained is used for housing or sports field.
6. **Production of natural fertilizers:** Bio-pesticides should be used in place of toxic chemical

pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Ex: Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.

7. **Proper hygienic condition:** People should be trained regarding sanitary habits.

Ex: Lavatories should be equipped with quick and effective disposal methods.

8. **Public awareness:** Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental education.

Ex: Mass media, Educational institutions and voluntary agencies can achieve this.

9. **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.

Ex: Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.

10. **Ban on Toxic chemicals:** Ban should be imposed on chemicals and pesticides like DDT, BHC, etc which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should be banned.

NOISE POLLUTION

INTRODUCTION

Noise is defined as, "the unwanted, unpleasant or disagreeable sound that causes discomfort to all living beings". Sound intensity is measured in decibels (dB) , that is the tenth part of the longest unit Bel. One dB is the faintest sound that a human ear can hear.

Types of noise: Noise is classified as:

- Industrial Noise
- Transport Noise
- Domestic Noise

Industrial Noise:

- It is sound with a high intensity sound caused by industry machines. Sources of such noise pollution are caused by machines in various factories, industries and mills. Noise from mechanical saws and pneumatic drills is unbearable and a nuisance to the public.
- The Indian Institute of Otorhinolaryngology, Chennai reported that increasing industrial pollution damages the hearing ability by at least 20%.
- Workers in steel industry, who work close to heavy industrial blower, are exposed to 112dB for eight hours suffer from occupational pollution.

Transport Noise:

- Transport noise mainly consists of traffic noise from road, rail and aircraft. The number of automobiles on roads like motors, scooters, cars, motor cycles, buses, trucks and diesel engine vehicles has increased enormously in the recent past further aggravating the problem of transport noise.
- Noise levels in most residential areas in metropolitan cities are hovering around the border line due to increased vehicular noise pollution. This high level of noise pollution leads to deafening in the elderly.

Domestic noise:

- This type of noise includes disturbance from household gadgets and community.
- Common sources of noise are musical instruments, TV, VCR, Radios, Transistors, Telephones, and loudspeakers etc.
- Ever since the industrial revolution, noise in the environment has been doubled every ten years.

EFFECTS OF NOISE POLLUTION

Noise pollution affects both human and animal health. It leads to:

1. Contraction of blood vessels
2. Making skin pale
3. Excessive adrenalin in the blood stream which is responsible for high blood pressure
4. Blaring sounds are known to cause mental distress
5. Heart attacks, neurological problems, birth defects and abortion
6. Muscle contraction leading to nervous breakdown, tension, etc
7. The adverse reactions are coupled with a change in hormone content of blood, which in-turn increases heart beat, constriction of blood vessels, digestive spasms and dilation of the pupil of the eye.
8. Adverse affects health, work efficiency and behavior. Noise pollution may cause damage to the heart, brain, kidneys, liver and may produce emotional disturbance.
9. The most immediate and acute effect of noise is impairment of hearing that diminishes some part of the auditory system. Prolonged exposure to noise of certain frequency pattern leads to chronic damage to the inner ear.
10. Impulsive noise may cause psychological and pathological disorders
11. Ultrasonic sound can affect the digestive, respiratory, cardiovascular system and semicircular canals of the internal ear.
12. The brain is adversely affected by loud and sudden noise by jets and airplanes. People are subjected to psychiatric illness.
13. Recent reports suggest that blood is thickened by excessive noise.
14. The optical system of human beings is also affected by noise pollution.
15. Severe noise pollution causes: Popularly dilation, Impairment of night vision and Decrease in rate of color perception

CONTROL MEASURES OF NOISE POLLUTION

1. **SOURCE CONTROL:** This includes source modification such as acoustic treatment to machine surface, design changes, limiting operational timings, etc
2. **TRANSMISSION PATH INTERVENTION:** This includes containing the source inside a sound insulating enclosure, constructing a noise barrier or provision of sound absorbing materials along the path.
3. **RECEPTOR CONTROL:** This includes protection of the receiver by altering the work schedule or provision of personal protection devices such as ear plugs for operating noisy machinery. The measure may include dissipation and deflection methods.
4. **OILING:** Proper oiling will reduce noise from the machine.

PREVENTIVE MEASURES OF NOISE POLLUTION

1. Prescribing noise limits for vehicular traffic
2. Ban on honking (usage of horns) in certain areas
3. Creation of silence zones near schools and hospitals
4. Redesigning buildings to make them noise proof
5. Reduction of traffic density in residential areas
6. Giving preference to mass public transport system.

MARINE POLLUTION

INTRODUCTION

The discharge of waste substances in to the sea resulting in harm to the living resources, hazards to the human health hindrances to the fishery and impairment of quality use of sea water.

SOURCES OF MARINE POLLUTION

1. **Dumping the wastes:** Dumping of untreated wastes and sewages in the oceans by coastal towns, cities and industries. Rivers on the way to sea carry huge amount of sewage garbage agricultural discharge pesticide heavy metals. Huge quantity of plastic dumped in to the sea.
2. **Oil:** This is discharged in to the sea as crude oil and as separate fraction. Oil and its fractions are used in houses automobiles and industries. This causes devastation of marine environment
3. **Radioactive materials** enter the ocean from nuclear weapon testing.
4. **Toxics:** Toxic waste is the most harmful form of marine pollution. Once toxic wastes affects an organism it quickly passes along the food chain and as sea food which cause various problems.
5. **Marine Debris:** Garbage like plastic bags, ropes helium balloons

EFFECTS OF MARINE POLLUTION

1. Heavy metals and organic pollutants damages birds by thinning of egg shells and tissue damage of egg.
2. Oil pollution causes damage to marine animals and plants including algae bird, fish etc.
3. Oil spilling in the sea causes abnormal low body temperature in birds resulting in hypothermia. During Exxon Valdez accident 150 rare species of bald eagles are affected by ingested oil.
4. Oil films are able to retard the rate of oxygen uptake by water.
5. Hydrocarbon and benzpyrene accumulate in food chain and consumption of fish by man may cause cancer.
6. Many marine birds ingest plastic that causes gastrointestinal disorders.

7. Oil spills inhibit photosynthesis and the growth of planktons. All aquatic animals depend either directly or indirectly on planktons the basis of tropic chain.

CONTROL MEASURES OF MARINE POLLUTION

1. Nature and world conservation union suggest the principles
 - i. The industrial unit on the coastal lines should be equipped with pollution control instrument.
 - ii. Urban growth near the coast should be regulated.
2. Methods of removal of oil
 - i. Physical methods**
 - a.** skimming the oil off the surface with suction device
 - b.** Floating oil can be absorbed using absorbing materials like poly urethane foam. Chopped straw and saw dust also used to absorb oil from the sea water.
 - ii. Chemical methods** like dispersion, emulsification and using chemical additives are used to coagulate the oil.

PROTECTIVE METHODS

1. Municipal and industrial waste should be treated before disposing into sea
2. Coastal waste are periodically analyzed for detecting pollution level
3. Soil erosion in the coastal land should be arrested by suitable techniques
4. Recreation beaches should be maintained to meet hygienic and aesthetic standard.

THERMAL POLLUTION

INTRODUCTION

Thermal pollution is defined as the addition of excess of undesirable heat to water thereby making it harmful to man, animal or aquatic life. Thermal pollution may also cause no significant departures from or activities of aquatic communities.

SOURCES OF THERMAL POLLUTION

The following sources contribute to thermal pollution.

1. Nuclear power plants:

- Nuclear power plants including drainage from hospitals, research institutions, nuclear experiments and explosions, discharge a lot of heat that is not utilized along with traces of toxic radio nuclides into nearby water streams.
- Emissions from nuclear reactors and processing installations are also responsible for increasing the temperatures of water bodies.
- The operations of power reactors and nuclear fuel processing units constitute the major contributor of heat in the aquatic environment. Heated effluents from power plants are discharged at 10 C higher than the receiving waters that affect the aquatic flora and fauna.

2. Coal-fired power plants:

- Coal fired power plants constitute a major source of thermal pollution. The condenser coils in such plants are cooled with water from nearby lakes or rivers.
- The resulting heated water is discharged into streams thereby raising the water temperature by 15C. Heated effluent decreases the dissolved content of water resulting in death of fish and other aquatic organisms.
- The sudden fluctuation of temperature also leads to "thermal shock" killing aquatic life that has become acclimatized to living in a steady temperature.

3. Industrial effluents:

- Industries like textile, paper, pulp and sugar manufacturing release huge amounts of cooling water along with effluents into nearby natural water bodies.

- The waters polluted by sudden and heavy organic loads result in severe drop in levels of dissolved oxygen leading to death of several aquatic organisms.

4. **Domestic Sewage:**

- Domestic sewage is discharged into rivers, lakes, canals or streams with minimal treatment or without any treatment. These wastes have a higher organic temperature and organic load.
- This leads to decrease in dissolved oxygen content in the receiving waters resulting in the set-up of anaerobic conditions causing release of foul and offensive gases in water.
- Eventually, this leads to development of anoxic conditions resulting in rapid death of aquatic organisms.

5. **Hydro-electric power:**

- Generation of hydroelectric power sometimes leads to negative thermal loading in water systems. Apart from electric power industries, various factories with cooling requirement contribute to thermal loading.

THERMAL POLLUTION IN STREAM BY HUMAN ACTIVITIES

- Industries and power plants use water to cool machinery and discharge the warm water into a stream.
- Stream temperature rises when trees and tall vegetation providing shade are cut.
- Soil erosion caused due to construction also leads to thermal pollution
- Removal of stream side vegetation
- Poor farming Practices also lead to thermal pollution

EFFECTS OF THERMAL POLLUTION

1. **Reduction in dissolved oxygen:** Concentration of Dissolved Oxygen (DO) decreases with increase in temperature.
2. **Increase in toxicity:** The rising temperature increases the toxicity of the poison present in water. A 10C increase in temperature of water doubles the toxicity effect of potassium

cyanide, while 80C rise in temperature triples the toxic effects of o- xylene causing massive mortality to fish.

3. **Interference in biological activity:** Temperature is considered to be of vital significance to physiology, metabolism and biochemical processes that control respiratory rates, digestion, excretion, and overall development of aquatic organisms. Temperature changes cause total disruption to the entire ecosystem.
4. **Interference in reproduction:** In fishes, several activities like nest building, spawning, hatching, migration and reproduction depend on optimum temperature.
5. **Direct mortality:** Thermal pollution is directly responsible for mortality of aquatic organisms. Increase in temperature of water leads to exhaustion of microorganisms thereby shortening the life span of fish. Above a certain temperature, fish die due to failure of respiratory system and nervous system failure.
6. **Food storage for fish:** Abrupt changes in temperature alter the seasonal variation in the type and abundance of lower organisms leading to shortage of right food for fish at the right time.

CONTROL MEASURES OF THERMAL POLLUTION

The following methods can be adapted to control high temperature caused by thermal discharges:

1. **Cooling towers:** Use of water from water systems for cooling systems for cooling purposes, with subsequent return to the water way after passage through a condenser, is called cooling process. Cooling towers transfer heat from hot water to the atmosphere by evaporation. Cooling towers are of two types:
 - **Wet cooling tower:** Hot water coming out from the condenser (reactor) is allowed to spray over baffles. Cool air, with high velocity, is passed from sides, which takes away the heat and cools the water.
 - **Dry cooling tower:** Here, hot water is allowed to flow in long spiral pipes. Cool air with the help of a fan is passed over these hot pipes, which cools down hot water. This cool water can be recycled.

2. **Cooling ponds:** Cooling ponds are the best way to cool thermal discharges. Heated effluents on the surface of the water in cooling ponds maximize dissipation of heat to the atmosphere and minimize the water area and volume. The warm water wedge acts like a cooling pond.
3. **Spray ponds:** The water coming out from condensers is allowed to pass into the ponds through sprayers. Here water is sprayed through nozzles as fine droplets. Heat from the fine droplets gets dissipated to the atmosphere.
4. **Artificial lakes:** Artificial lakes are manmade water bodies that offer once through cooling. The heated effluents can be discharged into the lake at one end and water for cooling purposes may be withdrawn from the other end. The heat is eventually dissipated through evaporation.

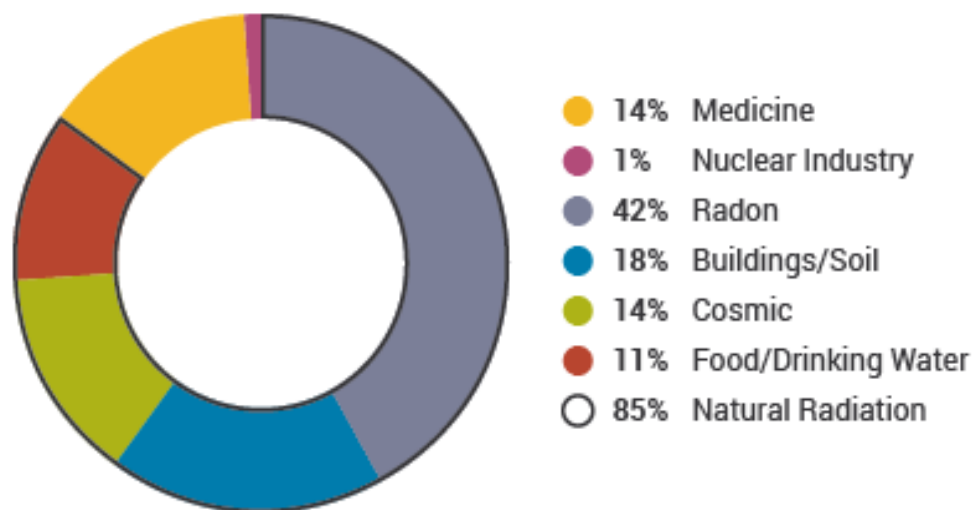
NUCLEAR HAZARDS:

Nuclear pollution is the physical pollution of air, water and soil by radioactive materials.

