

GANDHI ACADEMY OF TECHNOLOGY AND ENGINEERING



LECTURE NOTES
ON
ENVIRONMENTAL STUDIES
3RD SEMESTER

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Unit 1: The Multidisciplinary nature of environmental studies

Definition –

Environmental studies are an interdisciplinary subject examining the interplay between the social, legal, management, and scientific aspects of environmental issues. Interdisciplinary means that issues are examined from multiple perspectives.

Scope of environmental studies-

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

1. The study creates awareness among the people to know about various renewable and non-renewable resources of the region. The endowment or potential, patterns of utilization and the balance of various resources available for future use in the state of a country reanalysed in the study.
2. It provides knowledge about ecological systems and cause and effect relationships.
3. It provides necessary information about biodiversity richness and the potential dangers to the species of plants, animals, and microorganisms in the environment.
4. The study enables one to understand the causes and consequences due to natural and man induced disasters (flood, earthquake, landslide, cyclones etc.) and pollution and measures to minimize the effects.
5. It enables one to evaluate alternative responses to environmental issues before deciding on an alternative course of action.
6. The study exposes the problems of overpopulation, health, hygiene, etc. and the role of arts, science and technology in eliminating/ minimizing the evils from society.

inherited from our ancestors to the younger generation without deteriorating their quality.

Importance of environmental study -

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

Importance

- World population is increasing at an alarming rate especially in developing countries. The natural resources endowment in the earth is limited.
- The methods and techniques of exploiting natural resources are advanced.

- The resources are over-exploited and there is no foresight of leaving the resources to the future generations.
- The unplanned exploitation of natural resources leads to pollution of all types and at all levels.
- The pollution and degraded environment seriously affect the health of all living things on earth including man.
- The people should take a combined responsibility for the deteriorating environment and begin to take appropriate actions to space the earth.
- Education and training are needed to save the biodiversity and species extinction.
- The urban area, coupled with industries, is major sources of pollution.
- The number and area extinct under protected area should be increased so that the wild life is protected at least in these sites.
- The study enables the people to understand the complexities of the environment and need for the people to adapt appropriate activities and pursue sustainable development, which are harmonious with the environment.
- The study motivates students to get involved in community action, and to participate in various environmental and management projects.
- It is a high time to reorient educational systems and curricula towards these needs.

Need for public awareness –



- Increasing population, Urbanization and poverty have generated pressure on the natural resources and lead to a degradation of the environment. To Prevent the Environment from Further Degradation, the supreme court has ordered and initiated environmental protection awareness through government and non-government agencies to take part in protecting our environment.
- Environmental pollution cannot be prevented by laws alone. Public participation is equally important with regard to environmental protection.
- Climate change, loss of biodiversity, declining fisheries, ozone layer depletion, illegal trade of endangered species, destruction of habitats, land degradation, depleting ground water supplies, introduction of alien species, environmental

pollution, solid waste disposal, storm water and sewage disposal pose a serious threat to ecosystems in forest, rural, urban and marine ecosystems.

- Both formal and informal education on the environment will give the interested individual the knowledge, values, skills and tools needed to face the environmental challenges on a local and global level.

Unit 2: Natural Resources

Renewable and non renewable resources:

Renewable Resources

The resources which cannot be exhausted even after continuous utilization are termed as renewable resources. Examples of renewable resources are the sun, wind, and tidal energy.

Non-Renewable Resources

The resources which cannot be immediately replaced once they are depleted are called Non-renewable resources. Examples of Non-renewable resources include fossil fuels, such as coal, petroleum and natural gas and rare minerals typically found in meteorites.

a) Natural resources and associated problems – Forest Resources -

Forest is important renewable resources. Forest vary in composition and diversity and can contribute substantially to the economic development of any country. Plants along with trees cover large areas, produce variety of products and provide food for living organisms, and also important to save the environment.

Over exploitation of forests

Forests contribute substantially to the national economy. With increasing population increased demand of fuel wood, expansion of area under urban development and industries has lead to over exploitation of forest .At present international level we are losing forest at the rate of 1.7 crore hectares annually. Overexploitation also occurs due to overgrazing and conversion of forest to pastures for domestic use.

Deforestation

1. Forest are burned or cut for clearing of land for agriculture ,harvesting for wood and timber , development and expansion of cities .These economic gains are short term where as long term effects of deforestation are irreversible
2. Deforestation rate is relatively low in temperate countries than in tropics If present rate of deforestation continues we may losses 90% tropical forest in coming six decades
3. For ecological balance 33% area should be under forest cover but our nation has only 20.6% forest cover.

Causes Of deforestation -

Forest area in some developed area has expanded. However in developing countries area under forest is showing declining trend particularly in tropical region. Main causes of deforestation are

- a) *Shifting cultivation or jhum cultivation*
- b) *Commercial logging*
- c) *Need for fuel wood*
- d) *Expansion for agribusiness*
- e) *Development projects and growing need for food*
- f) *Raw materials for industrial use*

Case Studies -

Jhum Agriculture or shifting agriculture has destroyed large number of hectare of forest tracts in North-Eastern states and Orissa. Jhum agriculture is subsistence agriculture in which tract of forest land is cleared by cutting trees and it is used for cultivation.

After few years, when productivity of the land decreases, cultivators abandon the land and clear next tract. As a result of this practise, combined with increasing population there is rapid deforestation as more and more cultivators clear forest to cultivate land. Also, with increase in population there is cultivators are forced to return to previous tracts. shortage of firewood and timber, due large scale tree cutting. Increased traffic volumes on these roads leads to increased pollution in the area.

Timber extraction

There has been unlimited exploitation of timber for commercial use. Due to increased industrial demand; timber extraction has significant effect on forest and tribal people.

Logging

- Poor logging results in degraded forest and may lead to soil erosion especially on slopes.
- New logging roads permit shifting cultivators and fuel wood gatherers to gain access to the logging area.
- Loss of long term forest productivity
- Species of plants and animals may be eliminated
- Exploitation of tribal people by contractor.

Mining

Major effects of mining operations on forest and tribal people are:

- Mining from shallow deposits is done by surface mining while that from deep deposits is done by sub-surface mining. It leads to degradation of lands and loss of top soil. It is estimated that about eighty thousands hectare land is under stress of mining activities in India
- Mining leads to drying up perennial sources of water sources like spring and streams in mountainous area.

- Mining and other associated activities remove vegetation along with underlying soil mantle, which results in destruction of topography and landscape in the area. Large scale deforestation has been reported in Mussoorie and Dehradun valley due to indiscriminating mining.

➤ **Effects of dams on forests and tribal people**

Pandit Jawaharlal Nehru referred dam and valley projects as “Temples of modern India”. These big dams and rivers valley projects have multi-purpose uses. However, these dams are also responsible for the destruction of forests.

- They are responsible for degradation of catchment areas, loss of flora and fauna, increase of water borne diseases, disturbance in forest ecosystems, rehabilitation and resettlement of tribal peoples.
- India has more than 1550 large dams, the maximum being in the state of Maharashtra (more than 600), followed by Gujarat (more than 250) and Madhya Pradesh (130).
- The highest one is Tehri dam, on river Bhagirathi in Uttarakhand and the largest in terms of capacity is Bhakra dam on river Satluj in Himachal Pradesh. Big dams have been in sharp focus of various environmental groups all over the world, which is mainly because of several ecological problems including deforestation and socio-economic problems related to tribal or native people associated with them.
- The Silent valley hydroelectric project was one of the first such projects situated in the tropical rain forest area of Western Ghats which attracted much concern of the people.
- The crusade against the ecological damage and deforestation caused due to Tehri dam was led by Shri. Sunder Lal Bahuguna, the leader of Chipko Movement.

WATER RESOURCES:

- Water is the most abundant, inexhaustible renewable resource. It covers 70% of the globe in the form of oceans, rivers, lakes, etc. Of this 70%, only 3% is available as freshwater.
- From this 3%, roughly 2% is frozen in polar icecaps and only a fraction of the remaining 1% is used as drinking water (potable). 90% of the water is utilized for agricultural purposes in India.

USE OF SURFACE AND GROUND WATER

- **Consumptive use:** In such uses, water is completely utilized and cannot be reused. Ex: Domestic, industrial and irrigation
- **Non-consumptive use:** In such uses, water is not completely utilized and is reused Ex: Hydropower plant

Other uses:

1. Water is used for domestic purposes like drinking, bathing, cooking, washing, etc.
2. Water is used in commercial establishments like hotels, theaters, educational institutions, offices, etc.
3. Almost 60-70% of fresh water is used for irrigation
4. 20-30% of water is used for industrial operations by refineries, iron & steel industries, paper & pulp industries, etc.
5. Water plays a key role in sculpting the earth's surface, moderating climate and diluting pollutants.

OVER-UTILIZATION OF SURFACE & GROUND WATER

The rapid increase in population and industrial growth led to severe demand on water resources. After using all available surface water resources to the maximum, human beings began using groundwater to meet their needs.

1. The increased extraction of groundwater far in excess of the natural recharge led to decreased groundwater level. The erratic and inadequate rainfall caused reduction in storage of water in reservoirs. This also led to decrease of groundwater.

2. Building construction activities seal permeable soil zone and reduce the area for percolation of rainwater thereby increasing surface runoff.

3. If groundwater withdrawal rate is higher than recharge rate, sediments in aquifers get

compacted resulting in sinking of overlying land surface. This is called land subsidence

which leads to structural damage in buildings, fracture in pipes and reverses the flow of

canals leading to tidal flooding.

4. Over-utilization of groundwater in arid and semi-arid regions for agriculture disturbs equilibrium of reservoir in the region causing problems like lowering of water table and decreased pressure in aquifers coupled with changes in speed and direction of water flow.

5. Over utilization of groundwater in coastal areas leads to rapid intrusion of salt water from the sea thereby rendering it unusable for drinking and agriculture.

6. Over-utilization of groundwater leads to decrease in water level thereby causing earthquake, landslides and famine.

Drought

- Water is a very basic necessity for the survival of life on earth. Imagine life with insufficient amount of water, it will be impossible to do the daily activities of cleaning, cooking, drinking etc.
- Life will turn out to be a miserable chaos. Water cycle has helped in maintaining the quantity of water on the surface of earth. About 50 liters of water is needed per day per person in order to sustain a healthy life.
- There are many areas where people do not receive this basic quantity of water. Areas that do not receive adequate amount of rainfall and have dry soil suffer from droughts. Whereas areas which receive heavy rainfall and have marshy soil generally get flooded.
- Drought conditions result from a lack of precipitation and this has many effects on the surrounding land and weather conditions. Drought conditions can worsen after prolonged periods of no rainfall, especially in areas where the water supply is short.

Causes drought?

Lack of rainfall (or precipitation): Droughts can occur when there is the lack of 'expected' precipitation (rain and snow).

Note that we say 'expected' because the lack of rain alone does not mean a drought.

FLOOD

Reasons of Flood

- Rains: Each time there are more rains than the drainage system can take, there can be floods. Sometimes, there is heavy rain for a very short period that result in floods. In other times, there may be light rain for many days and weeks and can also result in floods.
- River overflow: Rivers can overflow their banks to cause flooding. This happens when there is more water upstream than usual, and as it flows downstream to the adjacent low-lying areas (also called a floodplain), there is a burst and water gets into the land.
- Strong winds in coastal areas: Sea water can be carried by massive winds and hurricanes onto dry coastal lands and cause flooding. Sometimes this is made worse if the winds carry rains them. Sometimes water from the sea resulting from a tsunami can flow inland to cause damage.
- Dam breaking (Dams are built along the side of a river and are used to prevent high water from flooding bordering land). Sometimes, too much water held up in the dam can cause it to break and overflow the area. Excess water can also be intentionally released from the dam to prevent it from breaking and that can also cause floods.

Conflicts over water (international & inter-state).

Conflict through pollution: Rivers are also used for industrial purposes. They act as reservoirs for supply of fresh water and also a receptor of waste water

and rubbish from the industry. Water crossing borders that has been polluted by wastes from one country develops into an international conflict.

Management of water conflicts

1. Concerted efforts are required to enforce laws that check these practices to control water pollution.
2. In order to overcome the problem of sharing river water in a country, the concept of interlinking of rivers has been suggested.
3. Rivers should be nationalized; the National Water Authority and River Basin Authority should be given powers to ensure equitable distribution of basin water

Food resources:

World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

Food Resources:

- Almost entirely from agriculture, animal husbandry and fishing. Although India is self-sufficient in food production, it is only because of modern patterns of agriculture that are unsustainable and which pollute our environment with excessive use of fertilizers and pesticides.
- The FAO defines sustainable agriculture as those which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable.
- Most of our large farms grow single crops (monoculture). If this crop is hit by a pest, the entire crop can be devastated, leaving the farmer with no income during the year. On the other hand, if the farmer uses traditional varieties and grows several different crops, the chance of complete failure is lowered considerably.
- Many studies have shown that one can use alternatives to inorganic fertilizers and pesticides. This is known as Integrated Crop Management.