SOURCES OF NUCLEAR HAZARDS

The sources of radioactivity include both natural and manmade.

Sources of Radiation



Natural Sources	Manmade sources
<ul style="list-style-type: none"> • Cosmic rays from outer space • Emissions from radioactive materials in the earth crust: rocks, marine sediments etc.) 	<ul style="list-style-type: none"> • Mining and processing of radioactive ores • Use of radioactive materials in Power plants • Use of radioactive technology (X-ray machines, radioisotopes used in machine) • Industrial applications include wastes from nuclear reactors • Research applications: radioactive fallouts during nuclear weapons testing • In a nuclear plant, any leak or accident taking place emit nuclear radiation • Nuclear tests conducted under the ground or under oceans which also release radiation • Uranium mining and milling, nuclear reactors and reprocessing of nuclear fuel cause nuclear pollution

EFFECTS OF NUCLEAR HAZARDS

Studies have shown that the health effects due to radiation are dependent on the level of dose, kind of radiation, duration of exposure and types of cells irradiated. Radiation effects can be somatic or genetic.

1. **Somatic effects:** Somatic affects the function of cells and organs. It causes damages to cell membranes, mitochondria and cell nuclei resulting in abnormal cell functions, cell division, growth and death.
2. **Genetic effects:** Genetic effects the future generations. Radiations can cause mutations, which are changes in genetic makeup of cells. These effects are mainly due to the damages to DNA molecules. People suffer from blood cancer and bone cancer if exposed to doses around 100 to 1000 roentgens.

Other effects of nuclear hazards

- i. Causes delirium, convulsions & death within hours or days with brain exposure
- ii. Eye cell die, forming cataracts with eye exposure
- iii. Vomiting, bleeding of the gums, mouth ulcers etc.
- iv. Blood vessel damage is indicated by red spots on the skin
- v. Nausea, vomiting & Infection of the intestinal wall can kill weeks afterwards
- vi. Unborn children are affected by mental retardation or brain damage.

MANAGEMENTS OF RADIOACTIVE WASTE

- The radioactive waste which comes out from industry, nuclear reactors should be stored and allowed to decay either naturally in closed drums or in very large underground air tight cemented tanks **(Delay and Decay)**.
- The intermediate radioactive waste should be disposed off into the environment after diluting it with some inert materials **(Dilute and Disperse)**
- Now-a-days small quantities of high activity wastes are converted into solids such as concrete and then it is buried underground or sea. **(Concentrate and contain)**

CONTROL MEASURES OF RADIOACTIVE WASTE

1. Laboratory generated nuclear wastes should be disposed off safely and scientifically.
2. Nuclear power plants should be located in areas after careful study of the geology of the area, tectonic activity and meeting other established conditions.
3. Appropriate protection against occupational exposure.
4. Leakage of radioactive elements from nuclear reactors, careless use of radioactive elements as fuel and careless handling of radioactive isotopes must be prevented.
5. Safety measure against accidental release of radioactive elements must be ensured in nuclear plants.
6. Unless absolutely necessary, one should not frequently go for diagnosis by x- rays.
7. Regular monitoring of the presence of radioactive substance in high risk area should be ensured.
8. Among the many options for waste disposal, the scientists prefer to bury the waste in hundreds of meters deep in the earth's crust is considered to be the best safety long term option.
9. Nuclear devices should never be exploded in air.
10. In nuclear reactor coolants may be used to prevent extraneous activation products
11. Tightly sealed boxes & closed cycle system can be used to decrease the radioactive emissions
12. Production of radioisotopes should be minimized
13. Minimum no of nuclear installations should be commissioned
14. Fission reactions should be minimized
15. The use of radio isotopes may be carried under jet of soil or water instead of

gaseous forms

16. Wet drilling may be employed along with underground drainage
17. Extreme care should be exercised in disposal of industrial wastes
18. Use of high chimneys & ventilations at the working place for dispersing radio-pollutants
19. Disposal methods are the possible ways to distribute the radio-pollutants

DISPOSAL OF RADIOACTIVE WASTE

High level wastes (HLW)

They are dangerous & so converted them into inert solids & then buried deep into earth or stored in deep salt mines. Ex. Spent nuclear fuel

Medium level wastes (MLW)

MLW are solidified & are mixed with concrete in steel drums before buried in deep mines

Low level wastes (LLW)

LLW are disposed off in steel drums in concrete lined trenches

CASE STUDY: CHERNOBYL NUCLEAR DISASTER

In April 26 1986, melt down of the Chernobyl nuclear reactor in Russia, has leaked out the radioactive rays & radioactive materials.

Effects: About 2000 persons died, more suffered due to degeneration of cells, severe bleeding, and anemia, skin cancer, animals, plants was also affected more.

SOLID WASTE MANAGEMENT

INTRODUCTION

Rapid population growth and urbanization in developing countries has led to people generating enormous quantities of solid waste and consequent environmental degradation. The waste is normally disposed in open dumps creating nuisance and environmental degradation. Solid wastes cause a major risk to public health and the environment. Management of solid wastes is important in order to minimize the adverse effects posed by their indiscriminate disposal.

TYPES OF SOLID WASTES

Depending on the nature of origin, solid wastes are classified into

1. Urban or municipal wastes
 2. Industrial wastes
 3. Hazardous wastes
- **Sources of urban wastes:** Domestic wastes containing a variety of materials thrown out from homes.
Ex: Food waste, Cloth, Waste paper, Glass bottles, Polythene bags, Waste metals, etc.
 - **Commercial wastes:** It includes wastes coming out from shops, markets, hotels, offices, institutions, etc.
Ex: Waste paper, packaging material, cans, bottle, polythene bags, etc.
 - **Construction wastes:** It includes wastes of construction materials.
Ex: Wood, Concrete, Debris, etc.
 - **Biomedical wastes:** It includes mostly waste organic materials
Ex: Anatomical wastes, Infectious wastes, etc.

CLASSIFICATION OF URBAN WASTES

Urban wastes are classified into:

- **Bio-degradable wastes** - Those wastes that can be degraded by micro organisms are

called bio-degradable wastes

Ex: Food, vegetables, tea leaves, dry leaves, etc.

- **Non-biodegradable wastes:** Urban solid waste materials that cannot be degraded by micro organisms are called non-biodegradable wastes.

Ex: Polythene bags, scrap materials, glass bottles, etc.

SOURCES OF INDUSTRIAL WASTES

- The main source of industrial wastes is chemical industries, metal and mineral processing industries.

Ex: Nuclear plants: It generated radioactive wastes

- **Thermal power plants:** It produces fly ash in large quantities
- **Chemical Industries:** It produces large quantities of hazardous and toxic materials.
- **Other industries:** Other industries produce packing materials, rubbish, organic wastes, acid, alkali, scrap metals, rubber, plastic, paper, glass, wood, oils, paints, dyes, etc.

EFFECT OF IMPROPER SOLID WASTE MANAGEMENT

1. Due to improper disposal of municipal solid waste on the roads and immediate surroundings, biodegradable materials undergo decomposition producing foul smell and become a breeding ground for disease vectors.
2. Industrial solid wastes are the source for toxic metals and hazardous wastes that affect soil characteristics and productivity of soils when they are dumped on the soil.
3. Toxic substances may percolate into the ground and contaminate the groundwater.
4. Burning of industrial or domestic wastes (cans, pesticides, plastics, radioactive materials and batteries) produce furans, dioxins and polychlorinated biphenyls that are harmful to human beings.
5. Solid waste management involves waste generation, mode of collection, transportation, segregation of wastes and disposal techniques.

STEPS INVOLVED IN SOLID WASTE MANAGEMENT



Two important disposal methods involved in solid waste management are-

1. Reduce, Reuse and Recycle (3R) of Raw Materials
2. Discarding wastes

REDUCE, REUSE AND RECYCLE (3R)

- **Reduce** - If usage of raw materials is reduced, the generation of waste also gets reduced.
- **Reuse** - Refillable containers that are discarded after use can be reused. Rubber rings can be made from discarded cycle tubes and this reduces waste generation during manufacture of rubber bands
- **Recycle**- Recycling is the reprocessing of discarded materials into new useful products
Ex: Old aluminum cans and glass bottles are melted and recast into new cans and bottles, preparation of cellulose insulation from paper, Preparation of automobile body and construction material from steel cans.

This method (**Reduce, Reuse & Recycle**), i.e, **3R's** help save money, energy, raw materials and reduces pollution.

DISCARDING WASTES

The following methods are adopted for discarding wastes:

- Landfill
- Incineration and
- Composting

1. LANDFILL:

Solid wastes are placed in a sanitary landfill in which alternate layers of 80 cm thick refuse is covered with selected earth-fill of 20 cm thickness. After 2-3 years solid waste volume shrinks by 25-30% and land is used for parks, roads and small buildings. This is the most common and cheapest method of waste disposal and is mostly employed in Indian cities.

Advantages:

1. It is simple and economical
2. Segregation of wastes is not required
3. Land filled areas can be reclaimed and used for other purposes
4. Converts low-lying, marshy waste-land into useful areas.
5. Natural resources are returned to soil and recycled.

Disadvantages:

1. Large area is required
2. Land availability is away from the town, transportation costs are high
3. Leads to bad odor, if landfill is not properly managed.
4. Land filled areas will be sources of mosquitoes and flies requiring application of insecticides and pesticides at regular intervals.
5. Causes fire hazard due to formation of methane in wet weather.

2. INCINERATION:

- It is a hygienic way of disposing solid waste. It is suitable if waste contains more hazardous material and organic content. It is a thermal process and very effective for detoxification of all combustible pathogens. It is expensive when compared to composting or land-filling.
- In this method municipal solid wastes are burnt in a furnace called incinerator.
- Combustible substances such as rubbish, garbage, dead organisms and non-combustible matter such as glass, porcelain and metals are separated before feeding to incinerators.
- The non-combustible materials can be left out for recycling and reuse. The leftover ashes and clinkers may account for about 10 to 20% which need further disposal by sanitary landfill or some other means.

- The heat produced in the incinerator during burning of refuse is used in the form of steam power for generation of electricity through turbines.
- Municipal solid waste is generally wet and has a high calorific value. Therefore, it has to be dried first before burning. Waste is dried in a preheated drum from where it is taken to a large incinerating furnace called "destructor" which can incinerate about 100 to 150 tons per hour.
- Temperature normally maintained in a combustion chamber is about 700 C which may be increased to 1000 C when electricity is to be generated.

ADVANTAGES:

1. Residue is only 20-25% of the original and can be used as clinker after treatment
2. Requires very little space
3. Cost of transportation is not high if the incinerator is located within city limits
4. Safest from hygienic point of view
5. An incinerator plant of 3000 tons per day capacity can generate 3MW of power.

DISADVANTAGES:

1. Its capital and operating cost is high.
2. Operation needs skilled personnel.
3. Formation of smoke, dust and ashes needs further disposal and that may cause air pollution.

3. COMPOSTING:

- It is another popular method practiced in many cities in our country.
- In this method, bulk organic waste is converted into fertilizer by biological action. Separated compostable waste is dumped in underground trenches in layers of 1.5m and finally covered with earth of 20cm and left for decomposition.
- Sometimes, **Actinomycetes** are introduced for active decomposition. Within 2 to 3 days, biological action starts. Organic matter is destroyed by *Actinomycetes* and lot of heat is liberated increasing the temperature of compost by 75C and the refuse is finally converted into powdery brown colored odorless mass called **humus** that has a fertilizing value and can be used in agriculture. Humus contains lot of Nitrogen essential for plant growth apart from phosphates and other minerals.

ADVANTAGES:

1. Manure added to soil increases water retention and ion-exchange capacity of soil.
2. This method can be used to treat several industrial solid wastes.
3. Manure can be sold thereby reducing cost of disposing wastes
4. Recycling can be done

DISADVANTAGES:

1. Non-consumables have to be disposed separately
2. The technology has not caught-up with the farmers and hence does not have an assured market.

ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

- Environment protection has been burning issue in last half century. In order to tackle the menace of pollution, urgent steps have to be taken at not only global or country level, but also at local level.
- In fact, the role of individuals in prevention of pollution is of critical importance, because it is the individuals that make a community or country.
- It is better and more viable to prevent pollution by educating individuals than controlling pollution.
- Individuals should encourage modifying their lifestyle and living habits if that are not healthy for environment.

Ways in Which a Individual can Help in Prevention of Pollution

1. Individuals should minimize wastage of resources such as electricity. Every unit of electricity saved is equivalent unit of electricity produced as it not only saves the fuel that would be used to produce that electricity, but also help to prevent pollution that is accompanied by burning of that fuel. Therefore, person should always switch off appliances when not in use.
2. Individuals should prefer walking or use cycles instead of using motor vehicles, especially when distances to be travelled are small.
3. Individuals can make considerable contribution by using mass transport (buses, trains, etc) instead of using personal vehicles.
4. When going to workplace, colleagues from nearby localities should pool vehicles instead of going in individual personal vehicles.
5. Taking personal vehicles for periodic pollution checks at centres approved by authorities.
6. Individuals should reuse items whenever possible.
7. Products that are made of recycled material should be given preference.
8. Use gunny bags made of jute instead of plastic bags.
9. Take part in environment conservation drives such as tree planting drives.

10. Use water resources efficiently.
11. Use renewable resources by installing equipment such as solar heaters and using solar cookers.
12. Dispose potentially harmful products such as cells, batteries, pesticide containers, etc properly.
13. Use of refrigerators should be minimised wherever possible as they are main source of CFC, which is responsible for Ozone layer depletion.
14. Follow and promote family planning, as more population means more resources utilized and more resources utilized imply more pollution.
15. Avoid making noise producing activities such as listening to loud music.
16. Use handkerchiefs instead of paper tissues.
17. Organize drives to clean streets and clean drains with help of other people of locality.
18. Spread awareness and inspire other people to prevent pollution. Individuals should be encouraged to acquire information and innovations from world over and implement them locally.
19. Plant more trees, Reduce deforestation
20. Use of eco friendly products.
21. Use natural gas than coal
22. Use organic manure instead of inorganic fertilizers

DISASTER MANAGEMENT

HAZARD: It is a perceived natural event which threatens both life and property.

DISASTER

- A disaster is the realization of this hazard
- It is defined as the geological process and it is an event concentrated in time and space in which a society or subdivision of a society undergoes severe danger and causes loss of its members and physical property.

TYPES

Natural disasters – refers to those disasters that are generated by natural phenomena.

Man-made disasters – refers to the disasters resulting from man-made hazards.

FLOODS

- Increased rainfall or rapid snow melting causes more flow of water in the streams. This excess water flow in a stream covering the adjacent land is called a flood.
- Floodplain is a generally flat area of land next to a river or stream. It is defined in terms of a flood frequency. Flood frequency is referred as 10 -year flood, 100- year flood, etc.
- A 10-year flood at any point in a stream is that discharge of water which may be expected to occur on average once in 10 years. Floodplains are generally fertile, flat and easily formed.

CAUSES OF FLOOD

- Construction of buildings in a flood plain
- Removing vegetation
- Paving roads and parking areas
- Deforestation
- Heavy rainfall
- Urbanization
- Earthquakes

EFFECTS OF FLOOD

- Erosion of top soil and vegetation
- Damage and loss to land, house and property
- Spread of endemic waterborne diseases
- Interruption of basic facilities of community such as highways, railways, telephone, electricity and day-to-day essentials
- Silting of reservoirs and dams

FLOOD CONTROL

- Construction of flood control dam
- Deepening, widening and straightening of streams
- Lining of streams
- Banning of construction of buildings in floodplains
- Converting flood-plains into wildlife habitat, parks, and recreation areas.

LANDSLIDES

- Landslides occur when mass of earth material move downward. It is also called mass wasting or mass movement.
- Sudden landslide occurs when unconsolidated sediments of a hillside are saturated by rainfall or water logging.
- Many landslides take place in coincidence with earthquakes. The most common form of landslides is earthquake induced landslides or more specifically rock falls and slides of rock fragments that form on steep slopes.
- The size of area affected by earthquake induced landslides depends on the magnitude of the earthquake, its focal depth, the topography and geologic conditions near the causative fault, the amplitude, frequency, composition and duration of ground shaking.

CONTROL MEASURES OF LANDSLIDES

- Avoid construction activity in landslide occurring areas.
- Reducing slope of hilly side
- Stabilizing the slope portion
- Increasing plantation of deep rooted vegetation on the slope.

EARTHQUAKES

- An earthquake occurs when rocks break and slip along a fault in the earth. Earthquakes occur due to deformation of crust and upper mantle of the earth.
- Due to heating and cooling of the rock below these plates, movement of adjacently overlying plates and great stresses, deformation occurs.
- Tremendous energy can build-up between neighboring plates.
- If accumulated stress exceeds the strength of the rocks, the rocks break suddenly releasing the stored energy as an earthquake.
- The earthquake releases energy in the form of waves that radiate from the epicenter in all directions.
- The 'p' wave or primary wave alternately compresses and expands material in the same direction it is travelling.
- This wave can move through solid rocks and fluids.
- These are the fastest waves. The s wave or secondary wave is slower and shake the ground up, down, back and forth perpendicular to the direction in which it is travelling. Surface waves follow both the 'P' and 'S' waves.
- The magnitude of an earthquake is measured in Richter scale. The Richter scale is logarithmic.

EFFECTS OF EARTHQUAKE

- Ground shaking
- Liquefaction of ground
- Ground displacement
- Landslides
- Flood
- Fire
- Tsunami

Severity of an earthquake: Generally it is measured by its magnitude on Richter scale.

Richter Scales

Less than 4

4- 4.9

5- 5.9

6- 6.9

7- 7.9

More than 8

Severity of earthquake

Insignificant

Minor

Damaging

Destructive

Major

Great

CONTROL MEASURES OF EARTHQUAKE

- There is virtually no technique to control the occurrence of earthquake. However, certain preventive measures can be taken to minimize the damage.
- Minimizing development activity (especially construction, mining, construction of dams and reservoirs) in areas known to be active seismic zones.
- Continuously monitoring seismic activity using 'seismographs' and alerting people regarding any recorded disturbance in advance.

CYCLONES

It is a meteorological process, intense depressions forming over the open oceans and moving towards the land. Cyclone is measured by Saffir-Simpson scale.

EFFECTS OF CYCLONE

- The damage depends on the intensity of cyclone the damage to human life, crops, roads, transport, could be heavy.
- Cyclone occurrence slows down the developmental activities of the area.

CYCLONE MANAGERMENTS

- Satellite images are used by meteorological departments for forecasting the weather conditions which reveal the strength and intensity of the storm.
- Radar system is used to detect the cyclone and is being used for cyclone warning.

CHAPTER 6

SOCIAL ISSUES AND THE ENVIRONMENT

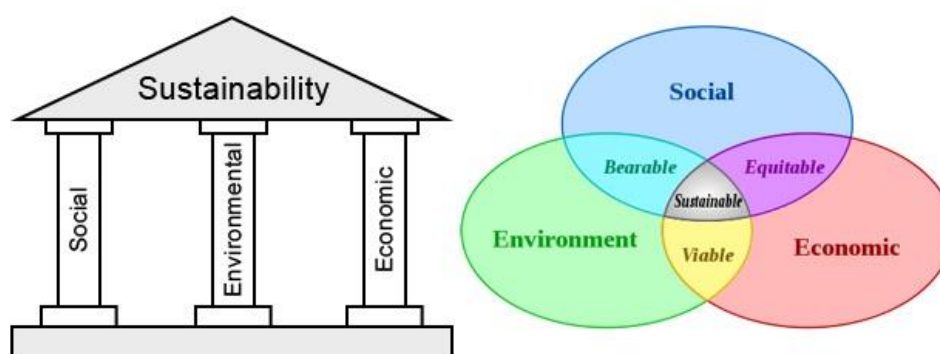
FROM UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT

Man is part of the nature and he is bound to obey the laws of nature. He depends on his environment for basic things. More developmental activities are adopted in order to increase the quality of life. For that he uses the available resources. The Earth has limited supply of resources and renewable resources. These are to be managed in a scientific manner for availing the generations to come. Hence developmental activities are to be taken with more care about the environment and its protection. It brings benefits to all not only to the present generation but also for future generations.

SUSTAINABLE DEVELOPMENT: Meeting the needs of the present without compromising the ability of future generation to meet their own needs.

Important components of Sustainable development:

1. Economic development
2. Social development
3. Environmental protection



True sustainable development aims at optimum use of natural resources with high degree of reusability, minimum wastage, least generation of toxic by-products and maximum productivity.

ASPECTS OF SUSTAINABLE DEVELOPMENT:

- **Inter generational equity:** It states that we should hand over a safe, healthy and resourceful environment to future generation.
- **Intra generational equity:** A technological development of rich countries should support the economic growth of poor countries and help in narrowing the wealth gap and lead to sustainability.

APPROACHES FOR SUSTAINABLE DEVELOPMENT:

1. Developing appropriate technology

Technology which is locally adoptable, eco friendly, resource efficient and culturally suitable should be adopted. It uses local labor, less resources and produces minimum waste.

2. Reduce, Reuse and Recycle (3R approach)

Use of natural resources again and again instead of throwing it on wasteland and recycling the material into further products. It reduces waste generation and pollution.

3. Providing environmental education and awareness

Thinking and attitude of people towards earth and environment should be changed by providing environmental awareness and education.

4. Consumption of renewable resources

It is very important to consume the natural resources in such a way that the consumption should not exceed the regeneration capacity.

5. Non-renewable resources should be conserved by recycling and reusing.
6. By population control we can make sustainable development.

URBAN PROBLEMS RELATED TO ENERGY

Urbanization: Movement of human population from rural; areas to urban areas for want of better education, communication, health, employment etc.

Causes: Cities are the main centers of economic growth, trade transportation, medical facilities and employment.

Urban sprawl:

The phenomenon of spreading of the cities in to sub-urban or rural areas is called urban sprawl. Urban growth is so fast and is difficult to accommodate all commercial industrial residential and educational facilities within the limited area.

Energy demanding activities:

Urban people consume lot of energy and materials in comparison with rural people. This is because urban people have high standard of life and their life style demand more energy.

Examples for energy demands:

1. Residential and commercial lightings.
2. Industries using large proportion of energy.
3. Usage of fans fridge, A.C, washing machines.
4. Control and prevention of pollution technologies need more energy.

Solution for urban energy problems:

1. Energy consumption must be minimized in all aspects.
2. Public transportation should be used instead of motor cycles and cars.
3. Using of solar energy and wind energy.
4. Production capacity must be increased.

WATER CONSERVATION

The original source of water is precipitation from the atmosphere. The water available on the earth may occur in all three stages as gas, liquid or solid. Temperature is the main factor in deciding the state of water. As a liquid, the water forms hydrosphere. About 75% of the Earth's surface is covered by the hydrosphere.

The process of saving water for future utilization is called conservation of water.

NEED FOR WATER CONSERVATION:

1. Better life style requires more fresh water.
2. Agriculture and Industrial activities require more fresh water.
3. As the population increases the requirement of water is also more.

STRATEGIES OF WATER CONSERVATION:

- 1. Reducing evaporation losses:** Evaporation of water in humid regions can be reduced by placing horizontal Barriers of asphalt below the soil surface.
- 2. Reducing irrigation losses:** Sprinkling and irrigation conserves water by 30- 40%. Irrigation in early morning (or) later evening reduces evaporation losses. Growing hybrid crop varieties also conserve water.
- 3. Reuse of water:** Treated waste water can be reused for irrigation. Water from washings, bath rooms etc. can be used for washing cars, gardening.
- 4. Preventing of wastage of water:** Closing the taps when not in use and repairing any leakage from pipes.
- 5. Decreasing run off losses:** Run off, on most of the soils can be reduced by using contour cultivation (or) Terrace farming.
- 6. Avoid discharge of sewage:** Disposal into natural water resources should be avoided

METHODS OF WATER CONSERVATION:

Rain water Harvesting and Watershed management

What is rain water harvesting?

- It means capturing rain where it falls or capturing the run off in your own village or town. And taking measures to keep that water clean by not allowing polluting activities to take place in the catchment.
- Therefore, water harvesting can be undertaken through a variety of ways:
 1. Capturing runoff from rooftops
 2. Capturing runoff from local catchments
 3. Capturing seasonal floodwaters from local streams
 4. Conserving water through watershed management
- These techniques can serve the following the following purposes:
 - i. Provide drinking water
 - ii. Provide irrigation water
 - iii. Increase groundwater recharge
 - iv. Reduce storm water discharges, urban floods and overloading of sewage treatment plants
- In general, water harvesting is the activity of direct collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into the groundwater.
- Rain is the first form of water that we know in the hydrological cycle, hence is a primary source of water for us.
- Rivers, lakes and groundwater are all secondary sources of water. In present times, we depend entirely on such secondary sources of water.
- In the process, it is forgotten that rain is the ultimate source that feeds all these secondary sources and remain ignorant of its value.
- Water harvesting means to understand the value of rain, and to make optimum use of the rainwater at the place where it falls.

RAINWATER HARVESTING:

It is a technique of collecting and storing rain water for use in non-monsoon periods. In the present age, concrete houses, well-built roads, footpaths and well –concreted courtyards have left few open grounds. With the decrease in natural forest cover, increase in concrete jungles and the decrease in exposed earth; very little open ground is left for water to soak in and thereby increase the ground water table. So, artificial recharging of the ground water is extremely essential. It is done through rain water harvesting. For the purpose, rain water is collected at the roof top or in an open well and then carried down for immediate use or it is directed into the aquifer.

Rain water harvesting techniques:

There are two main techniques for rain water harvesting:

1. Storage of rain water on the surface for future use
2. Recharge of ground water

Recharge of ground water is a recent concept and the structures used for the purpose are:

- i. Pits
- ii. Trenches
- iii. Dug wells
- iv. Hand pumps
- v. Recharge shaft
- vi. Lateral shafts with bore wells
- vii. Spreading technique

OBJECTIVES OF RAINWATER HARVESTING:

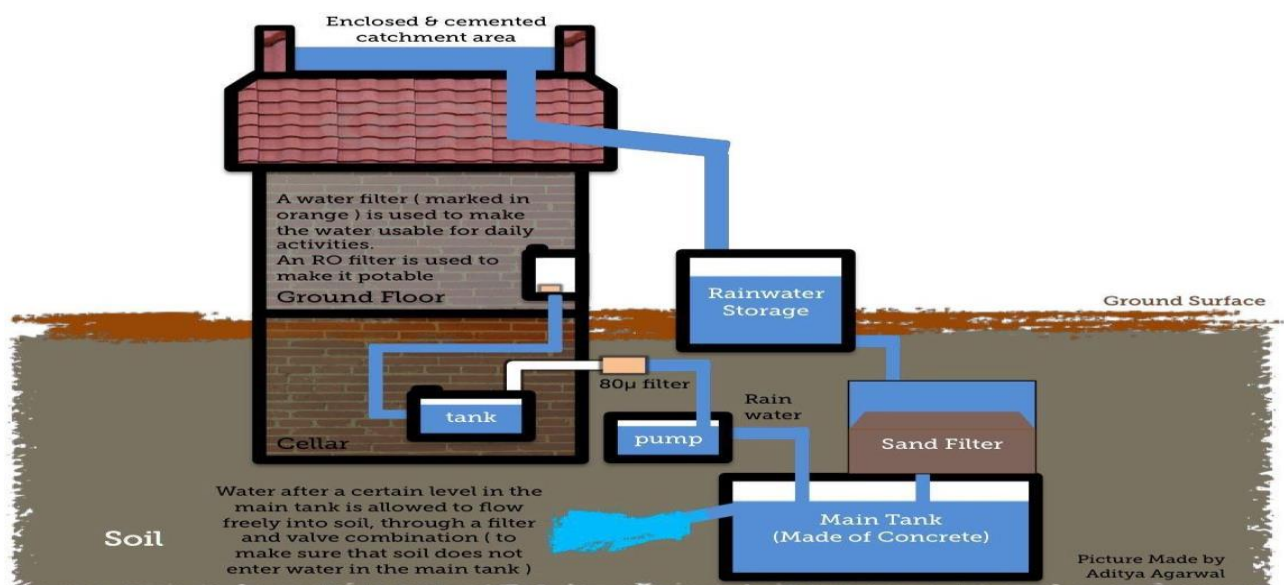
1. To raise the water table by recharging the ground water.
2. To minimize water crises and water conflicts
3. To reduce rain water runoff and soil erosion.
4. To reduce the ground water contamination from intrusion of saline water

Concept of rain water harvesting

Rain water harvesting involves collecting water that falls on roof of house during Rain and conveying water through PVC or Al pipe to a nearby covered storage tank.