World food problems:

Our fertile soils are being exploited faster than they can recuperate.

- Forests, grasslands and wetlands have been converted to agricultural use, which has led to serious ecological questions.
- Our fish resources, both marine and inland, show evidence of exhaustion.
- There are great disparities in the availability of nutritious food.

Some communities such as tribal people still face serious food problems leading to malnutrition especially among women and children. These issues bring in new questions as to how demands will be met in future even with a slowing of population growth

Food security, loss of genetic diversity and alternate food sources

(fisheries):

Changes caused by agriculture and overgrazing:

Agriculture has both primary and secondary environmental effects. A primary effect is an effect on the area where the agriculture takes place i.e. on-site effect. A secondary effect, also called an off-site effect, is an effect on an environment away from the agricultural site. The effects of agriculture on the environment can be broadly classified into three groups, viz. global, regional and local:

(1) Global Effects: These include climate changes as well as potentially extensive changes in chemical cycles.

(2) Regional Effects: These generally result from the combined effects of farming practices in the same large region. Regional effects include deforestation, desertification, large scale pollution, increase in sedimentation in major rivers and in the estuaries at the mouths of the rivers and changes in the chemical fertility of soils over large areas. In tropical waters, sediments entering the ocean can destroy coral reefs.

Effects of modern agriculture - Fertilizer Pesticide problems, Water logging, Salinity

Agriculture is an art, science and industry of managing the growth of plants and animals for human use. Agriculture includes preparation of soil for cultivation of crops, harvesting crops, breeding and raising livestock, dairying and forestry. The two major types of agriculture are:

1. Traditional agriculture
2. Modern or Industrialized agriculture

MODERN AGRICULTURE

Modern agriculture makes use of hybrid seeds of single crop variety, technologically advanced equipment, fertilizers, pesticides and water to produce large amounts of single crop.

Problems using fertilizers

1. Micronutrient imbalance
2. Nitrate pollution
3. Eutrophication

WATER LOGGING

If water stands on land for most of the year, it is called water logging. In water logged

conditions, pore-voids in the soil get filled with water and soil-air gets depleted. In such a condition the roots of plants do not get enough air for respiration. Water logging also leads to low mechanical strength of soil and low crop yield.

CAUSES OF WATER LOGGING

1. Excessive water supply to the croplands
2. Heavy rain
3. Poor drainage

MEASURES TO PREVENT WATER LOGGING

1. Avoid and prevent excessive irrigation
2. Sub-surface drainage technology
3. Bio-drainage by trees like Eucalyptus

SALINITY

Water not absorbed by soil, is evaporated leaving behind a thin layer of dissolved salts in the top soil. This is called salinity of the soil. Saline soils are characterized by accumulation of soluble salts like sodium chloride, calcium chloride, magnesium chloride, sodium sulphate, sodium carbonate and sodium bicarbonates. Saline conditions are exhibited when pH is greater than 8.0

PROBLEMS IN SALINITY

Saline soils yield less crop In order to remedy the condition of saline soils the following two techniques may be used:

1. Salt deposit is removed by flushing with good quality water
2. By using a sub-surface drainage system, the salt water is flushed out slowly.

CASE STUDIES

Canal irrigation in Haryana resulted in rising water table followed by water logging and salinity causing low crop productivity thereby huge economic losses. Similarly, the "Indira Gandhi Canal Project" in Rajasthan converted a big area into a "water soaked waste land". In Delhi, accumulation of pesticides and DDT in the body of mothers caused premature deliveries or low birth weight infants. Food centre at Centre for Science and Environment (CSE) India reported Pepsi and Coca-Cola companies sold soft drinks with a pesticide content 30-40 times higher than EU guidelines permit.

Energy resources:

Renewable and non-renewable energy sources –

Energy is broadly classified into two main groups: Renewable and Non-renewable.

Renewable Energy

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

Pros and Cons of Renewable energy:

- The sun, wind, geothermal, ocean energy are available in the abundant quantity and free to use.
- The non-renewable sources of energy that we are using are limited and are bound to expire one day.
- Renewable sources have low carbon emissions, therefore they are considered as green and environment friendly.
- Renewable helps in stimulating the economy and creating job opportunities. The money that is used to build these plants can provide jobs to thousands to millions of people.
- You don't have to rely on any third country for the supply of renewable sources as in case of Non-renewable sources.
- Renewable sources can cost less than consuming the local electrical supply. In the long run, the prices of electricity are expected to soar since they are based on the prices of crude oil, so renewable sources can cut your electricity bills.

Non-Renewable Energy

Non-Renewable energy is the energy which is taken from the sources that are available on the earth in limited quantity and will vanish fifty-sixty years from now. Non-renewable sources are not environmental friendly and can have serious affect on our health.

USE OF ALTERNATE RENEWABLE ENERGY SOURCES

1. Solar energy is renewable and does not cause environmental pollution
2. Energy sources that create minimum pollution, are safe not prone to security threats and have universal availability have the best chance of large-scale utilization in future.
3. Hydro-electric power generation is expected to the existing ecological balance.
4. Apart from generating heat, hydel power plants critically endanger aquatic and terrestrial biotic.
5. Radioactive pollutants released from nuclear plants are chronically hazardous. Commissioning of Boiling Water Power Reactors (BWRs) result in accumulation of large number of radionuclides in water
6. Dangerous radioactive waste cannot be buried in/land without the risk of polluting soil and underground water. The waste cannot be dumped in rivers as it poisons aquatic life and human beings.

7. Burning of coal, oil, wood, dung cakes and petroleum products have well established environmental problems. The smoke produced causes respiratory and digestive problems leading to lung, stomach and eye diseases.

CASE STUDIES

Wind energy India is generating 1200 MW electricity using wind energy. The largest wind farm is in Kanyakumari in Tamil Nadu, which generates 380 MW electricity. Hydrogen-Fuel cell car General motor company of China invented experimental cars that run on electric motors fuelled by hydrogen and oxygen. These cars produce no emission and the only waste products being water droplets and water vapour. Commonly known alternative energy sources.

LAND RESOURCES

- In India, land is generally called as “MOTHER LAND”. It is because of our life depend on it for food, fibre , fuel and other basic amenities. Therefore, it is the valuable gift of nature to human beings. Top layer of the land is called soil, which is renewable resource and essential for survival of life.
- Land available for cultivation is approximately 14 million hectares. But it is reducing day by day. It is due to mismanagement. The earth is made up of three principal layers cores, mantle and crust. Cores are inner most fluid layers.
- Land is classified in to 9 categories .
They are (i) forests,
(ii) land put to non-agricultural use
(iii) barren land unculturable land
(iv) permanent pastures and other grazing lands
(v) misc. tree crops and groves
(vi) culturable waste
(vii) fallow land
(viii) current fallow
(ix) net area sown.

LAND SUITABLE FOR CULTIVATION AND OTHER USES :

- There are four class of land which are suitable for cultivation and other purposes. Their details & limitations are as
- Soils in class I have very few or no limitations that restrict their use.
- This type of land is nearly level and the erosion hazard is low.
- soils are deep, well-drained, easily worked, hold water well and are either fairly well supplied with plant nutrients or are highly responsive to the application of fertilizers. The soils are not subject to damage because of overflow.
- Soils in this class are suited to a wide range of plants, may be used for cultivated crops, pastures, forests and wild life, food and cover.

The limitations of soils in class II may result from the effects of one or more of the following factors : (i) a gentle slope,

(ii) a slight susceptibility to erosion,

(iii) less than ideal soil depth,

(iv) occasional damaging overflow,

(v) wetness which can be corrected by drainage, but existing permanently as a moderate limitation, (vi) slight to moderate salinity or sodium, easily corrected but likely to re-occur, and

(vii) a slight climatic limitation on soil use and management.

Limitations of soils in class III may result from the effects of one or more of the following factors :

(i) moderately sloping land.

(ii) moderately susceptible to water or wind erosion.

(iii) frequent overflow accompanied with some crop damage,

(iv) very slow permeability of the subsoil,

(v) wetness or continuing water-logging after drainage,

(vi) shallow soil depth up to the bedrock, hard-pan or clay-pan which limits the rooting-zone and the water storage,

(vii) low moisture holding capacity,

(viii) moderate salinity or sodium, and

(ix) moderate climatic limitation.

The soils can be used for raising cultivated crops, pastures, forests and wild-life food and cover.

The use of these soils for cultivated crops is limited as a result of the effect of one or more permanent features, such as

(i) steep slopes,

(ii) severe susceptibility to water and wind erosion,

(iii) severe effect of past erosion,

(iv) frequent over-flow accompanied with severe crop damage,

(v) excessive wetness with a continuing hazard of water-logging after drainage,

(vi) severe salinity or sodium, and

(vii) moderately adverse climate.

These soils can be used for crops, pastures, forests and wild life food and cover.

LAND DEGRADATION

- The total land under agricultural use is around 58.4% i.e. grossed cropped area is 167.41 million hectares. The land not fit for cultivation i.e. barren land is around 9.9%. The area under forest is 21.6%, but it needs to be raised.
- land resources are the precious resources. Food security depend on conservation and proper utilization of all resources.
- Due to use and over exploitation land resources are degraded. It is due to the more & more pressure with increasing population.
- Land degradation is a real alarm. Because soil formation is a very slow process. In millions of years we have a layer crust of fertile soil. In general, formation of 1.0 cm soil crust from parent material take 300 - 400 years.

- Fertile soil have high percentage of organic matter vis-a-vis microorganisms. Each gram of fertile soil have 30 billion micro-organisms.

Significance of the problem :

- In India, green revolution brought about technological breakthrough, which led to the use of short duration high yielding varieties helping intense use of land in a year, increasing area brought under irrigation and more use of Chemicals such as fertilizers and pesticides.
- India, being vastly agriculture oriented. Development of agriculture would lead to overall development of the nation and help eradication of poverty.
- It has been of late recognised that the increasing efforts to raise agricultural growth has cost us clearly in the form of land & water degradation

LANDSLIDES

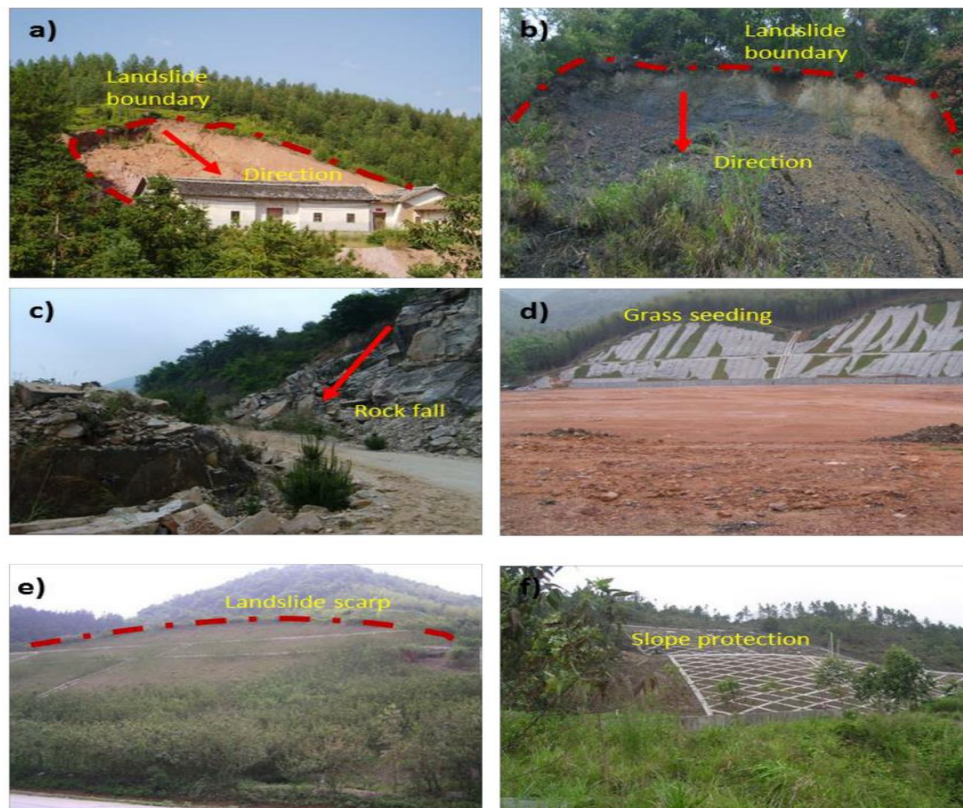
A landslide is a sudden collapse of a large mass of hillside. There are many different types of landslides where not only earth, but rock, mud, and debris flow down the side of a slope. Since the beginning of the monsoon season in June India has been hit by heavy rains and landslides affecting in particular, Arunachal Pradesh, Assam, and Bihar states

Landslides mostly occur

1. Where landslides have occurred before.
2. On steep slopes.
3. On benches.
4. Where drainage is causing a problem.
5. Where certain geologic conditions exists.