METHOD OF RAINWATER HARVESTING:

- **Roof top method:** Collecting rain water from roof of the building and storing in the ground. It is the low cost and effective technique for urban houses and buildings.
- The rain water from roofs, road surfaces, and play grounds is diverted into the surface tank or recharge pits. The pit base is filled with stones and sand.
- Rainwater harvesting systems channel rainwater that falls on to a roof into storage via a system of gutters and pipes.
- The first flush of rainwater after a dry season should be allowed to run to waste as it will be contaminated with dust, bird droppings etc.
- Roof gutters should have sufficient incline to avoid standing water. They must be strong enough, and large enough to carry peak flows.
- Storage tanks should be covered to prevent mosquito breeding and to reduce evaporation losses, contamination and algal growth.
- Rainwater harvesting systems require regular maintenance and cleaning to keep the system hygienic.



ADVANTAGES:

Rise in ground water level and minimizing the soil erosion and flood Hazards. Scarcity of water is reduced.

WATERSHED MANAGEMENT

Water shed (or) drainage basin: It is defined as land area from which water drains under the influence of gravity into stream, lake, reservoir (or) other body of surface water.

Watershed management of rain fall and resultant run off is called watershed management.

Factors affecting watershed:

- Overgrazing
- Deforestation
- Mining & construction activities
- Droughty climate also affects the water shed

Need or objectives of watershed management

1. To rise the ground water level
2. To protect the soil from erosion by runoff
3. To minimize the risks of floods, drought and landslides
4. To generate huge employment opportunities in backward rain fed areas to ensure security for livelihood

Watershed management techniques

1. Trenches (pits) were dug at equal intervals to improve ground water storage. Earthen dam or stone embankment must be constructed to check runoff water.
2. Farm pond can be built to improve water storage capacity of the catchment's area.

Maintenance of watershed

1. **Water harvesting:** Proper storage of water in water shed can be used in dry season in low rainfall areas.
2. **Afforestation and agro-forestry** help to prevent soil erosion and retention of moisture in watershed areas
3. **Reducing soil erosion:** Terracing, contour cropping minimize soil erosion and runoff on the slopes of water sheds
4. **Scientific mining and quarrying** minimize the destructive effect of mining in water shed areas.
5. **Public participation** is essential for water shed management. People should be motivated for maintaining water harvesting structures implemented by the government.

RESETTLEMENT & REHABILITATION

Based on the resettlement schemes proposed by each affected village and present policies, laws and regulations of different levels of governments and the resettlement requirements of ADB, the Resettlement Plan of Lauding Expressway Project was prepared by PPTA consulting team and the staff from NPAEC under GPCD assisted by design institute and Local County and township governments.



Target and Task

The overall objective of resettlement and rehabilitation is to ensure that the affected production base will be restored, the affected labor force will be re-employed, and income and livelihood of affected people will be improved or at least restored to their previous levels before resettlement.

At present, the rural population of project impact area is mainly engaged in agricultural activities, with most of their income coming from planting, economic trees, and animal husbandry. According to the actual production and living standard among affected villages, and the approved economic and social development plans for the relevant counties, the target of

Resettlement and rehabilitation is set as follows:

- The resettlement's grain production level will be self-sufficient after resettlement.
- The income per capita shall be recovered to the standard before resettlement.
- The affected public infrastructures, school, hospitals, social welfare level, natural environment and traffic condition etc. shall be improved after resettlement.

Resettlement Task

- In 2005, there were 2,829 households with 13,149 persons to be resettled or rehabilitated, in which 520 households and 2,352 persons will need house relocation.
- The basic resettlement policy of Lauding Expressway Project is to respect the wishes of affected People and maintain their current production and living traditions.
- Based on consultation of local affected peoples, the economic rehabilitation will be based on developing replaced farming resources within their own townships and villages.
- Planting will be the focus of economic Rehabilitation strategy by developing new farmland and improving the remaining farmland in the affected villages, and supplemented by developing various other income generation opportunities in the project areas.
- In other words, the resettlement and rehabilitation strategy will first to reestablish the physical production bases for the affected persons, which will provide a long-term development potential by fully utilizing local land resources.

Resettlement Principle:

Under such policy, a number of resettlement and rehabilitation principles have been developed for the Project.

1. The resettlement plan will be based on detailed inventory for land acquisition and houses Demolition, and adopted compensation standards and subsidies.
2. The resettlement shall be combined with the local development, resource utilization and Economic growth as well as environment protection. Considering the local conditions, a Practical and feasible resettlement plan should be developed to restore or improve their Economic production and create basic conditions for long-term development.

Overall Scheme of Resettlement

Since the construction of Lauding Expressway Project will only acquire limited land acquisition and demolition along the road alignment line, it will not have significant negative impacts on production and livelihood for most affected villages.

A series of consultation meetings were held among affected villages and townships. According to the resettlers' opinion and suggestion, and combined with the actual condition of affected area, the basic rehabilitation scheme was determined as follows:

1. Project affected persons will be resettled within their original villages and village groups, so that their way of production, living and social relationship can be maintained, which will be beneficial for them to restore or improve their production and income level after resettlement.
2. In order to reduce the impacts on the production and livelihood among resettlers, the demolished houses will be dismantled after the new houses built. The reconstruction of houses will adopt two approaches. For most relocated households, they will choose to rebuild their houses by themselves, and all salvage materials will belong to them. The second approach is for those who live near towns, their rehabilitation will be carried out by local government in order to promote small town development and save farmland.
3. The rural relocated households will be resettled in their original villages. For those who lose some farmland, the land-based rehabilitation will be adopted with a combination of developing new farmland, redistributing remaining farmland and receiving their share of resettlement subsidy among affected village groups.

ENVIRONMENTAL ETHICS

- It refers to issues, principles and guidelines related to human interactions with their Environment.
- Ethics is a branch of philosophy. It deals with morals and values. An ethic is a principle or value that we use to decide whether an action is good or bad.
- Ethics differs from country to country.

Functions of Environment:

1. It moderates climate conditions of the soil.
2. A healthy economy depends on healthy environment.
3. It is the life supporting medium for all organisms.
4. It provides food, air, water and other important natural resources to the human beings

Solution to environmental problems:

- Reduce the waste matter and energy resources
- Recycle and reuse as many of our waste product and resources as possible
- Avoid over exploitation of natural resources
- Minimize soil degradation and protect the biodiversity of the earth
- Reduce population and increase the economic growth our country

Ethical guidelines on environmental protection:

1. The earth is the habitat of all living species and not of human beings alone.
2. Natural resources and energies are depleting fast. We must protect them.
3. Involve yourself in the care of the earth and experience nature.
4. Respect nature, you are a part of it.
5. Think of the global cause and act for local protection
6. Keep yourself informed about ecological changes and developments.
7. Observe austerity, reserve scarce resources for the future and the future generations.
8. We must be cooperative, honest, affectionate and polite to society and nature.

CLIMATE CHANGE

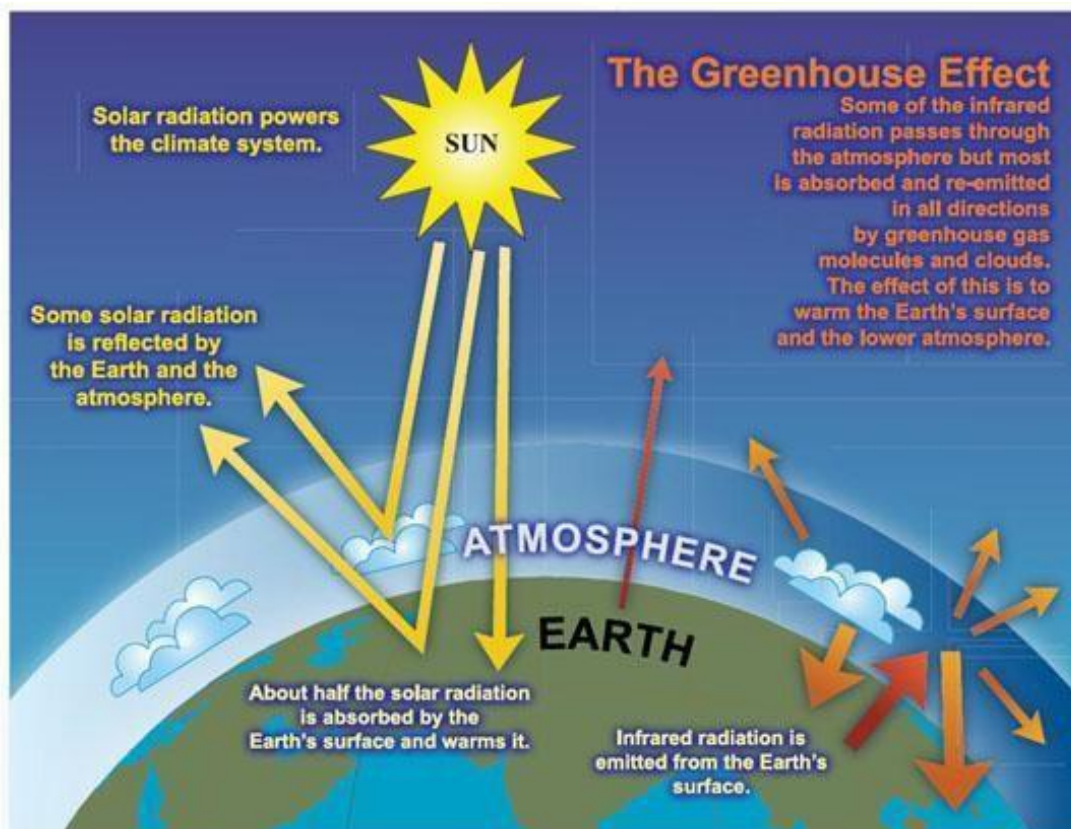
It is the average weather of an area. It is the general weather condition, seasonal variations of the region. The average of such conditions for a long period is called climate.

Causes of climate changes:

1. Presence of green house gases in the atmosphere Increases the global temperature.
2. Depletion of ozone layer increases the global temperature.

Effects of climate change:

1. Small climate changes disturb agriculture which leads To migration of animals and human.
2. Climate change may upset hydrological cycle which results in floods and droughts in different parts of the world.
3. Global pattern of winds and oceans currents also gets disturbed by climate change.

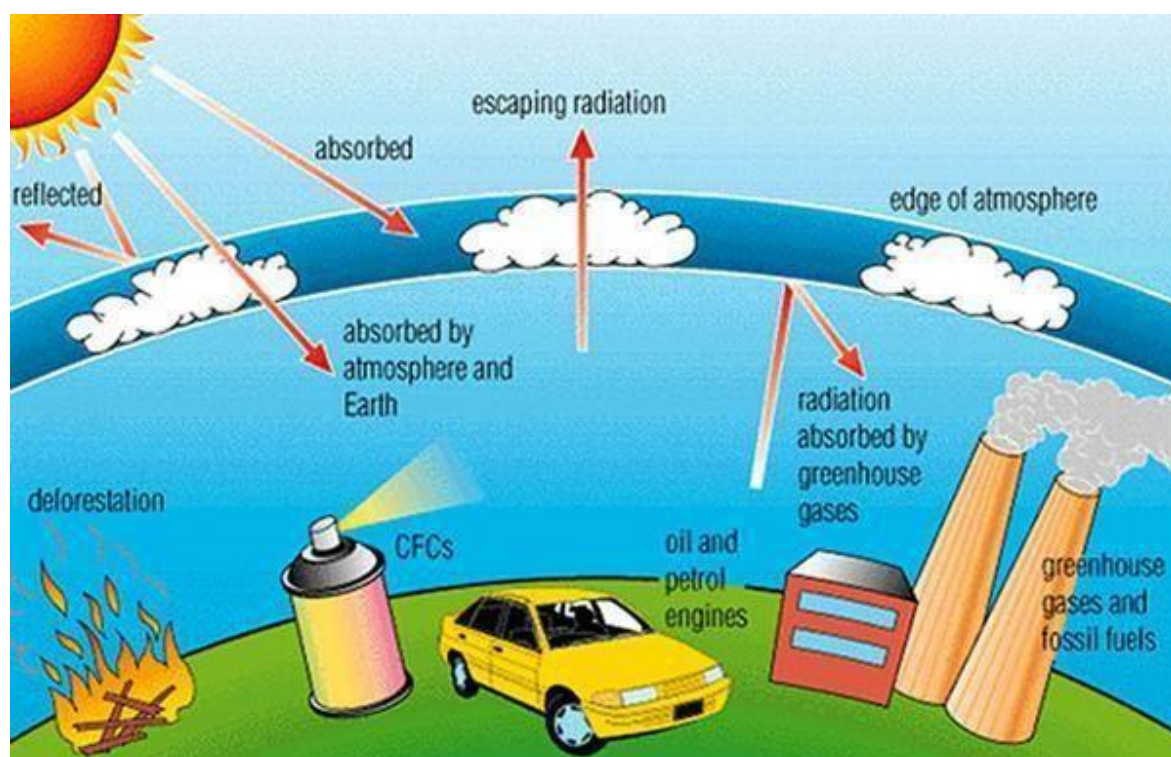


Green house effect:

Green house gases are CO₂, Methane, Nitrous oxide (NO₂), Chlorofluorocarbon (CFC). Among these CO₂ is the most important green house gas. O₃ and SO₂ act as serious pollutants causing global warming.

GLOBAL WARMING:

Green house gases in the atmosphere are transparent to light but absorb IR radiation. These gases allow sunlight to penetrate the atmosphere and are absorbed by the earth surface. This sunlight is radiated back as IR which is absorbed by gases. As a result the earth surface and lower atmosphere becomes warm. This is called global warming.



EFFECTS OF GLOBAL WARMING:

1. Sea level increases as result of melting and thermal expansion of ocean.
2. High CO₂ level in the atmosphere have a long term negative effect on crop production and forest growth.

3. Global rainfall pattern will change. Drought and floods will become more common. Raising temperature will increase domestic water demand.
4. Many plants and animal species will have a problem of adapting. Many will be at the risk of extinction, more towering varieties will thrive.
5. As the earth becomes warmer the floods and drought becomes more frequent. There would be increase in water-borne diseases.

MEASURES TO CHECK GLOBAL WARMING:

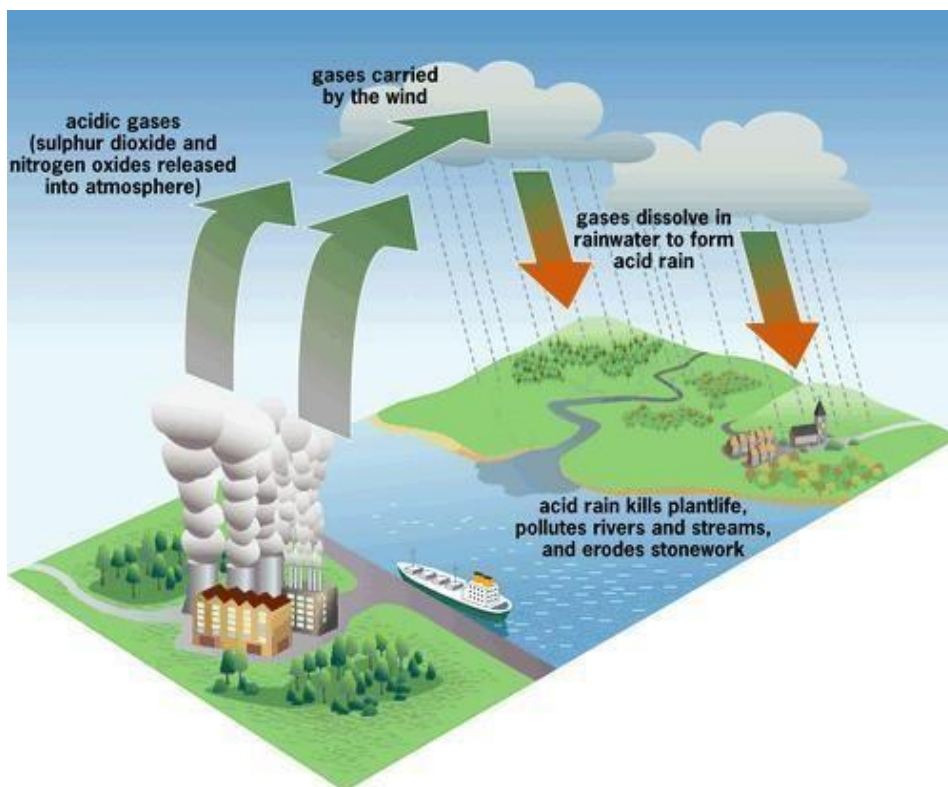
1. CO₂ emission can be cut by reducing the use of fossil fuel.
2. Plant more trees.
3. Shifting from coal to natural gas
4. Stabilize population growth
5. Remove efficiently CO₂ from smoke stocks
6. Removal atmospheric CO₂ by utilizing photo synthetic algae

ACID RAIN

Normal rain water is always slightly acidic (pH 5-5.6) because of CO₂ present in the atmosphere gets dissolved in it. Because of the presence of SO₂ and NO₂ gases as pollutants in the atmosphere, the pH of the rain is further lowered. This type of precipitation of water is called acid rain.

Formation:

Acid rain means the presence of excessive acids in the rain water. The thermal power plants industries and vehicles release NO₂ and SO₂ in to the atmosphere due to the burning of coal and oil. These gases react with water vapor in the atmosphere and form acids like HNO₃, H₂SO₄. These acids descend on to the earth as acid rain through rain water.



EFFECTS:

Effect on human being:

Human nervous system respiratory system and digestive system are affected by acid rain. It causes premature death from heart and lung disorder like asthma, bronchitis.

On building:

At present Taj Mahal in Agra is suffering due to SO_2 and H_2SO_4 fumes from Madura refinery. Acid rain corrodes houses, monuments, statues, bridges and fences. Acid rain causes corrosion of metals.

On terrestrial and lake ecosystem

- Reduce the rate of photosynthesis and growth in terrestrial vegetation.
- Acid rain retards the growth of crops like beans potatoes, carrot, spinach.
- Acid rain reduces fish population, black flies, mosquitoes, deer flies occurs largely which causes number of complications in ponds, rivers and lakes.
- Activity of bacteria and other microscopic animals is reduced in acidic water. The dead materials are not rapidly decomposed. Hence the nutrients like N, P are locked up in dead matter.

CONTROL OF ACID RAIN:

1. Emissions of NO₂ and SO₂ from industries from power plants should be reduced by using pollution control equipments.
2. Liming of lakes and soils should be done to correct the adverse effect of acid rain.
3. In thermal plants low sulphur content coal should be used.

OZONE LAYER DEPLETION

Ozone gas is present in the atmosphere. It is highly concentrated at the stratosphere between 10-50 Km above the sea level and is called as ozone layer.

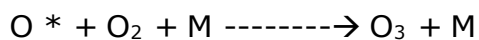
Importance: O₃ protects us from damaging UV radiation of the sun. It filters UV- B radiation.

Now days certain parts of O₃ layer is becoming thinner and O₃ holes are formed. Because of this more UV-B radiation reaches the earth's surface. UV-B radiation affects DNA molecules, causes damages to the outer cell of plants and animals. It causes skin cancer and eye disease in human beings.

Formation of O₃:

It is formed in the atmosphere by photochemical reaction $O_2 + h\nu \longrightarrow O^* + O^*$

The atomic oxygen reacts with molecular O₂ to form O₃



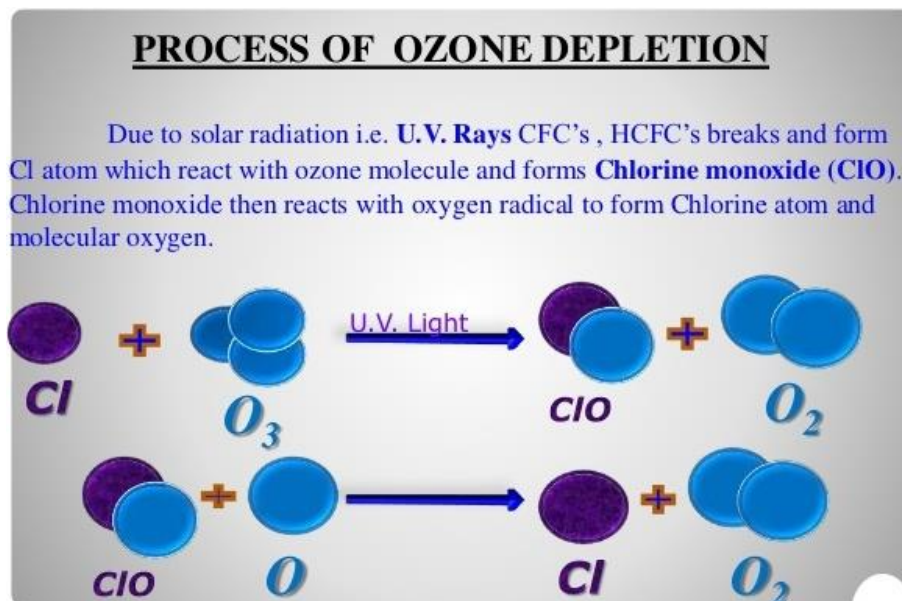
Where M = third body like nitrogen.

Causes of O₃ layer depletion:

Refrigerators, air conditioners, aerosol sprays and cleaning solvents release CFCs into the atmosphere. CFCs releases chlorine which breaks O₃ to O₂

Each chlorine atom is capable of breaking several O₃ molecules. It is a chain reaction. 1% loss of O₃ results in 2% increase in UV rays reaching the earth surface.

Ozone depletion chemicals: CFC, HCFC, BFC. Sometimes atmospheric sulfur dioxide (SO₂) is converted into H₂SO₄ which increases the rate of O₃ layer depletion.



EFFECTS OF OZONE LAYER DEPLETION:

A. Effects on human beings

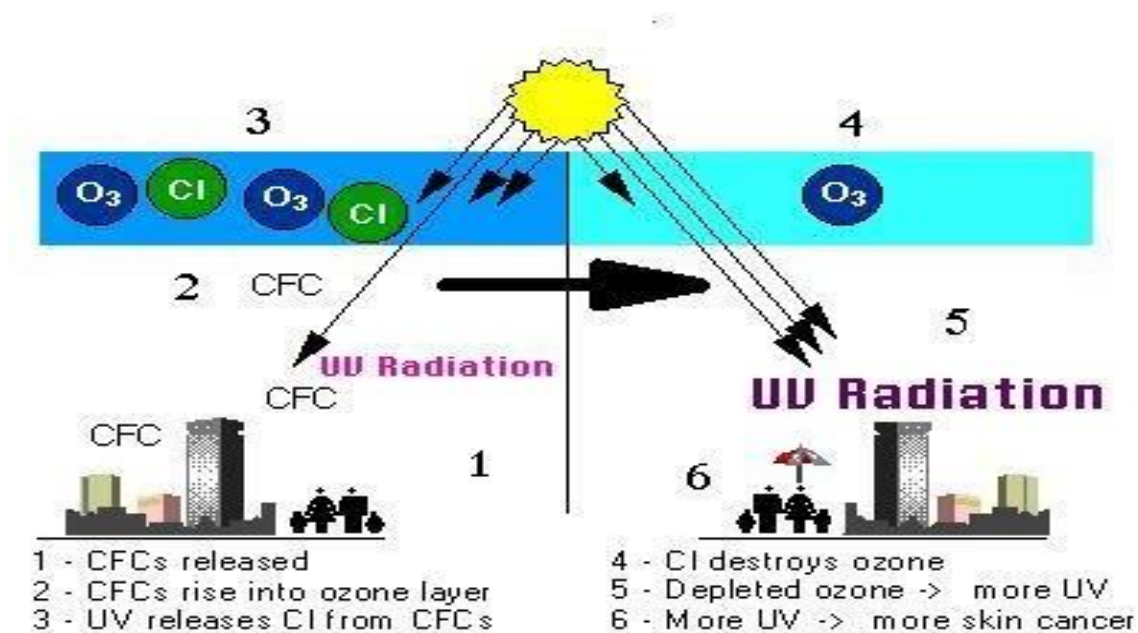
1. UV rays causes skin cancer
2. Increases the rate of non melanin skin cancer in fair colored people
3. Prolonged expose to UV rays leads to Actinic keratosis (slow blindness) and cataracts

B. Effects on aquatic system

1. UV rays affects phytoplankton, fish, larval crabs.
2. Phytoplankton consumes large amounts of CO₂. Decrease in phytoplankton results in more amount of CO₂ in atmosphere. This contributes to global warming.

CONTROL MEASURES:

1. Manufacturing and using of O₃ depleting chemicals should be stopped
2. Use of methyl bromide which is a crop fumigant should be controlled
3. Replacing CFCs by other materials which are less damage



NUCLEAR ACCIDENTS AND HOLOCAUST

Energy released during a nuclear reaction is called nuclear energy. Nuclear fission and nuclear fusion are used to prepare nuclear energy. During nuclear accidents large amount of energy and radioactive products are released into the atmosphere.

TYPES OF NUCLEAR ACCIDENTS:

- **Nuclear Test:** Nuclear explosions release radioactive particles and radioactive rays into the atmosphere.
- **Nuclear power plant accidents:** Nuclear power plants located in seismic vulnerable area may cause nuclear accidents which releases radiation.
- **Improper disposal of radioactive wastes:** Drums with radioactive wastes, stored underground rust and leak radioactive wastes into water, land and air.
- **Accidents during transport:** Trucks carrying radioactive wastes (or) fuels in accidents. The major accident at a nuclear power plant is a core melts down.

EFFECTS OF NUCLEAR RADIATION:

- 1.** Radiation affects DNA in cells.
- 2.** Exposure to low dose of radiation (100 to 250 rds) people suffer from fatigue, vomiting, and loss of hair.
- 3.** Exposure to high radiation (400 to 500 rds) affect bone marrow, blood cells, natural resistance fail of blood clot.
- 4.** Exposure to very high dose of radiation (10000rds) kills organisms by damaging the tissues of heart and brain.

NUCLEAR HOLOCAUST: Destruction of Biodiversity by nuclear equipments and nuclear bombs is called nuclear holocaust.