Types of landslides

1. Shallow, disrupted landslide-Example of this type is the Santa Susana Mountains and the mountains north of the Santa Clara River Valley. Here more than 75% of the slope area was denuded by landslides triggered by strong shaking,
2. Deep. Coherent Landslides. These triggered by the earthquake were far less numerous than disrupted slides, they contributed significantly to the total volume of landslide material because they tended to be much larger. Some of these landslides are



Man induces land slides:

Man can also cause slides by mining the earth, underground draining groundwater levels or overdeveloping hillsides. Man induced landslides are generally done for the development purposes i.e. industrial, forming roads, agricultural use, homes, etc. They use heavy explosives for that. In this case no serious casualties or damage occur because proper warned earlier to shift in safer places. affected

Effects :

No heavy damage occur in man induced landslides but thousands of and killed due to landslides. Many houses can be damaged and the loss of public properties is also noticed. Roads and rail communication may remain cut off from rest of the regions. Thunder storms cause debris flows on hill slopes leading to deposits of mud. Heavy rains at the same time may worsen the situation.

Soil erosion:

Soil erosion means the removal of material from the surface of the soil by the agency of running water, wind or even by gravity. Since the superficial layers of the soil are the richest in plant valuable plant nutrients and if it becomes sufficiently intense, may lead to the complete destruction of the soil as the seat of plant growth.

- Normal or geologic erosion. Geologic erosion takes place steadily but so slowly that ages are required for it to make any marked alteration in the major features of the earth's surface. There is always an equilibrium between the removal and formation of soil, so that unless the equilibrium is disturbed by some outside agency, the mature soil preserves, more or less, a constant depth and character indefinitely.
- Accelerated soil erosion. The removal of the surface soil from areas denuded of their natural protective cover as a result of human and animal interference takes place at a much faster rate than that at which it is built up by the soil-forming processes.
- Wind erosion. Wind erosion takes place normally in arid and semi-arid areas devoid of vegetation, where the wind velocity is high.
- The soil particles on the land surface are lifted and blown off as dust-storms. When the velocity of the dust-bearing winds is retarded, coarser soil particles are deposited in the form of dunes and thus fertile lands are rendered unfit for cultivation.
- Sheet erosion. Sheet erosion removes a thin covering of soil from large areas, often from entire fields, more or less, uniformly during every rain which produces a run-off.
- Rill erosion. When sheet erosion is allowed to continue unchecked, the silt-laden run-off forms a well-defined, but minute finger-shaped grooves over the entire field. Such thin channelling is known as rill erosion.
- Gully erosion. When rill erosion is neglected, the tiny grooves develop into wider and deeper channels, which may assume a huge size. This is called 'gully' erosion.

DESERTIFICATION

- Desertification is a process by which productive potential of arid or semiarid land falls. The decrease in productivity varies from 10%-50%. Thus, desertification leads to the conversion of irrigated crop land to desert (where productivity is minimum).
- It is characterized by the loss of vegetation cover, depletion of ground water, salinization and soil erosion.
- Drought in three consecutive years in Central India in recent years has accelerated the process of wind erosion and desertification.
- In Rajasthan and Kutch-Saurashtra area, extension in the area of desert is assuming serious proportion. Climatic change and anthropogenic activities are also responsible for desertification.
- During last so many years large area has been destroyed (agriculture land) by Sahara Desert. In India, also, so many places have been affected by desertification.
- Deforestation is also one of the causes of desertification. The increasing cattle population heavily graze in grasslands or forests and denude the land area, which is not suitable for seed germinations. Thus, overgrazing is also one of the causes for desertification.

Role of an individual in conservation of Natural resources :

- Planning of a suitable strategy for the conservation of our natural resources and most judicious execution of planned strategies is called as Conservation Management.
- Environmental planning, evaluation, monitoring, and impact assessment are methods of conservation management. The Indian philosophy of conservation is to keep “Harmony with Nature”.

1. People should at once stop the over utilization of natural resources instead they must be properly used.
2. Instead of deforestation, representation should keep in mind. We should take help from the Govt. for plantation programmes. Everybody should take part in plantation and care the plants.
3. We should protect wildlife. Though hunting is not allowed even then the persons are doing so. For these educated young should teach the lesson of wild life act.
4. Mixed cropping, crop rotation, and proper use of fertilizer insecticide, pesticides should be taught to farmers. Encourage the use of manures, biofertilizers organic fertilizers.
5. We should make habit for waste disposal, compose and to restore biodiversity.
6. Try to educate local people for the protection and judicious use of natural resources.
7. We should use light, fans and other domestic appliances when it is needed.
8. Maintain a balance between resources and human needs.
9. Maintain the essential ecological processes and the life support systems.
10. Install rain water harvesting system in houses, colonies.

We know “collecting drop-drop-drops form a big ocean”, similarly if each of us will aware about the judicious use of natural resources, all of us will conserve the nature.

Equitable use of resources for sustainable life Style:

- The equal distribution of natural resources should be for all irrespective of rich or poor. There must be balance between the need and consumption particularly for drinking water, food, fuel etc.
- The developed countries are utilizing more resources as compared to developing countries. This imbalance is responsible for rich become richer and poor gone poorer.
- This is due to sharp increase in population in developing countries. But it does not mean that people of developed countries are rich and having good life style, and less developed countries people are poor.
- Less developed countries also have rich and poor both but facing the problem of population and available natural resources.
- Developed countries like USA, Canada, Japan, Australia etc. have 22% of world's population utilising 86% of natural resources. Thus it is needed to divert the resources to poor countries to narrow down the gap between the two.

- To achieve sustainable life style, there should be equal distribution of global resources and income to meet everyone's need. But in the long process of economic development only the powerful and strong people exploited most of the environmental resources even at the cost of migration of poor people already using those resources.

Unit 3: Systems

CONCEPT OF ECOSYSTEM

Now, we can say Ecology deals with interrelationships between the biotic and abiotic compounds of an Ecosystem. The term ecosystem was first coined by A.G. Tausley 1935. It is derived by two words "eco" means environment and 'system' implies a complex of co-ordinated units.

An ecosystem concept is that the living organisms of a community not only interact among themselves but also have functional relationship with their non-living environment. This structural and functional system of communities and their environment is called an ecosystem.

FUNCTIONING AND TYPES OF ECOSYSTEMS

Depending upon the species, diversity and the manner in which they are organised, are of following types

1. Permanent and Natural ecosystem. These operate under natural conditions without any interference (even by human beings). These can be further classified in to

(i) Terrestrial ecosystem (ii) Aquatic ecosystem

Terrestrial ecosystems operate on land hence Forest, Desert and grassland and Agro-ecosystem included in this type. While Aquatic ecosystem operates in water. It can be divided in two

(a) Fresh water ecosystem

(b) Marine ecosystem

Freshwater ecosystems are usually named after the size and nature of the fresh water body such as pond, lake & river.

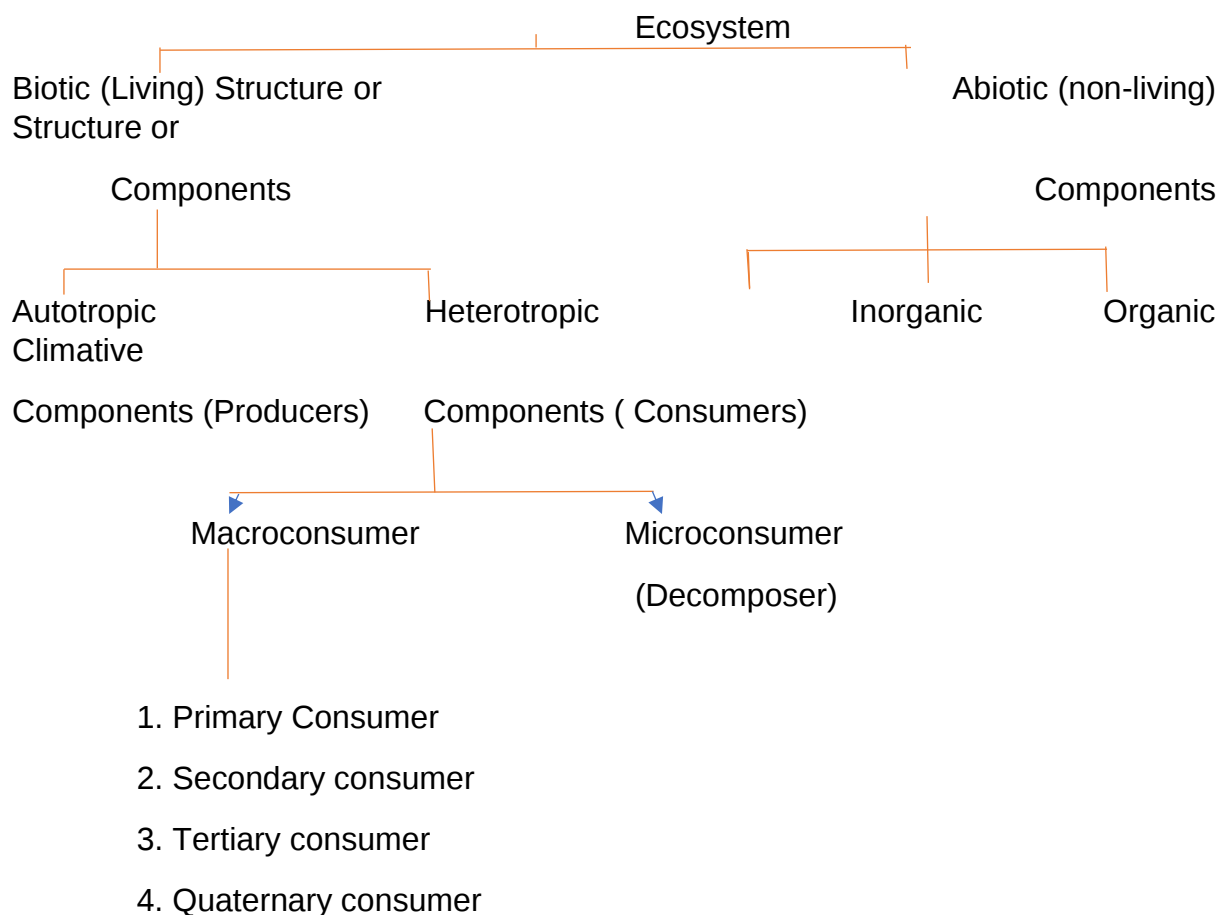
Marine ecosystem is largest ecosystem on earth, which consists of several subdivisions each having its physico-chemical and Biological characteristics. For example, in the deepest ocean producers are absent but in many other organisms survive which dependent for food on the dead organic matter coming from the upper layers of the ocean.

2. Temporary and Natural ecosystems. These are short lived but operate under natural conditions.

3. Artificial or Anthropogenic ecosystems. These are man-made like fishery tanks dams, croplands and space ecosystems also. Fish aquarium is also come under this head.

STRUCTURE OF AN ECOSYSTEM

It is a description of the species of organisms that are present (including information on their life histories, populations and distribution in space). The structure of ecosystem provides information about the range of climatic conditions that prevail in the area, composition and organization of Biological Communities and Abiotic compounds constitute the structure of an ecosystem. According to Odum, from the trophic (Food) point of view, an ecosystem has the following components:



1. Biotic Structure.

Producers, consumers and decomposers are components of biotic ecosystem. Living organisms exchange, expel, convert, assemble, disassembles, organise and otherwise manipulate the constituents of earth, air and water. Biotic structure includes plants, animals and microorganisms present in an ecosystem. We have identified producers, decomposers and consumers are the basic components of biotic ecosystem. These can be distinguished on the bases of their source of energy and material

(a) Autotrophic components (Autotrophic = self nourishing)

In which the fixation of light, energy, the use of simple inorganic substances and manufacture of complex material predominates. These are also called producers.

(b) Heterotrophic Components (Heterotrophic = other nourishing)

These utilize, rearrange and decompose the complex materials synthesized by the autotrophs. The most intense heterotrophic activity takes place where the organic matter accumulates in the soils and sediments. These are also called consumers.

PRODUCERS

All green plants are producers. They are also called "converters" or "transformers". They are living members of the ecosystem that utilize sunlight as their energy source and simple inorganic rich chemicals as their own food. Producers are largely photosynthetic plants and their kind varies with the kind of ecosystem. In dense forest the trees are the most important producers. In lakes and ponds, the producers are rooted or large floating and microscopic plants (phytoplankton) usually the algae.

CONSUMERS

As we have seen earlier, consumers are heterotrophs, the living organisms which ingest other organisms. They derive their food directly or indirectly from the producers. The food is then digested i.e. broken down to simple substances which are metabolized in the consumer's body and released the waste product to the environment. Consumers are of following types---

(1) PRIMARY CONSUMERS- These are also called 'HERBIVORES' which feed directly on the producers. They vary with the kind of ecosystem. For example a deer and giraffe is a primary consumer in forest ecosystem, while cow or a goat is in a grassland or crop ecosystem. Protozoans and certain crustaceans which feed on floating algae are also primary consumers.

(ii) SECONDARY CONSUMERS- They are also called "CARNIVORES" (meat eaters). For example insects, gamefish in a pond eat primary consumers.

(iii) TERTIARY CONSUMERS. - In most of ecosystem some organism that eat other carnivores like they are tertiary consumers.

(iv) OMNIVORE-- A person or animal eating plants and animals is called omnivores.

(v) TOP CARNIVORES- Some ecosystem have animals like lion and vulture, which are not killed or rarely killed and eaten by other animals are called top carnivores.

(vi) DETRITIVORES- These are the bottom living which subsist on the rain of organic detritus from autotrophic layers e.g. beetles, termites, ants, crabs etc.

3. DECOMPOSERS- They are also the living components, mainly bacteria and fungi which breakdown complex compounds of dead protoplasm of producers and consumers to simple organic compounds and ultimately into inorganic nutrients. In all the ecosystems, this biotic structure prevails.

2. ABIOTIC STRUCTURES OR COMPONENTS. - The physical and chemical components of an ecosystem constitute its abiotic structure. It includes two things

(i) MATERIALS OR CHEMICAL FACTOR-The materials are like water, minerals, atmospheric gases and other inorganic salts. They also include some organic matter such as amino acids, decay products, lipids, carbohydrates, proteins etc. The quantity of abiotic materials like the minerals present at any given time in an ecosystem is termed as the 'standing state' or 'standing crop'.

(ii) ENERGY OR PHYSICAL FACTOR. This is in the form of light, heat and stored energy in chemical bonds. Annual rainfall, wind latitude and altitude etc. are also some physical factors, which have a strong influence on ecosystem. For proper functioning of an ecosystem there must be a continuous 'flow of energy' and 'cycling of minerals' among the organisms of the ecosystem.

ENERGY FLOW IN THE ECOSYSTEM

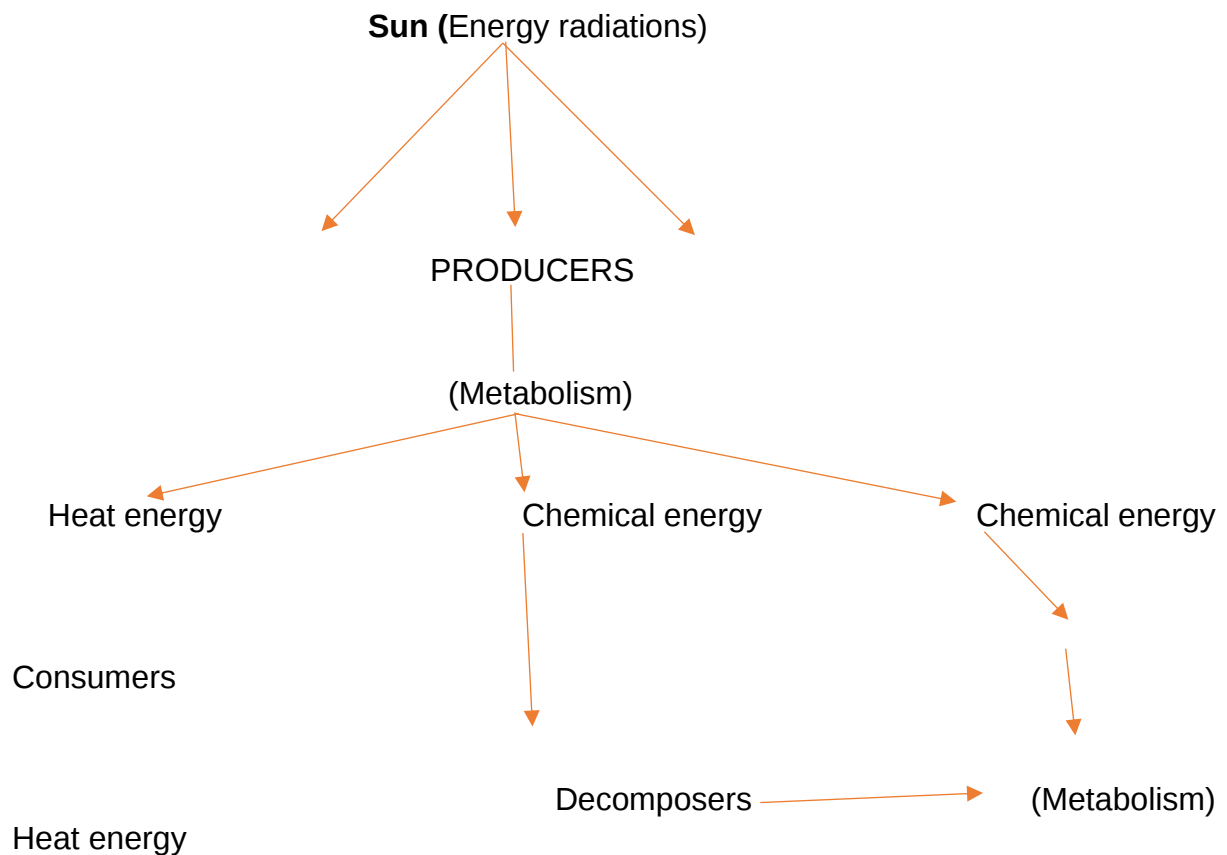
Energy is needed for every biological activity. Solar energy is transformed in to chemical energy by a process of photosynthesis. This energy is stored in plant tissue and then transformed in to mechanical and heat form during metabolic activities.

The flow of energy follows the two laws of thermodynamics.

1st law of thermodynamics: The law states that energy can neither be created nor be destroyed but it can be transformed from one form to another. Similarly , as we have read earlier Solar energy utilized by green plants in photosynthesis converted in to biochemical energy of plants and later in to that of consumers.

2nd law of thermodynamics. The law states that energy transformation involves degradation or dissipation of energy from a concentrated to a dispersed form. We have seen dissipation of energy occurs at every trophic level. There is loss of 90% energy, only 10% is transferred from one trophic level to the other.

SUN AS THE SOURCE OF ENERGY. Sun is the source of energy which extends radiations from high frequency to low frequency. Approximately 99% of total energy is in the region between UV and IR. The visible spectrum spreads over 0.38 μ to 0.77 μ involving about 50% of solar p radiations. Some autotrophs however utilize energy released from oxidation processes for the synthesis of organic food.



ENERGY FLOW MODELS

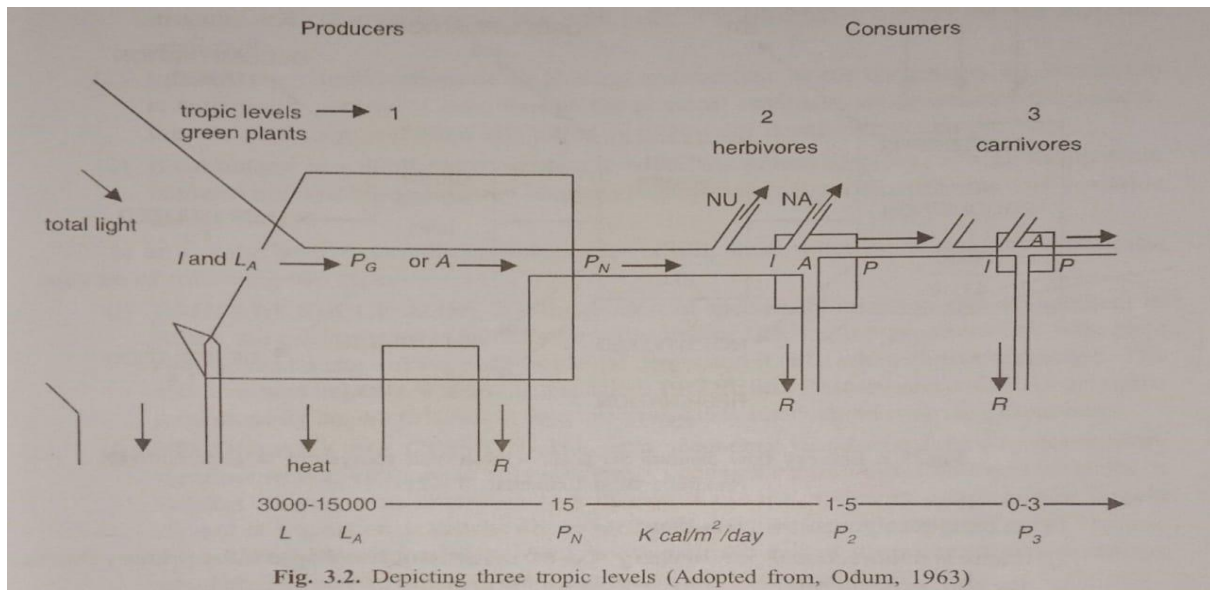
As we have seen that there is unidirectional flow of energy from sun to the producers and then various types of consumers. Therefore, behaviour of energy in ecosystem can be termed Energy flow. About 34% of the sunlight reaching the atmosphere is reflected back in to its atmosphere . 10% is held by ozone layer, water vapours and other atmospheric gases. Rest 56% reaches the earth surface. Out of this 1-5% is used by green plants for photosynthesis.



Rest is absorbed as heat by ground vegetation or water. The flow of energy in an ecosystem can be explained with the help of various energy flow models.

1. ODUM'S ENERGY FLOW MODEL

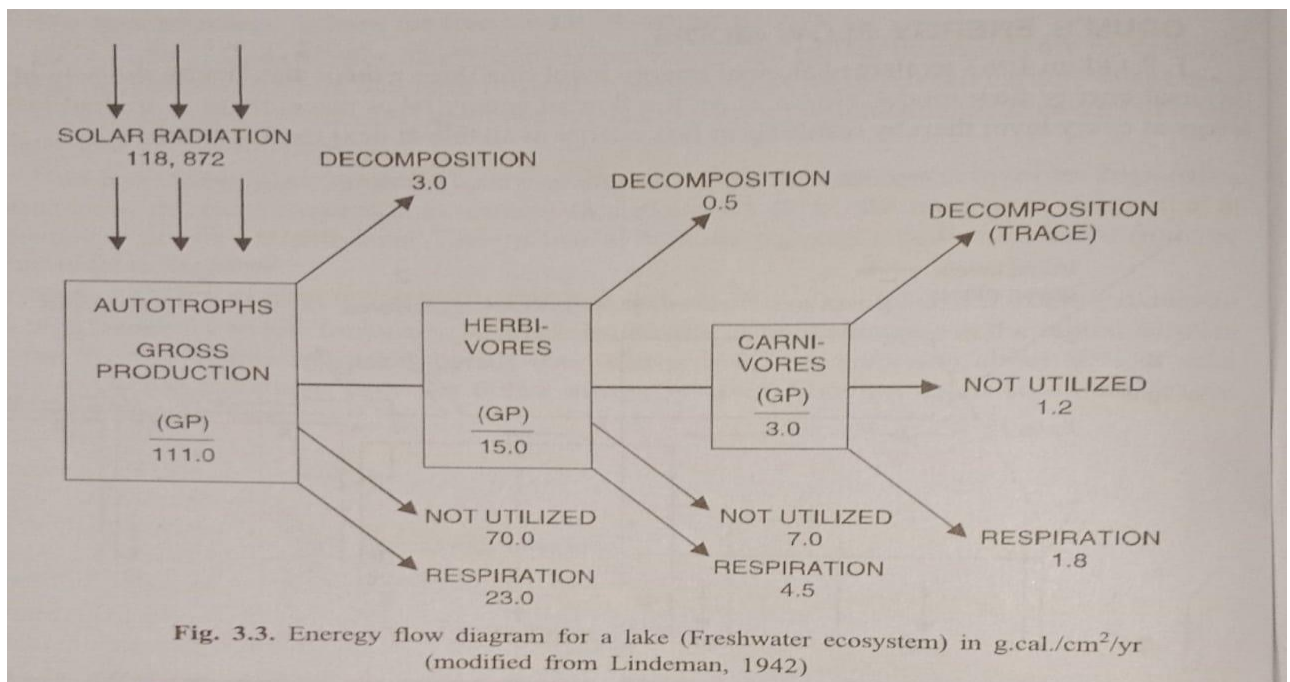
E.P. Odum 1963 explained flow of energy involving three trophic levels with the help of his universal energy flow model. As the flow of energy takes place, there is gradual loss of energy at every level thereby resulting in less energy available at next trophic level.