Effects of nuclear holocaust: Nuclear winter

- Nuclear bombardment will cause combustion of wood, plastics, forests etc.
- Large quantity of soot will be carried out into the atmosphere.
- Black soot absorbs all UV radiation and will not allow the radiation to reach the earth. Therefore cooling will happen. This reduces evaporation of water.
- In stratosphere there won't be significant moisture to rain out the black soot.
- Due to nuclear explosion a process opposite to global warming will occur. This is called Nuclear winter.

Nuclear holocaust in Japan:

In Aug 6th and 9th, 1945 two nuclear bombs were dropped in Hiroshima and Nagasaki in Japan. About 100000 people were killed and the cities were badly destroyed. This explosion emitted forceful neutrons and gamma radiation. Radioactive Strontium liberated in the explosion replaced calcium in the bones. Large scale bone deformities occurred in the people of these cities.

ENVIRONMENTAL LEGISLATION AND LAWS

WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

This act provides for maintaining and restoring the sources of water. It also provide for preventing and controlling water pollution.

Features of water act:

1. This act aims to protect the water from all kind of pollution and to preserve the quality of water in allaquifers.
2. The act further provides for the establishment of central board and state boards for prevention of water pollution.
3. The states are empowered to restrain any person from discharging a pollutant (or) sewage (or) effluent into any water body without the consent of the board.
4. The act is not clear about the definition of pollutant, discharge of pollutant toxic pollutant.

State pollution control board

The consent of this board is needed

- To establish any industry or any treatment and disposal system or any extension or addition which likely discharge or trade effluent into a stream or well or river or on land.
- To use any new or altered outlet for the discharge of sewage
- To begin to make any new discharge of sewage
- Act also empowers the state board to order closure or stoppage of supply of Electricity, water or any other service to the polluting unit.

AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

This act was enacted in the conference held at Stockholm. It envisages the establishments of central and state control boards to monitor air quality and pollution control.

Important features:

1. The central board may lay down the standards for quality of air.
2. The central board co-ordinates and settle the disputes between state boards.
3. The central board provides technical assistance and guidance to state boards.
4. The state boards are empowered to lay down the standards for emission of air pollutants from industries or other resources.
5. The state boards are to examine the manufacturing processes and control equipment for the prescribed standards.
6. The direction of central board is mandatory on stateboards.
7. Without the consent of the central board operation of an industrial unit is prohibited in heavily polluted area.
8. Violation of law is punishable with imprisonment for three months or fine of Rs 10000 or both.
9. This act applies to all pollution industries.
10. This act empowers the state board to order closure of any industrial unit or stoppage of water supply or stoppage of electricity.

FOREST (CONSERVATION) ACT, 1980

This act is enacted in 1980. It aims to arrest deforestation. This act covers all types of Forests including reserved forests, protected forests and any forest land.

Important Features of the act:

1. The reserved forests shall not be diverted or dereserved without the permission of central govt.
2. The forest land may not be used for non-forest purposes.
3. This act stops illegal activities within forest area.

Features of amendment act of 1988:

1. Forest departments are forbidden to assign any forest land by way of lease or to any private person or NG body for re-forestation.
2. For re-forestation clearance of any forest land is forbidden.
3. The division of forest land for non-forest uses is punishable.

WILD LIFE ACT, 1972

- This act was amended in 1983, 1986, and 1991.
- This act is aimed to protect and preserve all animals and plants that are not domesticated.
- India has 350 species of mammals, 1200 species of birds and about 20000 known species of insects. Some of them are listed as endangered species in wild life protection act.
- Wild life is declining due to human action. Wild life products like skins, feathers, ivory etc. have decimated the population of many species. Wild life population monitored regularly and management strategies formulated to protect them.

Important Features:

1. The act covers the rights and non- rights of forest dwellers.
2. It allows restricted grazing in sanctuaries but prohibits in national parks.
3. It also prohibits the collection of non timber forest.
4. The rights of forest dwellers recognized by forest policy of 1988 are taken away by Amended wild life act of 1991.

ENVIRONMENT (PROTECTION) ACT, 1986

This act empowers the central govt. to fix the standards for quality of air, water, soil, and noise. The central govt. formulates procedures and safe guards for handling of hazard substances.

Important features:

1. This act empowers the govt. to lay down procedures and safe guards for the prevention of accidents which cause pollution and remedial measures if accidents occur.
2. The govt. has the authority to close or prohibit or regulate any industry or its operation if the violation of provisions of the act occurs.
3. Violation of the act is punishable with imprisonment for 5 years or fine of one lakh or both.
4. If violation continues an additional fine of Rs 5000 per day may be imposed for entire period of violation of rules.
5. The act empowers the officer of the central govt. to inspect the sight or the plant or machinery for preventing pollution and to collect samples of air, water, soil and other materials from any factory or its premises for testing.

PUBLIC AWARENESS

In order to conserve our environment each and every one must be aware about our environment problems and objectives of various environmental policies at natural and local level.

Objectives of public awareness:

1. To create awareness among rural and city people about ecological imbalance, local environment and technological development
2. To organize meetings, tree plantation programs, group discussion on development, exhibitions
3. To focus on current environment problems and situations
4. To train our planners, decision makers, politicians and administrators
5. To eliminate poverty by providing employment that over comes the basic environmental issues

METHODS TO CREATE ENVIRONMENTAL AWARENESS:

1. Environmental education must be imparted to the students in schools and colleges.
2. Media like TV Radio and cable net work can educate the people on environmental issues through cartoons, documentaries, street plays.
3. Cinema about environmental education should be prepared and screened in theatres compulsorily .This films may be released with tax free to attract the public.
4. All the news papers and magazines must publish the environment related problems.
5. Special audio visual and slide shows should be arranged in public places.
6. Voluntary organizations like NCC, NSS, and ROTRACT Club should be effectively utilized for creating environmental awareness.
7. Arranging competitions like story and essay writing painting competition on environmental issues for student as well as public. Attractive prizes should be awarded for the best effort.
8. Public leaders sign actors and popular social reformers can make an appeal to the public about the urgency of environmental protection.

CHAPTER 7

HUMAN POPULATION AND THE ENVIRONMENT

- Our global human population, 7.8 billion at present, will cross the 10 billion mark by 2050.
- The needs of this huge number of human beings cannot be supported by the Earth's natural resources, without degrading the quality of human life.
- In the near future due to over population we may face the followings consequences:
 1. Fossil fuel from oil fields will run dry.
 2. It will be impossible to meet the demands for food from existing agro systems.
 3. Pastures will be overgrazed by domestic animals.
 4. Industrial growth will create ever-greater problems due to pollution of soil, water and air.
 5. Seas will not have enough fish.
 6. Larger ozone holes will develop due to the discharge of industrial chemicals into the atmosphere, which will affect human health.
 7. Global warming due to industrial gases will lead to a rise in sea levels and flood all low-lying areas, submerging coastal agriculture as well as towns and cities.
 8. Water 'famines' due to the depletion of fresh water will create unrest and eventually make countries go to war.
 9. The control over regional biological diversity, which is vital for producing new medicinal and industrial products, will lead to grave economic conflicts between biotechnologically advanced nations and the bio-rich countries.
 10. Degradation of ecosystems will lead to extinction of thousands of species, destabilizing natural ecosystems of great value.

GLOBAL POPULATION GROWTH

- The world population is growing by more than 90 million per year, of which 93% is in developing countries. This will essentially prevent their further economic 'development'.
- In the past, population growth was a gradual phenomenon and the Earth's ability to replenish resources was capable of adjusting to this increase.
- In the recent past, the escalation in growth of human numbers has become a major cause of our environmental problems.

- Human population growth increased from:
 - 1 to 2 billion, in 123 years.
 - 2 to 3 billion, in 33 years.
 - 3 to 4 billion, in 14 years.
 - 4 to 5 billion, in 13 years.
 - 5 to 6 billion, in 11 years.
- In the first half of the 1900s human numbers were growing rapidly in most developing countries such as India and China. In some African countries the growth was also significant.
- Several environmental ill-effects were linked with the increasing population of the developing world.
 - Poverty
 - Increased fragmentation of farm land
 - Unemployment.
 - Inadequate housing
 - Increasing level of air pollution from traffic, water pollution from sewage, and an inability to handle solid waste.
- By the 1970s most countries in the developing world had realized that if they had to develop their economics and improve the lives of their citizens they would have to curtail population growth.
- Though population growth shows a general global decline, there are variations in the rate of decline in different countries.
- By the 1990s the growth rate was decreasing in most countries such as China and India. The decline in the 90s was greatest in India.
- However, fertility continues to remain high in sub Saharan African countries.

Reasons that explain the differences in the rate of population control in different countries:

1. There are cultural, economic, political and demographic differences. Community and (or) religious thinking.
2. Lack of Government initiatives for Family Welfare Program
3. Limited access to a full range of contraceptive measures

HUMAN POPULATION

Population: Group of individuals belonging to the same species which live in a given area at given time

Population density: Number of individuals of the population per unit area per unit volume.

Parameters effecting population:

Birthrate (OR) Natality: Number of live births per 1,000 people in a population in a given year.

Death Rate (OR) Mortality: Number of deaths per 1000 people in a population in a given year.

Immigration: It denotes the arrival of individuals from neighboring population.

Emigration: It denotes the disposal of individuals from the original population to new areas.

Population Growth: Results from the difference between the rate of birth and death. In 1980 the global population was about 1 billion people. In 1930 it reached 2 billion. In 1975 it reached 4 billion within 45 years. Now the population is 7.8 billion. It reaches 10 billion by 2050 as per the World Bank calculation.

CAUSES OF VAST POPULATION GROWTH:

1. Due to decrease in death rate and increase in birth rate.
2. Availability of antibiotics, immunization increased food production, clean water and air, decreases the famine related deaths and infant mortality.
3. The poverty and illiteracy lead controlled growth of population.
4. Child Marriages
5. People's superstitions. People believe that it is because of God's grace.

CHARACTERISTICS OF POPULATION GROWTH:

Exponential growth: Population growth occur exponentially like 10 , 10^2 , 10^3 , 10^4 etc., which shows the dramatic increase in global population in the past 160 years.

Doubling Time: Time required for the population to double its size at a constant annual rate

It is calculated as follows:

$T_d = 70 / r$ When $r =$ annual growth rate

If a nation has 2 % annual growth its population will double in 35 years.

Infant Mortality:

Percentage of infant died out of those born in one year. This rate is decreased in the last 50 years. This differs widely in developing and developed countries.

Total fertility rates (TFR):

This means average number of children delivered by a woman in her life time. The TFR varies from 2 in developed to 4.7 in developing countries.

This ratio should be fairly balance in the society.

Male – female ratio has been upset in many countries including China - India. In china the ratio of girls and boys is 100 – 140.

Demographic transition:

Population growth is redacted to economic development. The birth rate and death rate full due to improved living conditions. This results in low population growth. This phenomenon is called demographic transition.

Variation of population among Nation:

- At present the world's population has crossed 7 billion. Less developed countries (Africa, Asia) have 80% population while developed countries have only 20%.
- In most developed countries like USA, Canada, Australia population increases by less than 1%. But in less developed countries the population increases by more than 1% per year.
- Kenya is the fastest population growing countries in the world.
- China & India's population was above 1000 million in 2000 years. Its share is 1/3 of the world population.

Variation of pollution based on Age structure

- Age structure of population can be classified into 3 classes.
 - i. Pre- productive population (0 – 14 years)
 - ii. Reproductive population (15 - 44 years)
 - iii. Post reproductive population (Above 45 years)
- Variation of population is now explained based on the above three classes.

1. Pyramid shaped Variation of population (increase)

Eg. In India, Bangladesh, Ethiopia, Algerian Reproductive population is more in companion to pre reproductive population and post productive population. Hence the population increases.

2. Bell shaped variation of population:

Eg: in France, USA, UK, Canada etc., pre reproductive population and reproductive population is more (OR) less equal. Hence population growth is stable.

3. Urn shaped variation of populations

Eg: In Germany, Italy, Sweden

In Japan pre productive age group population in smaller than the reproductive age group population. In the next 10 years. The number of people in reproductive age group is less than before resulting in decrease of population.

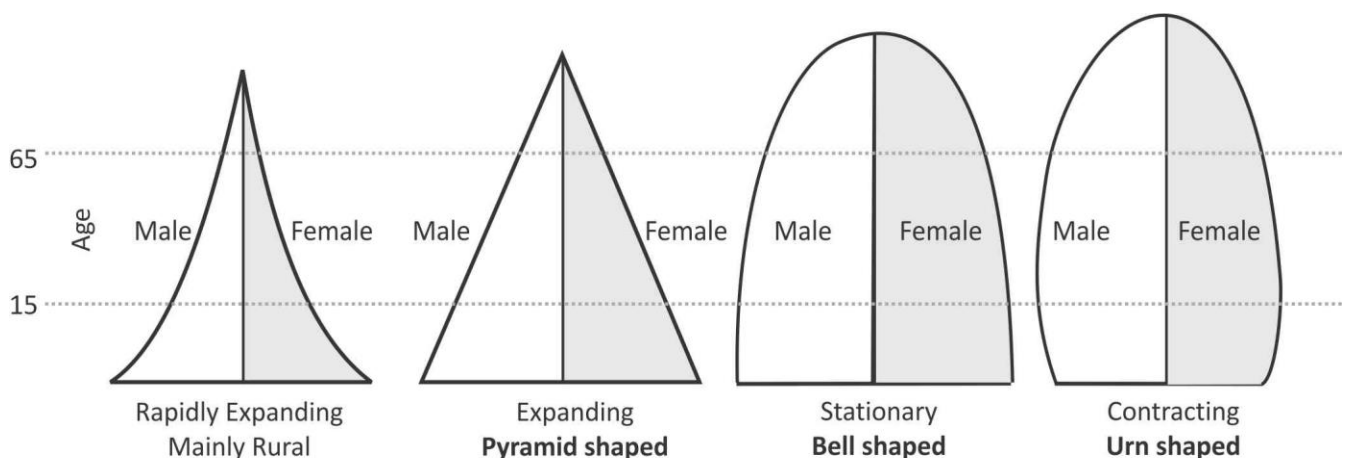


Fig. : Types of Pyramid

Population Explosion:

The enormous increase in population due to low death rate and high birth rate is called as population expansion.

Doubling time: The number of years needed for a population to double in size. The doubling time varies from country to country.

Population growth is higher in less developed countries.

Cause of population explosion:

- i. Invention modern medical facilities, reduces the death rate and increases birth rate, which leads to population explosion.
- ii. Increase of life expectancy is another important reason for population explosion.

Eg: In 1956, the average life expectancy of the human beings was 40 years. But now it is 61 years.

- iii. Illiteracy is one of the reasons for the population explosion.

Effect of population explosion (OR) environmental and social impacts of growing population:

- I.** Population explosion leads to environmental degradation.
- II.** Population explosion causes over exploitation of natural resources. Hence there will be a shortage of resources for the future generation.
- III.** Increase in population will increases diseases, economic in equity and command wars.
- IV.** Forests, grass lands are under threat.
- V.** The main reason for the growing unemployment is growing population.
- VI.** Educating vast population is a very big task.
- VII.** Population explosion is the main cause for pollution of air, land, water and noise.
- VIII.** Disposal of plastics and wastages is another problem of over population.
- IX.** Scarcity of fuel is also due to population explosion.

POPULATION EXPLOSION – FAMILY WELFARE PROGRAMME

- In response to our phenomenal population growth, India seriously took up an effective Family Planning Program which was renamed the **Family Welfare Program**.
- Slogans such as '**Hum do hamare do**' indicated that each family should not have more than two children.
- At the global level by the year 2000, 600 million, or 57% of women in the reproductive age group, were using some method of contraception.
- However the use of contraceptive measures is higher in developed countries – 68%, and lowers in developing countries - 55%.
- Family welfare program was implemented by Govt. of India as a voluntary program. It is a policy of growth covering human health, family welfare children and women's right.

Population stabilization Ratio

The ratio is derived by dividing crude birth rate by crude death rate.

Developed countries: The stabilization ratio of developed countries is 1, indicating zero population growth.

Developing countries:

The ratio of developing countries is rearing 3 which is expected to lower down by 2025. Stabilization in developing countries is possible only through family welfare programs.

Family planning Programme:

It provides educational and clinical services that help couples to choose how many children to have and when to have them. Family planning programs provide information on birth spacing, birth control, and health care for pregnant women and infants. It also reduced the number of legal and illegal abortions per year and decreased the risk of death from pregnancies.

Objectives:

- I. Reduce infant mortality rate to below 30 / 1000 infants.
- II. Achieve 100% registration of births, deaths, marriage and pregnancies.
- III. Encourages late marriages and late child bearing
- IV. Encourages breast feeding
- V. Enables to improve woman's health education, employment
- VI. Constrain the spread of AIDS / HIV.
- VII. Prevent and control of communicable diseases
- VIII. Slow down the population explosion by reducing fertility.
- IX. Pressure on the environment, due to over exploitation of natural resources is reduces.

FERTILITY CONTROL METHODS:

Traditional methods

It includes taboos and folks medicine.

Modern methods

It includes birth control techniques like mechanical barriers, surgical methods, chemical pills and physical barriers to implantation. More than 100 contraceptive methods are on trial.

Family planning programme in India:

- a. In 1952 India started family planning programme.
- b. In 1970 Indian govt. forced family planning campaigns all the over country.
- c. In 1978 govt. legally raised the minimum age of marriage for men from 18 to 21 and for women 15 to 18 years.
- d. In 1981 census report showed there is no drop in population. Hence funding for Family Planning programme has been increased.

METHODS OF STERILIZATION:

1. **Permanent methods** or **sterilisation** are done by a minor surgery.
 - a. **Tubectomy** in females is done by tying the fallopian tubes that carry the ovum to the uterus.

- b. **Male sterilization or vasectomy** is done by tying the tubes (vasa deferentia) that carry the sperm. Vasectomy does not cause any loss in the male's sexual ability but only arrests the discharge of sperm.

2. **Temporary birth control:**

- a. **Condoms** are used by males to prevent sperms from fertilizing the ovum during intercourse.
 - b. **Intrauterine devices (Copper Ts)** are small objects which can be placed by a doctor in the uterus so that the ovum cannot be implanted, even if fertilized. They do not disturb any functions in the woman's life or work.
 - c. **Oral contraceptive tablets (pills)** and **injectable drugs** are available that prevent sperms from fertilizing the ovum.
 - d. There are also traditional but less reliable methods of contraception such as abstinence of the sexual act during the fertile period of the women's cycle and withdrawal during the sexual act.
- Informing the public about the various contraceptive measures that are available is of primary importance. This must be done actively by Government Agencies such as **Health and Family Welfare**, as well as **Education and Extension workers**.
 - The greatest challenge the world now faces is how to supply its exploding human population with the resources it needs.
 - **Due to expanding population:**
 - i. Water shortages will become acute
 - ii. Soil will become unproductive
 - iii. Rivers, lakes and coastal waters will be increasingly polluted
 - iv. Water related diseases already kill 12 million people every year in the developing world.
 - v. By 2025, there will be 48 countries that are starved for water.
 - vi. Air will become increasingly polluted. Air pollution already kills 3 million people every year.
 - The first '**green revolution**' in the '60s produced a large amount of food but has led to several environmental problems. Now, a new green revolution is needed, to provide enough food for our growing population.

URBANIZATION:

- In 1975 only 27% of the people in the developing world lived in urban areas. By 2000 this had grown to 40% and by 2030 well informed estimates state that this will grow to 56%.
- The developed world is already highly urbanized with 75% of its population living in the urban sector. Urban population growth is both due to migration of people to towns and cities from the rural sector in search of better job options as well as population growth within the city.
- As a town grows into a city it not only spreads outwards into the surrounding agricultural land or natural areas such as forests, grasslands and wetlands but also grows skywards with high rise buildings.

Effects of Urbanization:

- i. The town loses its open spaces and green cover
 - ii. Destroys the quality of life in the urban area.
- Therefore good urban planning is essential.
 - i. Upgrading slum areas
 - ii. improving water supply and drainage systems
 - iii. providing adequate sanitation
 - iv. developing effective waste water treatment plants
 - v. An efficient public transport system
 - vi. City's natural green spaces, parks and gardens are maintained
 - vii. River and water front's are managed appropriately
 - viii. Roadside tree cover is maintained
 - ix. Hill slopes are afforested and used as open spaces
 - x. Architectural and heritage sites are protected.
 - India's urban areas will grow by a projected 297 million residents. In India people move to cities from rural areas in the hope of getting a better income. This is the **'Pull' factor**.

Causes of “pull factor”:

- a. A poor opportunity in the rural sector thus stimulates migration to cities.
- b. Loss of agricultural land to urbanisation and industry
- c. The inability of governments to sustainably develop the rural sector
- d. Lack of supporting infrastructure in rural areas
- e. Better education, health care and relatively higher living standards.
- f. For people living in wilderness areas in our forests and mountain regions, development has been most neglected.

In general the growing human population in the rural sector will only opt to live where they are if they are given an equally satisfying lifestyle.

Urban poverty and the Environment

- The number of poor people living in urban areas is rapidly increasing. A third of the poor people in the world live in urban centres.
- These people live in hutments in urban slums and suffer from water shortages and unsanitary conditions.
- During the 1990s countries that have experienced an economic crisis have found that poor urban dwellers have lost their jobs due to decreasing demands for goods, while food prices have risen.
- One billion urban people in the world live in inadequate housing, mostly in slum areas, the majority of which are temporary structures.
- Illegal slums often develop on Government land, along railway tracks, on hill slopes, riverbanks, marshes, etc. that are unsuitable for formal urban development.
- Adequate legal housing for the urban poor remains a serious environmental concern.
- Urban poverty is even more serious than rural poverty, as unlike the rural sector, the urban poor have no direct access to natural resources such as relatively clean river water, fuel wood and non wood forest products.
- The urban poor can only depend on cash to buy the goods they need, while in the rural sector they can grow a substantial part of their own food.
- Living conditions for the urban poor are frequently worse than for rural poor.

- Both outdoor and indoor air pollution due to high levels of particulate matter and sulphur dioxide from industrial and vehicle emissions lead to high death rates from respiratory diseases.
- Indoor air pollution due to the use of fuel wood, waste material, coal, etc. in 'chulas' is a major health issue. This can be reduced by using better designed 'smokeless' chulas, hoods and chimneys to remove indoor smoke.

ENVIRONMENT AND HUMAN HEALTH

- Environment related issues that affect our health have been one of the most important triggers that have led to creating an increasing awareness of the need for better environmental management.
- The assumption that human progress is through economic growth is not necessarily true.
- Urbanization and industrialization leads to diseases like:
 - a. Waterborne diseases such as infective diarrhoea
 - b. Air borne bacterial diseases such as tuberculosis
 - c. High-density city traffic leads to an increase in respiratory diseases like asthma.
 - d. Agricultural pesticides that enhanced food supplies during the green revolution have affected both farmers and consumers.
- Modern medicine promised to solve many health problems but many drugs have been found to have serious side effects. Thus development has created several long-term health problems.
- While better health care has led to longer life spans, coupled with a lowered infant mortality, it has also led to an unprecedented growth in our population which has negative implications on environmental quality.

A. Environmental health

- **Defined by WHO:** Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psychosocial factors in the environment.

- It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that adversely affect the health of present and future generations.
- Our environment affects health in a variety of ways.
 - i. Climate and weather affect human health.
 - ii. Public health depends on sufficient amounts of good quality food, safe drinking water, and adequate shelter.
 - iii. Natural disasters such as storms, hurricanes, and floods still kill many people every year.
 - iv. Unprecedented rainfalls trigger epidemics of malaria and water borne diseases.
 - v. The depletion of ozone in the stratosphere (middle atmosphere) also has an important impact on global climate and in turn human health, increasing the amount of harmful ultraviolet radiation that reaches the Earth's surface. This results in diseases such as skin cancer.

CASE STUDY: Bhopal Gas Tragedy

The siting of industry and relatively poor regulatory controls leads to ill health in the urban centres. Accidents such as the Bhopal gas tragedy in 1984 where Union Carbide's plant accidentally released 30 tonnes of methyl isocyanate, used in the manufacture of pesticides, led to 3,330 deaths and 1.5 lakh injuries to people living in the area.

Environmental health and human health are closely interlinked.

Examples of the linkages:

1. Millions of children die every year due to diarrhoea from contaminated water or food. An estimated 2000 million people are affected by these diseases and more than 3 million children die each year from waterborne diseases across the world. In India, it is estimated that every fifth child under the age of 5 dies due to diarrhoea. This is a result of inadequate environmental management and is mainly due to inadequate purification of drinking water.
2. Wastewater and/or sewage entering water sources without being treated leads to continuous gastrointestinal diseases in the community and even sporadic large epidemics.

3. Large numbers of people in tropical countries die of malaria every year and millions are infected. An inadequate environmental management of stagnant water, which forms breeding sites of *Anopheles* mosquitoes, is the most important factor in the spread of malaria.
4. Millions of people, mainly children, have poor health due to parasitic infections, such as amoebiasis and worms. This occurs from eating infected food, or using poor quality water for cooking food.
5. Hundreds of millions of people suffer serious respiratory diseases, including lung cancer and tuberculosis, from crowded homes and public places. Motor vehicle exhaust fumes, industrial fumes, tobacco smoke and cooking food on improper 'chulas', contribute to respiratory diseases.
6. Basic environmental needs such as clean water, clean air and adequate nutrition which are all related to environmental goods and services do not reach over 1000 million people living in abject poverty.
7. Population growth and the way resources are being exploited and wasted, threaten environmental integrity and directly affects health of nearly every individual.

Important strategic concerns:

1. The world must address people's health care needs and sustainable use of natural resources, which are closely linked to each other.
2. Strategies to provide clean potable water and nutrition to all people are an important part of a healthy living environment.
3. Providing clean energy sources that do not affect health is a key to reducing respiratory diseases.
4. Reducing environmental consequences of industrial and other pollutants such as transport emissions can improve the status of health.
5. Changing patterns of agriculture away from harmful pesticides, herbicides and insecticides which are injurious to the health of farmers and consumers by using alternatives such as Integrated Pest Management and non-toxic biopesticides can improve health of agricultural communities, as well as food consumers.
6. Changing industrial systems into those that do not use or release toxic chemicals

7. There is a need to change from using conventional energy from thermal power that pollutes air and nuclear power that can cause serious nuclear disasters to cleaner and safer sources such as solar, wind and ocean power

B. Climate and health

- Human civilizations have adapted mankind to live in a wide variety of climates. From the hot tropics to the cold arctic, in deserts, marshlands and in the high mountains. Both climate and weather have a powerful impact on human life and health issues.
- Natural disasters created by extremes of weather (heavy rains, floods, hurricanes) which occur overall short period of time, can severely affect health of a community.
- Poor people are more vulnerable to the health impacts of climate variability than the rich.
- Of approximately 80,000 deaths which occur world-wide each year as a result of natural disasters about 95% are in poor countries.

IMPACT OF CLIMATE VARIABILITY:

1. In weather-triggered disasters hundreds of people and animals die
2. homes are destroyed
3. crops and other resources are lost
4. Public health infrastructure, such as sewage disposal systems, waste management, hospitals and roads are damaged.
5. Heat waves cause heat-related illness and death (e.g. heat stroke).
6. Climate plays an important role in vector-borne diseases transmitted by insects such as mosquitoes. These disease transmitters are sensitive to direct effects of climate such as temperature, rainfall patterns and wind.