Out of total 3000 K Cal of light falling (L) on producers level, only 50% i.e. 1500 KCal is absorbed by autotrophs with an efficiency of energy capture is only 0.1 - 1%. As reported 21% of this energy is consumed in metabolic reactions of autotrophs for their growth, development, maintenance and reproduction. Thus gradual decline in energy at the second trophic level i.e. herbivores and then at third trophic level i.e. carnivores in grazing food chain is observed.

2. LINDEMAN'S ENERGY FLOW MODEL

Lindeman in 1942 gave the unidirectional energy flow model of fresh water ecosystem. Model shows that out of total 118,872 g.cal/cm²/year incident solar radiations, producers can utilize only 1% (111.0 g cal/cm²/year) in their photosynthesis.



- About 21% of this gross production (GP) is utilized in metabolic functions of producers, 3% is utilized in decomposition and 63% remains unutilized in decomposition and 63% remains unutilized.
- Thus only 13-14% i.e. 15 g.cal/ cm²/year of GP is available to herbivores. At this level about 30% of it (i.e.15 g.cal/cm²/year) is utilized in metabolic functions i.e. respiration, growth and reproduction etc.
- This is more than the autotrophs consumed i.e. 21%. Again 3% of it is utilized in decomposition while 47% is remains un-utilized. Thus only 20% energy of the autotrophs is available (i.e. 3 g.cal/cm²/year) to carnivorous.
- It is also reported that about 70% energy is available for carnivores, which is not utilized and only 28-6% of net production passes to carnivorous. Carnivores utilized 60% energy at this level in metabolic activities and rest is remains as un-utilized.

From both the figures it is clear that

1. There is unidirectional flow of energy i.e. the system would collapse if the primary source, the sun were cut off.
2. Progressive decrease in energy at each trophic level.
3. There is also a corresponding decrease in biomass. But there is no correlation between biomass and energy. This relationship may differ according to situations.

ECOLOGICAL SUCCESSION

Succession is the "birth" of an ecosystem, and subsequent "aging process of its abiotic and biotic features. ODUM (1971) has rightly included the following three parameters in his definition of ecological succession.

- (1) It is an orderly process of community development that involves changes in species structure and community processes with time, it is reasonably directional and therefore predictable.
- (2) It results from modifications of the physical environment by the community, i.e. succession is community controlled even though the physical environment determines the pattern, the rate of change and often sets limits as to how far development can go.
- (3) It culminates in a stabilized ecosystem in which maximum biomass (or high information content) and symbiotic function between organisms are maintained per unit of available energy flow.

In any of the basic environments such as terrestrial, fresh water or marine, the succession may be of following two types

- (i) PRIMARY SUCCESSION. It is the process of species colonization and replacement in which the environment is initially virtually free of life, i.e. the process starts with bare rock or sand dune or river delta or glacial debris and it ends when climax is reached. The series involved in primary succession is called PRESERE. Primary succession

occurs when a community begins to develop on a site previously unoccupied by living organisms.

(ii) **SECONDARY SUCCESSION.** The term secondary succession refers to community development on locations or sites previously occupied by well developed communities. It occurs where a community has been disrupted and the surface is completely or largely devoid of vegetation. It may be due to earthquake, fire or even clearing of forests by man. In each case organisms modify the environment in a way that allows one species to replace another. The series involved in secondary succession is called **SERIES**.

Depending on the moisture contents, the primary and secondary successions may be of the following types

(A) **HYDRACH** or **HYDROSERE**. The succession when starts in the aquatic environment such as ponds, lake, streams, swamps, bogs etc.

(B) **MESARCH** OR **MESOSERE**. It is an intermediate type with adequate moisture. The succession when begins in such an area is called mesarch.

(C) **XERACH** OR **XEROSERE**. The succession when starts in Xeric or dry habitat having minimum amounts of moisture, such as rocks, dry deserts etc is called xerach. A temporary community in an ecological succession on dry and sterile habitat is called Xerosere. It may be of three types

(i) **LITHOSERE**. i.e. succession initiating on rocks.

(ii) **PSAMMOSERE**. i.e. succession initiating on sand.

(iii) **HALOSERE**. i.e. succession initiating on saline water or soil.

Some times succession is also classified into two on the basis of community metabolism.

(a) **AUTOTROPHIC SUCCESSION.** It is characterised by early and continued dominance of autotrophic organisms like green plants. It begins in a predominantly inorganic environment and the energy flow is maintained indefinitely.

(b) **HETEROTROPHIC SUCCESSION.** It is characterised by early dominance of heterotrophs such as bacteria, actinomycetes, fungi and animals. It begins in a organic environment and there is a progressive decline in energy content.

GENERAL PROCESS OF SUCCESSION

The complete process of a primary autotrophic ecological succession involves the following sequential steps which follow one another.

1. NUDATION. The process of succession begins with the formation of a base area or nudation by several reasons such as volcanic eruption, flood, landslide, erosion deposition, fire, disease etc. Some base areas are also created by man e.g. walls, burning, digging etc.

2. INVASION. The invasion is the arrival of the reproductive bodies or propagules of various organisms and their settlement in the new or base area. Plants are the first invaders (pioneers) in any area because the animals depend on them for food. It includes the three steps

(1) Dispersal or migration. It is the process in which propagule leaves the parent plant and arrives the bare area. The seeds, spores or other propagule of the species reach the bare area through the agency of air, water or animals.

(ii) ECESIS. This is the successful establishment of migrated plant species in to new area. It includes germination of seeds, growth of seedlings and starting of reproduction.

(iii) AGGREGATION. This is the final stage of invasion where immigrant species increase their number by reproduction and aggregate in a large population in the area.

3. COMPETITION. As the number of individuals grows, there is competition both interspecific (between different species) and intra specific (within the same species) for space, water and nutrition. They influence each other in a number of ways known as COACTION.

4. REACTION. When living organism grow, use water and nutrients from the substratum in turn they have a strong influence on the environment which is modified to a large extent and known as reaction. When they become unsuitable for the existing species, favour some new one, which replace them. Thus, reaction leads to several seral communities.

5. STABILIZATION OR CLIMAX. Eventually a stage is reached when a final terminal community becomes more or less stabilised for a longer period of time and it can maintain itself in the equilibrium or steady state with climate of that area. This last seral stage is mature, self maintaining, self reproducing through development stages and relatively permanent. This final stable community of the sere is the CLIMAX COMMUNITY and the vegetation supporting it is the CLIMAX VEGETATION.

FOOD CHAINS

- Small herbivorous organisms such as Caterpillars field mice etc. Consume this 'vegetable material and convert it to animal material, which serve as food to meat eating animals. They are eaten by larger carnivores.
- This sequence of eating and being eaten, with the resultant transfer of energy is known as FOOD CHAIN.
- Thus in food chains organisms of an ecosystem are linked together. Each step is known as trophic level and the study of the energy flow through these steps is called trophic ecology. Food chains are not isolated from each other.
- Primary producers trap radiant energy of sun and transfer that to chemical or potential energy of organic compounds such as carbohydrates proteins and fats.
- When herbivore eats a plant and these compounds are oxidised. As we have read earlier the energy liberated is just equal to the amount of energy used in synthesizing the substances. When this animal is eaten by another one, along

with transfer of energy from a herbivore to carnivore a further decrease in energy occurs as the carnivore oxidise the organic substances for the first to liberate energy to synthesize its own cellular constituents. Such transfer of energy from organism to organism sustains the ecosystem.

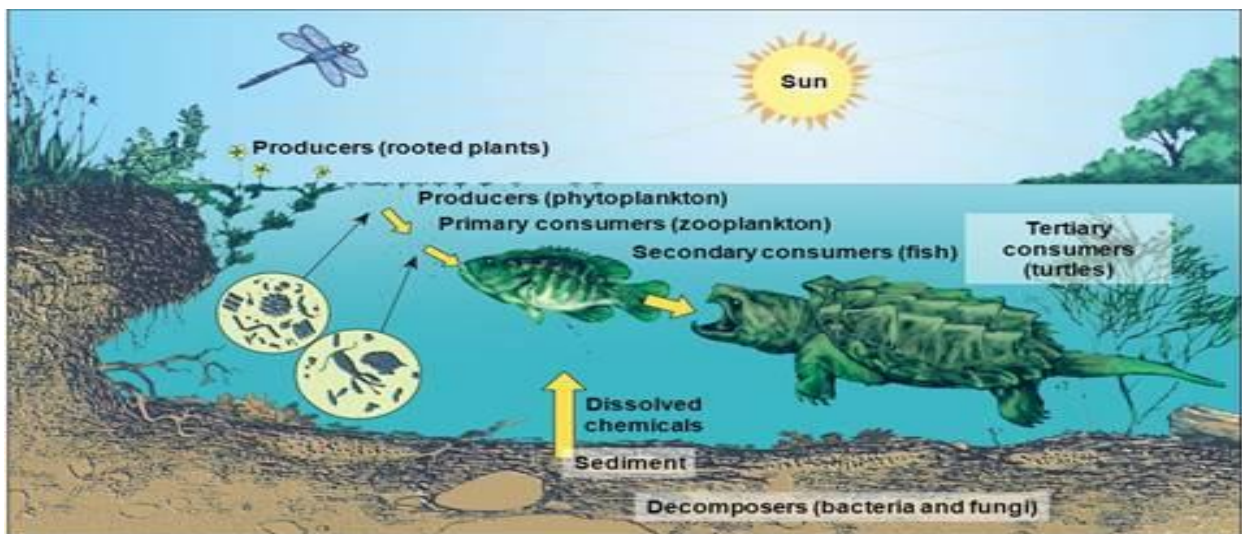
- The energy flows from primary producer to primary consumers, from primary consumer to secondary consumers and from secondary consumer to tertiary consumers and so on . This simple chain of eating and being eaten away is known as food chain.

Examples of food chains are :

1. Grass → Rabbit→ Fox→ Wolf→ Lion. (Grass land ecosystem)



2. Phytoplankton → Water fleas → Small fish → Tuna . (Pond ecosystem)



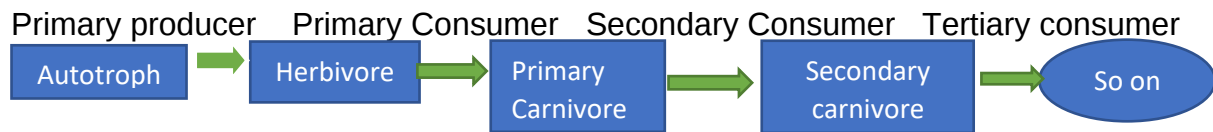
3. Litchens → Reinder → Man. (Arctic tundra)

In nature we can distinguish two types of food chains.

1.GRAZING FOOD CHAIN

This type of food chain starts from green plants and ends carnivores by passing through herbivores. The primary carnivores or secondary consumers eat herbivores or primary consumers of the ecosystem. And likewise, secondary carnivores or tertiary consumers eat primary carnivores. The total energy assimilated by primary carnivores or gross tertiary production and its disposition in to respiration, decay and further

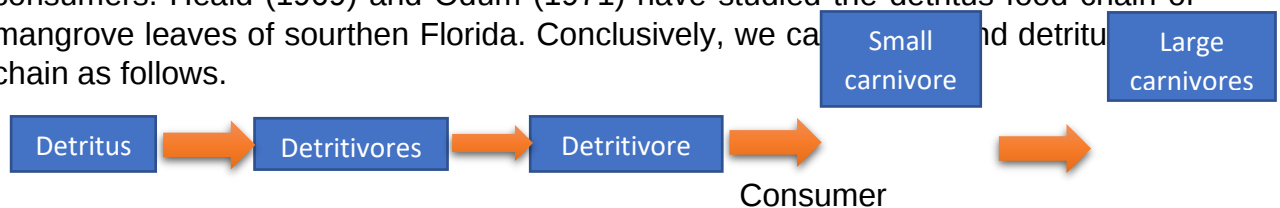
consumption by other carnivores is entirely analogous with that of herbivores. Thus much of the energy flow in these chains can be described as follows



DETRITUS FOOD CHAIN

The term detritus is given to organic wastes, exudates and dead matter derived from grazing food chain. The energy contained in this detritus is not lost to the ecosystem as a whole, rather it serves as the source of energy for a group of organisms (Detritivores), they differ from grazing food chain called the detritus food chain. Such food chains operates in the decomposing accumulated litter in a temperate forest.

In some ecosystems, considerably more energy flows through the detritus food chains than through the grazing food chains. The organisms of the detritus food chains are, algae, bacteria, slime molds, fungi, actinomycetes protozoa, insects, mites, crustaceans, molluscs worms, nematodes etc. Some species are highly specific in their food requirements and some can eat almost anything. All these are detritus consumers. Heald (1969) and Odum (1971) have studied the detritus food chain of mangrove leaves of southern Florida. Conclusively, we can say that the detritus food chain as follows.