Example:

- Malaria transmission is particularly sensitive to weather and climate. Unusual weather conditions, for example a heavy downpour, can greatly increase the mosquito population and trigger an epidemic.
- The cyclone in Orissa in 1999 caused 10,000 deaths. The total number of people affected was estimated at 10 to 15 million.

C. Infectious diseases

- Many infectious diseases have re-emerged with a vengeance. Loss of effective control over diseases such as malaria and tuberculosis, have led to a return of these diseases decades after being kept under stringent control.
- Other diseases were not known to science earlier and seem to have suddenly hit our health and our lives during the last few decades.
- **AIDS**, due to the **Human Immunodeficiency Virus (HIV)** caused through sexual transmission and **Severe Acute Respiratory Syndrome (SARS)** are two such examples.
- While these cannot be directly related to environmental change, they affect the environment in which we live by forcing a change in lifestyles and behaviour patterns.
- For example the SARS outbreak prevented people from several countries from travelling to other countries for months, severely affecting national economies, airline companies and the tourism industry.
- The newer broad-spectrum antibiotics, antiseptics, disinfectants, and vaccines once thought of as the complete answer to infectious diseases have thus failed to eradicate infectious diseases.
- Experts in fact now feel that these diseases will be the greatest killers in future and not diseases such as malignancy or heart disease.
- While antibiotic resistance is a well-known phenomenon there are other reasons for the re-emergence of diseases.
- With increasing global warming disease patterns will continue to change. Tropical diseases spread by vectors such as the mosquito will undoubtedly spread malaria further away from the equator.
- Global warming will also change the distribution of dengue, yellow fever, encephalitis, etc. Warmer wetter climates could cause serious epidemics of diseases such as cholera.

Globalisation and infectious disease

- Globalization is a world-wide process which includes the internationalization of communication, trade and economic organization.
- It involves parallel changes such as rapid social, economic and political adjustments.

Examples of Infectious diseases:

1) Tuberculosis:

- Nearly 1% of the world's population is newly infected with TB each year.
- It is estimated that overall, one third of the world's population is likely to be infected with the tuberculosis bacillus at some point in time.

2) **Malaria** is a life-threatening parasitic disease transmitted by mosquitoes.

- Today approximately 40% of the world's population, mostly those living in the world's poorest countries, risk getting malaria.
- The disease was once more widespread but it was successfully eliminated from many countries with temperate climates during the mid 20th century.
- Today malaria has returned and is found throughout the tropical and sub-tropical regions of the world and causes more than 300 million acute illnesses and at least one million deaths annually (WHO).

D. Water-related diseases

There are 4 major types of water related diseases:

1) Water borne diseases:

- These are caused by dirty water contaminated by human and animal wastes, especially from urban sewage, or by chemical wastes from industry and agriculture.
- Examples: cholera, typhoid, diarrhoea, dysentery, polio, meningitis, and hepatitis A and E, are caused due to improper drinking water. Pesticides entering drinking water in rural areas cause cancer, neurological diseases and infertility. Improving sanitation and providing treated drinking water reduces the incidence of these diseases.

2) Water based diseases:

- Aquatic organisms that live a part of their life cycle in water and another part as a parasite in man, lead to several diseases.
- In India, guinea worm affects the feet. Round worms live in the small intestine, especially of children.

3) Water related vector diseases:

- Insects such as mosquitoes that breed in stagnant water spread diseases such as malaria and filariasis.
- Malaria that was effectively controlled in India, has now come back as the mosquitoes have become resistant to insecticides.
- In addition, anti-malarial drugs are now unable to kill the parasites as they have become resistant to drugs.
- Other vector born diseases in India include dengue fever and filariasis. Dengue fever carries a high mortality. Filariasis leads to fever and chronic swelling over the legs.

4) Water scarcity diseases:

- In areas where water and sanitation is poor, there is a high incidence of diseases such as tuberculosis, leprosy, tetanus, etc. which occur when hands are not adequately washed.

HUMAN RIGHTS

Several environmental issues are closely linked to human rights.

These include:

1. The equitable distribution of environmental resources
2. The utilisation of resources and Intellectual Property Rights (IPRs)
3. conflicts between people and wildlife especially around Pas
4. resettlement issues around development projects such as dams and mines
5. Access to health to prevent environment related diseases

HUMAN RIGHTS

Human rights are the fundamental rights possessed by human beings irrespective caste, nationality, sex & language.

The aim of Govt. is to ensure happiness to the entire citizen with equal rights.

Under the Indian constitution the following fundamental rights have been guaranteed to human beings:

1. Human right to freedom
2. Human right to property
3. Human right to freedom of religion
4. Human right to culture and education
5. Human right to constitutional remedies
6. Human right to Equality
7. Human right to against exploitation
8. Human right to food and environmental
9. Human right to health

Human rights to freedom

- Every citizen has the freedom to express his view freely.
- Citizen can assemble at any place to express their views.
- Freedom to form unions (or) associations
- Freedom to slant any profession

Indian Constitution

Indian constitution provides for civil, social, cultural, educational and political rights.

Article 14 – equality before law.

Article 15: Prohibits discrimination on the ground of race, religion caste, sex (or) place of birth

Article 16: Provides equal opportunity for all citizens in regarding to employment

Article 19: Provides for freedom of speech and expression, forming association and union

Article 20: Protection from connection except in accordance with the law of the land

Article 22: lays down the rights of a person in custody.

Article 24: prohibits exploitation of labour children.

Article 25: grantees freedom to profess, practice and propagate a religion of one's choice

Equity

- One of the primary concerns in environmental issues is how wealth, resources and energy must be distributed in a community.
- Today the difference between the economically developed world and the developing countries is unacceptably high.
- The access to a better lifestyle for men as against women is inherent in many cultures.
- Last but not the least, we in the present generation cannot greedily use up all our resources leaving future generations increasingly impoverished.
- Rights to land, water, food, and housing are all a part of our environment that we all share.
- However, while some live unsustainable lifestyles with consumption patterns that the resource base cannot support, many others live well below the poverty line.
- The right to the use of natural resources that the environment holds is an essential component of human rights.
- People who live in wilderness communities are referred to as ecosystem people. They collect food, fuel wood, and non-wood products, fish in aquatic ecosystems, or hunt for food in forests and grasslands.

- The right to land or common property resources of tribal people is infringed upon by large development projects such as dams, mining and Protected Areas.

Nutrition, health and human rights

- There are links between environment, nutrition and health which must be seen from a human rights perspective.
- Proper nutrition and health are fundamental human rights. The right to life is a Fundamental Right in our constitution.
- Nutrition affects and defines the health status of all people, rich and poor. It is linked to the way we grow, develop, work, play, resist infection and reach our aspirations as individuals, communities and societies.
- Malnutrition makes people more vulnerable to disease and premature death.
- Poverty is a major cause as well as a consequence of ill-health. Poverty, hunger, malnutrition and poorly managed environments together affect health and weaken the socioeconomic development of a country.
- In our globalized 21st century, equity must begin at the bottom, hand in hand with a healthy environment, improved nutrition, and sustainable lifestyles.

Intellectual Property Rights and Community Biodiversity Registers

- Traditional people, especially tribal living in forests, have used local plants and animals for generations.
- This storehouse of knowledge leads to many new 'discoveries' for modern pharmaceutical products. The revenue generated from such 'finds' goes to the pharmaceutical industry that has done the research and patented the product.
- This leaves the original tribal user with nothing while the industry could earn billions of rupees.
- To protect the rights of indigenous people who have used these products, a possible tool is to create a **Community Biodiversity Register** of local products and their uses so that its exploitation by the pharmaceutical industry would have to pay a royalty to the local community.
- This however has still not been generally accepted.

VALUE EDUCATION

- Value education in the context of our environment is expected to bring about a new sustainable way of life.
- Education both through formal and non-formal processes must address:
 - understanding of environmental values
 - valuing nature and cultures
 - social justice
 - human heritage
 - equitable use of resources
 - managing common property resources

VALUE EDUCATION

Education is nothing but learning through which knowledge about a particular thing can be acquired. With the help of our knowledge and experience we can identify our value to understand ourselves and our relationship with other and their environment.

Types of Education:

Format Education: (In this all learning process are self related). All people will read write, will get good jobs and take with any problem with the help of formal education.

Value Education: It is an education used to analyze our behavior and provide proper direction to our youth. It teaches the youth the distinction between right & wrong, to be helpful loving, generous and tolerant.

Value based environmental education

This provides knowledge about the principle of ecology, fundamental of environment and biodiversity. It creates sense of duty to care for natural resources and to manage them in sustainable key.

Objectives:

1. Improve integral growth of human being.
2. To create attitudes and improvement towards sustainable life style
3. To increase awareness about our national history, cultural heritage, constitutional

rights, national integration

4. To understand our natural environment in which how land, air and water are interlinked
5. To know about various living and non living organism and their interaction with the environment

Types of values:

1. Universal values (or) social values:

These values tell about the importance of the human conditions. These are reflected in life, joy, love, tolerance, truth etc.

2. Cultural values:

These value various with respect to time and place. These are concerned with rights & wrong, good & bad, true & false and behavior of human beings. It is reflected in language, education, law, economics, philosophy etc.

3. Individual values:

These are personal principles and the result of individual personality and experience parents & teachers are the main key to shape and individual values. It is reflected in individual goods, relationship, commitments.

4. Global values:

Human civilization is a part of the planet. Nature and natural pheromone on the earth are interconnected and inter-linked with special bonds of harmony. If this harmony disturbed any where leads to catastrophic results due to ecological imbalance.

ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT AND HUMAN HEALTH

- The understanding of environmental concerns and issues related to human health has exploded during the last few years due to the sudden growth of Information Technology.
- The computer age has turned the world around due to the incredible rapidity with which IT spreads knowledge.
- IT can do several tasks extremely rapidly, accurately and spread the information through the world's networks of millions of computer systems.
 - A few examples of the use of computer technology that aid environmental studies include software such as using **Geographical Information Systems (GIS)**.
 - GIS is a tool to map land use patterns and document change by studying digitized toposheets and/or satellite imagery.
- The Internet with its thousands of websites has made it extremely simple to get the appropriate environmental information for any study or environmental management planning.
- Specialised software can analyse data for epidemiological studies, population dynamics and a variety of key environmental concerns.
- The relationship between the environment and health has been established due to the growing utilisation of computer technology. This looks at infection rates, morbidity or mortality and the etiology (causative factors) of a disease.
- As knowledge expands, computers will become increasingly efficient. They will be faster, have greater memories and even perhaps begin to think for themselves.
- Information Technology plays a vital role in the field of environment education. IT means collection, processing, storage and dissemination of information.
- The internet facilities, information through satellites and geographical information provides up to date information on various aspects of environment, weather.

Remote sensing

- It refers to any method which can be used to gather information about an object without coming in contact with it.
- Gravity, magnetic, electromagnetic forces could be used for remote sensing.

- Remote sensing covers various disciplines from laboratory testing to astronomies.
- Now remote sensing is used to denote identification of earth weathers by detecting the characteristic electromagnetic radiation. That is reflected by the earth.

Components of a remote sensing system

The system consists of a sensor to collect radiation. Other important parts are a platform, an aircraft, a balloon, rocket and satellite. The information received by the sensor is suitably manipulated and transported back to earth. The data are reformed and processed on the ground to produce photographs, computer compatible magnetic tapes and digital storage medium.

Applications:

1. Agriculture:

In India agriculture provides livelihood of 70% of population and contributes to about 35% of net nation product. We require optimal management of land and water resources along with high yielding variety seeds, fertilizer input.

Remote sensing can provide valuable information for land and water management.

2. Forests:

Remote sensing provides information clearly on the type, density and extent of forest cover, wood volume and biomass, forest fire, encroachment etc.

3. Land cover:

Spatial information on land is required at different scales. Depends upon the remote sensing, data is converted to map. The spatial resolution plays a role on the scale of mapping.

4. Water resources:

Remote sensing data has been used in many application related to surface water body mapping, ground water targeting, wet land, flood monitoring, reservoir sedimentation, water quality monitoring etc. One of the simplest applications is inventorying surface water body.

DATABASE

It is the collection of inter related data on various objects. In the computer the information of database is arranged in a systematic manner.

Applications:

1. The ministry of environment and forest:

- They are compiling database on various biotic components.
- Database is also available for diseases likes HIV/AIDS, Malaria, Fluorosis.

2. National Management Information System (NIMS)

- They compile database on R & D Projects along with information about research scientists and personnel involved.

3. Environmental Information System:

- It functions in 25 centers all over the country.
- They generate net work of database in areas like pollution control, remote sensing, biodiversity, and desertification.

4. Geographical information system (GIS)

- It is a technique of superimposing various thematic maps using digital data on large Number of inters related aspects.

Applications:

- a. Different thematic maps having digital information on water resources, soil type, forest land, crop land, grass lands are superimposed on a layered form in computer using soft ware.
- b. Interpretation of polluted zones, degraded lands can be made on GIS base.
- c. GIS can be used to check unplanned growth and related environmental problems.

SATELLITE DATA:

It helps in providing correct and reliable information of forest cover provides information of monsoon, ozone layer depletion Smog etc. and helps in discovering reserves of oil, minerals.

WORLD WIDE WEB (WWW)

More current data is available on WWW online learning centre.

Application of computers in the field of Environment & human health:

1. Unknown parameters can be stimulated by computer techniques
2. EIA (Environmental Impact Assessment) problems can be analyzed
3. Inventories of emission sources are compiled and maintained
4. Net-work analysis, statistical analysis and the status of environmental pollutions can be high lighted
5. Comprehensive administrative system can be developed by using computer network techniques.
6. Remote sensing-Graphical Interface System are useful for coral reef mapping and ocean resources. They are also useful to access the loss of biodiversity/hot spots etc.