FOOD WEBS

In nature simple food chain occur rarely. The same organism may operate in the ecosystem at more than one trophic level i.e. it may derive its food from more than one source. organism may be eaten by several organisms of a higher trophic level or an organism may feed upon several different organisms of lower trophic level. In this way individual food chains interconnect to form a complex network with several linkages and are known as food web. Thus food web is defined as —"**A network of food chains where different types of organisms connected at different trophic levels, so that there are a number of options of eating and being eaten at each trophic level.**"

The following five types of food chains are interconnected to form food web in this figure.

- (1) Grass → Grasshopper → Predatory bird (Hawk)
- (2) Grass → Grasshopper → Lizard → Hawk.
- (3) Grass → Rabbit Hawk (or vulture or man)
- (4) Grass → Mouse/Rat → Hawk
- (5) Grass → Mouse/Rat → Snake + Hawk.

This shows, food chains in natural conditions never operate as isolated sequences but are interconnected with each other forming some sort of interlocking pattern .

ECOLOGICAL PYRAMIDS

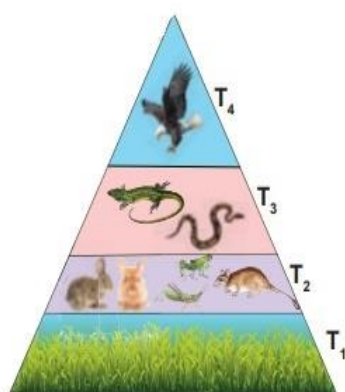
Charles Elton in 1927, noted that the animals at the base of the food chain are relatively abundant, while those at the end are relatively few in number i.e. there is progressively decrease in between the two extremes. Secondly, there is some sort of relationship between the numbers, biomass and energy content of the primary producers, consumers of the first and second orders and so on to top, Carnivores in any ecosystem.

Ecological pyramids are of three general types

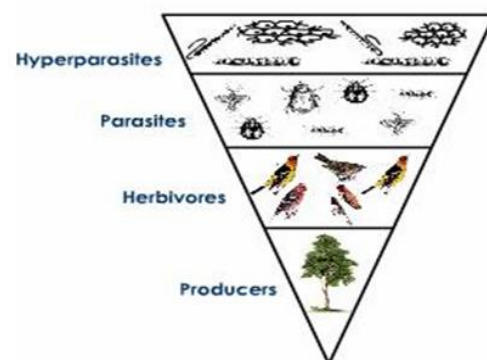
1. Pyramid of numbers - (Based on number of organisms at each level.)
2. Pyramid of Biomass - (Based on biomass of organisms)
3. Pyramid of energy - (Showing the rate of energy flow and/or productivity at successive trophic levels.)

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

- 1. Pyramid of numbers.** This deals with the relationship between the number of producers, herbivores and carnivores at successive trophic levels. At the base of such figure (pyramid) is always the number of primary producers and the subsequent structures on this base are represented by the number of consumers at successive levels. a grassland ecosystem, the producers which are mainly grasses are always many in number. This number then shows a decrease towards apex, as the primary consumers or herbivores like rabbits are less in



Pyramid of numbers
in grassland ecosystem



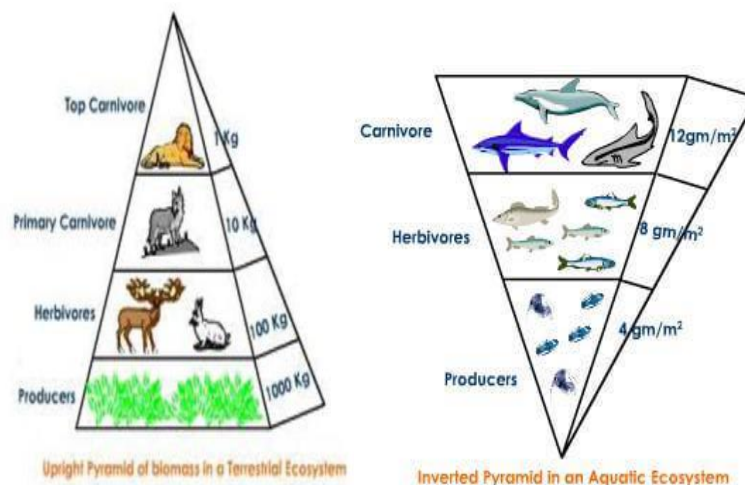
Inverted pyramid of number

(Upright pyramid)

number than the grasses. The secondary consumers are lesser in number than primary consumers. Finally the top consumers (tertiary) like hawks or other animals

are least in number. Thus the pyramid becomes upright. In a pond ecosystem, the pyramid is also upright.

2. Pyramid of Biomass. Pyramid of numbers of biomass is given where the weight of primary producers forms the base. The ecosystem, where the pyramid of biomass is upright. The biomass of one tree is very high. The biomass of a number of birds feeding upon the tree is far less than that of the tree. Similarly, the biomass of even a very large number of parasite in and on the body of the birds is far less.



3. Pyramid of energy

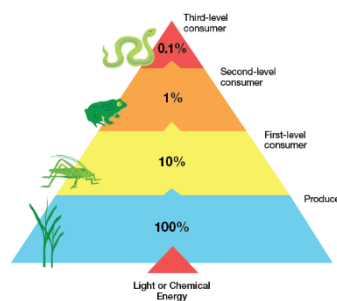
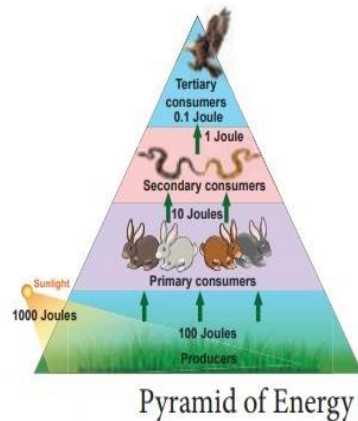


Figure 9. Energy Pyramid

- Generally three types of ecological pyramids, the energy pyramid give the best picture of overall nature of the ecosystem. As against the pyramids of numbers and biomass the shape of the pyramid of energy is always upright, because in this the time factor is always taken in to account.
- The pyramid of energy represent the total quantity of energy utilized by different trophic level organisms of an ecosystem per unit area over a set period of time. The population of phytoplanktons in aquatic ecosystem also complete sets of new generation in every few hours or days.
- The cumulative energy content of these generations of phytoplanktons trap in course of a year is certainly much more than that of only a few

generations of herbivore fishes in the corresponding time and space. The energy content of top carnivores (utilized in one year) is the least.



Therefore, the pyramid of energy is upright. The ratio of the amount of energy absorbed and the amount of energy which would be retained in biomass is known as ecological efficiency.

SOME MAJOR ECOSYSTEMS

There are three types of ecosystems in nature ..

1. Terrestrial ecosystem
2. Freshwater ecosystem
3. Marine ecosystem

A large geographical area with its specific and complex flora and associated fauna is called a biome. The physical factors like, nature of soil, rainfall, temperature, light etc. effects the vegetation of a biome. The ecological characteristics of some major ecosystems are given.

Terrestrial ecosystems

The terrestrial ecosystems may be Latitudinal biome or altitudinal. It consists of

- (i) Forest ecosystem
- (ii) Grassland ecosystem
- (iii) Desert ecosystem

FOREST ECOSYSTEM

Roughly 40% of the land is occupied by forest. But in India it is one-tenth. In India, tropical rain forests are found in Western Ghats, Andamans and North-East Himalayas. So these have maximum bio-diversity. The different components of a forest ecosystem are as:

Abiotic Component : These are the inorganic & organic substances present in the soil & atmosphere. In addition to the minerals present in the forests, we find the dead

organic debris. The light conditions are different due to complex stratification in the plant communities.

Biotic Component: The living organisms present in the food chain occur in the following order

1. Producers. These are mainly trees that show much species diversity and greater degree of stratification specially in tropical moist deciduous forest. In northern coniferous forest needle leaved evergreen tree, specially the spruces, firs and pines are with poor development of shrub and herb layers. Deciduous forest is greatly modified by man and much of it is replaced by cultivated and forest edge communities

2. Consumes. These are as follows

(a) Primary Consumers ; These are the herbivores that include the animals feeding leaves as ants, flies, beetles, leafhoppers bugs, spiders etc. Many of the larger herbivorous vertebrates some animals like elephants, nilgai, deer, moles, flying foxes, fruitbats, mongooses etc. are like moose, snowshoe hare, grouse are found on broad leaved developmental communities. Similarly on shoots and/or fruits. on tree grazing

(b) Secondary Consumers : These are the carnivores like snakes, birds, lizards, fox etc. feeding on herbivores. lion, tiger etc. that eat carnivores

(c) Tertiary Consumers: These are the top carnivores like lion, tiger etc. that eat carnivores of secondary consumers level.

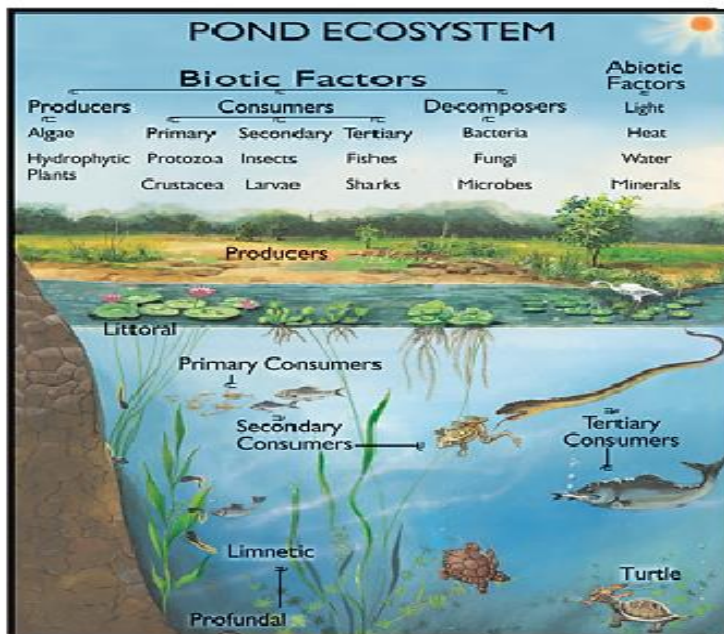
3. Decomposers. These are wide variety of micro-organisms like actinomyces (streptomyces) , bacteria (Bacillus, clostridium, Pseudomonas etc.), Fungi (species of Aspergillus, Coprinus, Polyporus, Fusarium, Trichoderma etc.). Rate of decomposition in tropical and subtropical forests is more rapid than that in the temperate ones.

AQUATIC ECOSYSTEMS

More than 70% of the land is covered by water. The important ecosystems are....

POND ECOSYSTEMS.

Ponds are small bodies of water in which the littoral zone is relatively large and the limnetic and profundal regions are small or absent. Stratification is of minor importance . Ponds may be found in most regions of adequate rainfall . They are continually being formed, as a stream shift position, leaving the former bed isolated as a body of standing water where organic materials are accumulated.



Temporary ponds are dry for part of the year are specially interesting and support a unique community organisms in such ponds must able to survive in a dormant stage during dry period.

Ponds play an important role in the villages where most of the activities like washing clothes, bathing, swimming, cattle bathing etc. are centre around ponds. We may study the pond as an ecosystem.

Abiotic Component. Apart from heat, light the basic inorganic and organic compounds, elements are water, CO₂, oxygen, calcium, nitrogen, phosphorus, amino acids etc. The amount of the minerals present at any time in the physical environment of the pond. "Standing state" may be estimated by appropriate methods. Light intensity and turbidity index of water at different depths can also be measured by lux-photometer and Secchi disc respectively.

Biotic Components They are as follows

1. Producers. These are autotrophic, green plants and bacteria. They fix radiant energy and with the help of minerals from water & mud form complex organic substances like Carbohydrates, proteins & lipids. Producers are of the following types

(a) Macrophytes. These are mainly rooted larger plants which include partly or completely submerged floating and emergent hydrophytes. The common species of the plants are Trapa, Typha, Sagittaria, Nymphaea, Chara, Hydrilla, Utricularia, Marsilea, Azolla, Sylviaia, Spirodella, Lemna etc...

(b) Phytoplankton. These are minute, floating or suspended lower plants like Ulothrix, Spirogyra, Cladophora, Oedogonium, Cosmarium, Eudorina, Pandorina, Volvox, Chlamydomonas etc. and some flagellates. Biomass is estimated as weight of standing crop per unit area or volume. Generally, biomass and energy content of the vegetation decreases from the margin of the pond towards its centre. Energy content is generally expressed in terms of cal/gm dry wt.

2. Consumers. Most of the consumers are herbivores except insects and some large fish. But generally are heterotrophs. In pond consumers are distinguished as

(i) Primary Consumers. These are herbivores, also known as “primary macro consumers” feeding directly on living plants. They may be large or in small size. They are further differentiated as

(a) Benthos. These are the animals associated with living plants labelled as 'a' in fig and those bottom forms which feed upon the plants remains at the bottom labelled as 'b' in fig. Benthic population include fish, insect larvae, mites, molluscs, crustaceans etc. Besides there some animals like cows, buffaloes and birds also visit the pond.

(b) Zooplanktons. These are chiefly the rotifers, (Brachionus, Lecane etc.), protozoans (Euglena, Coleps etc.) and Crustaceans (Cyclops, Stenocypris etc.). They feed on phytoplanktons .

(ii) Secondary Consumers. These are Carnivores like insects and fish which feed on primary consumers (herbivores) like Zooplanktons.

(iii) Tertiary Consumers. These are some large fish feed on smaller fish.

In pond fish may occupy more than one trophic levels.

3. Decomposers. These are microconsumers, which absorb only a fraction of the decomposed matter. They decompose organic matter of both producers as well as microconsumers in simple forms. Thus they play an important role in return of mineral elements again to pond. The bacteria, actinomycetes and fungi (species Aspergillus, Cladosporium, Pythium, Penicillium, Circinella etc.) are most common decomposers in water and mud of the pond.

MARINE (OCEAN) ECOSYSTEM

The marine environment of seas and oceans is large occupying 70% of the earth surface. The volume of the surface area of marine environment lighted by sun is small in comparison to the total volume of water involved.

The biotic components of an ocean are as follows

1. PRODUCERS

These are autotrophs, which are mainly the phytoplanktons. They trap radiant energy from sun through their pigments. A number of macroscopic seaweeds (Brown and red algae) are also come in this category. They are in distinct zones at different depths of water.

2. CONSUMERS

These are heterotrophic macroconsumers being dependent for their nutrition on the primary producers. These are directly on producers

(i) The herbivores like Crustacians, molluscs, fishes etc. which feed are called primary consumers. called secondary.

(ii) The carnivores fishes like shad, herring etc. feeding on herbivores are secondary consumers

(iii) The top carnivores fishes like cod, haddock, halibut etc. that feed on are called tertiary consumers.

3. Decomposers. The microbes active in the decay of dead organic matter are chiefly and some fungi.

ESTUARIES (ESTUARINE ECOLOGY)

Estuarine is derived from the word aestus means tide. Pritchard in enclosed coastal body of water, which has a free connection with the open sea. It is thus strongly affected by tidal action and within it sea water is mixed with fresh water from land drainage. River mouths, coastal bays, tidal marshes and bodies of water behind barrier beaches are examples To illustrate estuaries, the different classifications will be represented based on

- (1) Geomorphology
- (2) Water Circulation and stratification
- (3) Systems energetics.

According to Pritchard 1967, four subdivisions of estuaries are from geomorphological point of view

- (i) Drowned river valleys
- (ii) Fjord type estuaries
- (iii) Bar - built estuaries
- (iv) Estuaries formed by tectonic processes.

River - delta estuaries found at the mouths of large rivers such as Mississippi or the Nile. It is different from former. On hydrographic basis estuaries can be placed in three broad categories.

- (a) Highly stratified or salt wedge estuary.
- (b) The partially mixed or moderately stratified estuary.
- (c) The completely mixed or vertically homogeneous estuary

The Hypersaline estuary is a special type.

Physico Chemical Aspects of Estuaries :

- Current and salinity both are important here. Estuarine currents result from the interaction of a one direction stream flow which varies with the session and rain fall with oscillation ocean tides and with wind. The salinity varies vertically and horizontally and fluctuates amazingly between 0.5 to 0.35%.
- The sessional and tidal cycles causes changes in nutrient concentration in the estuary. Any how, all estuaries have high productivity.
- The concentration of nutrients and fix carbon is The sessional and tidal cycles cause level of production within the detritus food chain.

LAKE ECOSYSTEM

Lakes are inland depressions containing standing water. They vary in size and depth (few feet to 5000 feet). Some lakes wave outlet streams. In lake there are three to five well recognized horizontal strata namely.

(i) Littoral zone

Shallow water near the shore forms this zone. - Different zone of a deep freshwater lake. It contains upper warm and oxygen rich circulating water layer, which is called epilimnion. It include rooted vegetation.

(i) **Sublittoral zone.** It extends from rooted vegetation to the non circulating cold water with poor oxygen zone i.e. hypolimnion.

(iii) **Limnetic zone.** It is the open water zone away from the shore. It is up to the depth of effective light penetration where rate of photosynthesis is equal to the rate of respiration. (iv) **Profundal zone.** It is the deep water area beneath limnetic zone and beyond the depth of effective light penetration.

(v) **Abyssal zone.** It is found only in deep lakes since it begins at about 2000 meter from the surface.

Kinds of lakes. Based on the physical factors, productivity etc. different classifications of lakes are given. Based on temperature, Hutchinson (1957) classified into dimictic, monomictic and polymictic. Based on Humic acid contents, the lakes are classified in to clear water lakes and Brown water lakes.

Physico-chemical properties of lakes

Lakes have the tendency to become thermally stratified during summer and winter to undergo definite seasonal periodicity in depth. Light too penetrates only to a certain depth, depending on turbidity.

Biotic Communities of lakes

Organisms depending on substratum are called pedonic forms and that are free from it called limnetic forms. The lakes have several type of organisms.

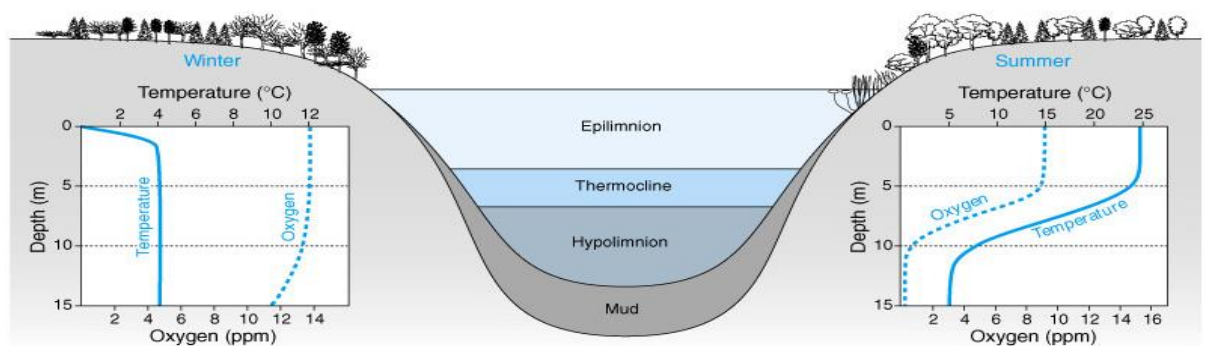
(1) **Neuston.** These including floating plants such as duckweeds and many type of animals.

Animals are called epineuston while others including insects called hyponeuston.

(ii) **Plankton.** These are small plants and animals whose powers of self locomotion is very limited. Certain zooplanktons are very active some planktons are called as nekto planktons, (iii) **Nekton.** These animals are swimmers.

(iv) **Bethos.** These includes the organisms living at the bottom of the water mass. These living above the sediment water interface are termed benthic epifauna and those living in sediments itself are termed as infauna.

Stratification in lakes.



- During the summer the top water become warmer than the bottom waters, as a result only the warm top layer circulates and it does not mix with the more viscous colder water, called thermocline.
- The upper water layer is epilimnion. Colder noncirculating water is the hypolimnion. Subtropical lakes having surface temperatures that never fall below 4°C. In terms of water circulation patterns most of the lakes of the world can be conveniently assigned to one of the following categories (Hutchinson 1957).

(a) Dimictic (mictic = mixed) Two sessional periods of free circulation.

(b) Cold monomictic. Water never above 4°C (polar regions), seasonal overturn in summer. (c) Warm monomictic. Water never below 4°C. One period of circulation in winter.

(d) Polymictic. More or less continually circulating with only short, if any, stagnation period. (e) Oligomictic. Rarely mixed.

(f) Micromictic. Permanently stratified.

STREAMS

Biotic community in streams is quite different from that of ponds. Most streams in the vicinity of urban areas are polluted. Streams are fresh water aquatic systems where water current is a measure controlling factor, oxygen and nutrients are in water. Differences between streams and ponds revolve around a triad of conditions.

ZONATION IN STREAMS

- In streams zonation is longitudinal. In streams we find zones increasingly older stages from source to mouth. Changes are more pronounced in the upper part, because of gradient, volumes of flow and chemical composition changes rapidly.
- The change in composition of communities is likely to be more pronounced in the first mile than in the last fifty miles . The longitudinal distribution of fish in a stream may be selected as a specific example. Thompson & Hunt found that the number

Unit 4: Biodiversity and it's Conservation

INTRODUCTION

Biodiversity may be defined as, "Biological diversity means the variability among living organisms from all sources including, interalia, terrestrial, marine and other ecosystems and the ecological complexes of which they are part, this includes diversity within species between species and of ecosystem.

GENETIC, SPECIES AND ECOSYSTEM DIVERSITY

Biodiversity is usually analysed at three levels i.e. species, genetic and ecosystem, each of which has its own significance.

1. Diversity of Biotic Communities and Ecosystems :

- Depending largely Upon the availability of abiotic resources and conditions of the environment an ecosystem develops its own characteristic community of living organisms.
- A small pond, for example, constitutes an ecosystem and possesses a set of flora and fauna different from a river which is another type of ecosystem. Different types of forests, grass-lands, lakes, ponds, rivers, wet-lands etc. represent diverse ecosystems each with a characteristic biotic community.

2. Diversity of Species Composition within a Community : The biotic component in an ecosystem may be composed of a few species only or a large number of species of plants, animals and microbes, which react and inter-act with each other and with the abiotic factors of the environment. The richness of species in an ecosystem is usually referred to as Species diversity.

3. Diversity of Genetic Organization within a Species :

Within a species there are often found a number of varieties or races or strains which slightly differ from each other in one, two or a number of characters such as shape, size, quality of their product, resistance to insects, pests and diseases, ability to withstand adverse conditions of environment etc.

BIOGEOGRAPHICAL CLASSIFICATION OF INDIA

India is one of the 12 mega biodiversity countries in the world. The country is divided in to 10 biogeographic regions. The wide variety in physical features and climatic conditions have resulted in a diversity of ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and deserts which harbour and sustain immense biodiversity.

The following 13 biogeographical regions have been identified in India :

1. Himalaya
2. The Desert

3. Deccan Peninsula
4. Malabar
5. Andaman Islands
6. Nicobar Islands
7. Gangetic Plains
8. Laccadive Islands
9. Maldives/Chagos Island
10. Western Ghats
11. Burman/Bangalian forest
12. Marine Coast
13. Coromondal Mahanandian

Floristic (Botanical) Regions of India

The country has been divided into the following nine floristic regions with respect to floral diversity :

(i) Western Himalayas : It extends from Kumaon to Kashmir and has annual rainfall up to 200 cm. Correspond to three climatic belts, there are three zones of vegetation.

(a) Submontane zone. It is constituted of tropical and sub tropical parts and extends up to 1500 meters altitude. It comprises mostly of Siwalik ranges. Snowfall does not occur. The plants like *Shorea robusta*, *Dalbergia sissoo*, *Cedrela toona*, *Eugenia jambolana*, *Acacia Catechu*, *Butea monosperma* (Dhak) *Zizyphus* etc. are found in this region.

(b) Temperate Zone. Above submontane zone extend temperate zone forests up to 3500 meter altitude. They are dominated by plant species like *Acer*, *Ulmus*, *Rhododendron*, *Betula*, *Salix*, *Populus*, *Cornus*, *Bumex*, *Pinus*, *Taxus*, *Picea* etc.

(c) Alpine Zone. It extends from 3500 - 4500 metres altitudes and is characterized with alpine forest vegetation. Most common tree species are *Betula*, *Juniperus*, *Rhododendron* etc. and herbs like *Primula*, *Potentilla*, *Polygonum* etc.

(ii) Eastern Himalayas. It includes regions of Sikkim and NEFA and is characterised by more rainfall, less snow and higher temperature. This is also divided into the following three zones altitudinally.

(a) Tropical zone. Upto 1800 metres altitudes, this zone has tropical semi-evergreen or moist deciduous forests. These forests comprise the plants like *Shorea robusta*, *Acacia catechu*, *Dalbergia sissoo*, *Terminalia*, *Albizia*, *Cedrela*, *Dendrocalamus* (bamboo) etc.

(b) Temperate zone. This zone extends between 1800 metres to 3800 metres altitudes and has typical montane temperate forests which are dominated by oaks like *Michelia*, *Quercus*, *Pyrus*, *Symplocos*, *Eugenia*, etc., at lower levels and by conifers as *Juniperus*, *Cryptomeria*, *Abies*, *Pinus*, *Larix*.

(c) Alpine zone. Beyond the temperate zone, extends alpine zone upto 5000 meters altitudes. It has alpine vegetation including *Juniperus* and *Rhododendron* with its other typical flora.

(iii) Indus plains. This zone includes the arid and semiarid regions of Punjab, Rajasthan, Kutch, part of Gujarat and Delhi. The rainfall is less than 70 cm. The vegetation is tropical thorn forest in semi-arid region and is typical desert in the arid region.

(iv) Gangetic plains. This region extends over Uttar Pradesh, Bihar, Bengal and part of Orissa and is characterised by moderate amount of rainfall and most fertile (i.e., alluvial) soils.

(v) Central India. It comprises Madhya Pradesh, parts of Orissa and Gujarat. The rainfall is 150–200 cm and its vegetation is thorny, mixed deciduous and teak type. The chief plants of this region are *Tectona grandis*, *Madhuca*, *Diospyros*, *Butea*, *Dalbergia*, *Terminalia*, *Carissa*, *Zizyphus*, *Acafia*, *Mangifera*, etc.

(vi) Malabar (west coast). This region include western coast of India from Gujarat to Cape Comorin and has heavy rainfall. The forests are tropical evergreen in extreme west, semievergreen towards interior subtropical or montane temperate evergreen forests in Nilgiris and mangroves near Bombay and Kerala coast.

(vii) Deccan Plateau. This region extends all over peninsular India (i.e., Andhra Pradesh, Tamil Nadu and Karnataka) and has rainfall upto 100 cm.

(viii) Assam. This region is characterised by heavy rainfall (200 to 1000 cm). The vegetation is either dense evergreen forest or sub-tropical. The evergreen forests include trees like *Dipterocarpus macrocarpu*, *Mesua ferrca*, *Shorea robusta*, *Ficus elastica*, etc., bamboos as *Bambusa pallida*, *Dendrocalamus hamiltonii*, etc., grasses like *Imperata cylindrica*, *Saccharum* sp., *Themedasp.*, insectivorous plants as *Nepenthes* sp., and also epiphytes (ferns and orchids).

(ix) Andmans. This region possesses a varied type of vegetation: mangroves and beech forest at its coasts and evergreen forests of tall trees in the interior, Important plant species of this island are *Rhizophora*, *Mimusops*, *Calophyllum*, *Lagerstroemia*, etc.

VALUES OF BIODIVERSITY

Biodiversity is a valuable natural resource for the survival of man kind. Man has domesticated a number of economically important plants and animal species. Old traditional varieties and the wild relatives of domesticated plants and animals constitute a vital genetic resource for us

Consumptive value.

- Most of the developing countries obtain fuel wood from forests. Still more than 1500 million people cook their food by burning wood. About 1000 million cubic meter wood is used for fuel across the globe.
- This imposes heavy pressure on forests. Hunting of wild life, use of grass with some commercially important plants as fodder are of only consumptive. fully depend on forests (biodiversity) for their habitation and livelihood.

SOCIAL VALUES : Social value is one of the instrumental values where something has as a means to another's end. Materialistic uses of biodiversity are the core of instrumental values by ecosystems

- (1) Provision of food, fuel and fiber.
- (2) Provision of shelter and building materials.
- (3) Purification of air and water.
- (4) Detoxification and decomposition of wastes.
- (5) Generation and renewal of soil fertility, including nutrient cycling.
- (6) Control of pests and diseases.
- (7) Stabilization and moderation of earth's climate.
- (8) Maintenance of genetic resources as key inputs to crop varieties.
- (9) Live stock breeds, medicines and other products etc.

Ethical values : Ethical or religious values is also one of the indirect values of biodiversity. The ethical and religious value of biodiversity is rooted in the understanding that humanity is part of nature and that we are just one species among others. All species have an inherent right to exist. Future generations also have an inherent right to know them and to have the choice of using them or not.

Aesthetic value : The aesthetic value of biodiversity has been expressed in many ways through art, poetry, songs, literature, music and dance. Forests are closely linked with our religion and culture. Human race has a great evolutionary attachment with forests as our ancestors lived in forests

OPTION VALUES : Biological resources existed in this biosphere are very important for human beings. The option value of biodiversity suggests that any species may prove to be a miracle species. It is the precious gifts of nature presented to us. Option value is the indirect value of a species to provide an economic benefit to human society at some point in near future.

BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVELS

Biodiversity at Global level

It is estimated that there exists 5 – 30 million species of living forms on our earth and of there only 1.5 million have been identified and include 300000 species of green plants and fungi, 800000 species of insects, 40,000 species of vertebrates and 3,60,000 species of microorganisms.

The countries identified are

1. Brazil
2. Colombia
3. Venezuela
4. Peru
5. Ecuador
6. Indonesia
7. Democratic Republic of Congo (Zaire)
8. India
9. China
10. Malaysia
11. Australia
12. Mexico.

BIODIVERSITY AT NATIONAL LEVEL

- The Indian landmass extending over a total geographical area of about 3029 million hectares, is bounded by Himalayas in the north, the bay of Bengal in the east, the Arabian sea in the west, and Indian Ocean in the South. The wide variety in physical features and climatic situation have resulted in a diversity of ecological habitats.
- This richness in biodiversity is due to immense variety of climatic and altitudinal conditions coupled with varied ecological habitats.
- The Indian region having a vast geographical area is quite rich in biodiversity with a sizable percentage of endemic flora and fauna.
- These vary from the humid tropical Western Ghats to the hot desert of Rajasthan, from the cold desert of Ladakh and the icy mountain of Himalayas to the warm coasts of peninsular India.

BIODIVERSITY AT LOCAL LEVEL

The biodiversity at local level can be well understood by demarcating the points, places, zones rich in biodiversity. This can be understood as compositional i.e. rich in plants & animals of same habitats and genetic make up.

We can also study the local biodiversity on following lines

1. Richness of species at a given place.

2. Physical characteristics of habitat and vegetation in particular area.
3. Change in species composition across different habitats.
4. Local diversity based on climate, geographical, ecological and other processes responsible for creation.
5. Rate of change across gradients and conditions.

It is said that environmental variables are responsible for diversity but temperature play an important role in affecting the biodiversity of an area. Thus local areas are well affected in heterogenous and homogenous habitats.

THREATS OF BIODIVERSITY

- One of the measure threat to Biodiversity is space, food and raw material for expanding human and plant establishment. Since 1600 there have been over 1000 recorded extinctions of plants and animal species.
- Probably early humans were directly responsible for extinction of many large and smaller mammals But the elimination of species is a normal process of the natural world. When species die or extinct, they will replace by others. Due to human population and its impact on ecosystems, thousands of species and subspecies become extinct every year.
- According to E.O.Wilson, we are losing 10,000 organisms a year i.e 27 per day. It is studied that 99% of all species of fossil that ever existed are now extinct.

The following are the measure causes and issues related to threats to biodiversity.

HABITAT LOSS : Habitat loss due to human activities and other disturbances are wellknown factor. Varying human disturbances are changing ecosystems and are thus threatening the biodiversity. Due to habitat degradation wild populations become more vulnerable to predators and diseases. This is especially true for wild life, which suffer due to habitat loss and fragmentation.

POACHING OF WILDLIFE

Poaching is another threat to wildlife. As an ancient period, hunters, collectors, and smugglers (traders) are the measure threat to a number of species including endangered species. They collected furs, hides, horns, tusks, and some live specimens, herbal products and smuggled to others for millions of dollars.

MAN-WILDLIFE CONFLICTS

Struggle for existence. This is applicable for both, man and wild animal. Due to habitat loss animals come out of the forest and destroy the crops later on they become danger to human being. Villagers and affected people kill them.

Unit 5: Environmental Pollution

AIR POLLUTION

“Air pollution may be defined as the presence in the atmosphere of one or more contaminants in such quantities and of such duration as may be, or may tend to be injurious to human, plant or animal life, or property, or which unreasonably interfere with the comfortable enjoyment of life, or property, or the conduct of business.”

CLASSIFICATION OF AIR-POLLUTANTS

The air pollutants may be classified in different ways as follows:

(a) According to origin:

(i) Primary pollutants which are directly emitted into the atmosphere and are found such as e.g., CO, NO₂, SO₂, and hydrocarbons.

(ii) Secondary pollutants which are derived from the primary pollutants due to chemical or photo-chemical reactions in the atmosphere, e.g., Ozone, Peroxy-acyl nitrate (PAN), Photo-chemical smog, etc.

(b) According to chemical composition:

(i) Organic pollutants, e.g.,-Hydrocarbons, aldehydes, ketones, amines and alcohols.

(ii) Inorganic pollutants

Carbon compounds (e.g., CO and carbonates)

Nitrogen compounds (e.g., NO_x, and NH₃)

Sulphur compounds (e.g., H₂S, SO, SO₂, and H₂SO₄)

Halogen compounds (e.g., HF, HCl and metallic fluorides)

Oxidising agents (e.g., O₃)

Inorganic particles (e.g., fly ash, silica, asbestos and dusts from transport, mining, metallurgical and other industrial activities).

(c) According to state of matter :

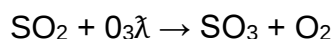
(i) Gaseous pollutants which get mixed with the air and do not normally settle out, e.g., CO, NO_x, and SO₂.

(ii) Particulate pollutants which comprise of finely divided solids or liquids and often exist in colloidal state as aerosols, e.g.,- smoke, fumes, dust, mist, fog, smog and sprays.

Biochemical effects of some important air pollutants

1. Oxides of Sulphur (SO_x)

- SO_x , comprises of SO_2 , and SO_3 . They are Colourless, heavy water soluble with pungent and irritating odour. SO_x pollution is due to volcanic activity, combustion of fuels, Coal fired power stations, transportation, Refineries, metallurgical operations, chemical plants and other natural and human activities.
- In atmosphere, oxidation of SO_2 , in to SO_3 , by photolytic and Catalytic processes (in presence of O_3 , NO_x , or hydrocarbons) giving rise to the formation of photochemical smog. In humid conditions of the atmosphere SO_3 , reacts with water vapours to produce droplets of H_2SO_4 aerosols, give rise to the so called "Acid Rain".



Biochemical effects: Absorbs quickly and irritates the upper respiratory tract. Reacts with cellular constituent chemicals e.g., enzymes. The H_2SO_4 formed lowers PH, impairs enzymatic functions and destroys various functional molecules. Leads to bronchial spasms, breathlessness, impaired pulmonary function via airway resistance, impaired lung clearance and increased susceptibility for infection.

2. Oxides of Nitrogen (NO_x)

Characteristics: NO_x mostly comprises of NO , NO_2 , and N_2O . NO is colourless gas and is slightly soluble in water. NO_2 , is reddish brown gas, somewhat water-soluble, oxidizing agent, can react with water to form HNO_3 , which is a powerful oxidizing agent and capable of reacting with almost all metals and many organic compounds. NO_2 , can travel into the respiratory system. It is also involved in the formation of ozone in the atmosphere.

Biochemical effects: Oxidises cellular lipids, Forms bonds with haemoglobin and reduces the efficiency of oxygen transport. Disrupts some cellular enzyme systems. Higher levels and prolonged exposures may cause pulmonary fibrosis, inflammation of lung tissues and lead to death. Causes nitric acid mediated effects some of which are similar to that of H_2SO_4 . NO can form addition compound with haemoglobin, if it enters the blood stream.

3. Carbon monoxide (CO)

Characteristics : Colourless, odourless, toxic gas, slightly water soluble but still is extremely dangerous because it has a greater affinity for haemoglobin than that of O_2 .

Biochemical effects : It competitively inhibits combination of O , and haemoglobin. It attacks haemoglobin and displaces o , to form carboxyhaemoglobin, and thus reducing the oxygen carrying capacity of blood.

(Under normal conditions): $\text{O}_2 + \text{Hb} \xrightarrow{\lambda} \text{O}_2\text{Hb}$ (oxyhaemoglobin)

(In presence of CO): $\text{O}_2\text{Hb} + \text{CO} \xrightarrow{\lambda} \text{CO Hb} + \text{O}_2$ (Carboxyhaemoglobin)

The immediate response to CO-poisoning is loss of judgment, which is responsible for many automobile accidents. Further exposure to higher levels of CO leads to various metabolic disorders such as asphyxiation and causes death. CO-poisoning can be cured by providing fresh O₂ which reverses the above reaction.

4. Ozone (O₃) and other photochemical oxidants such as peroxyacetyl nitrate (PAN) present in photochemical smog.

Characteristics : Ozone is a pale blue gas, fairly water soluble, unstable, sweetish odour. Very reactive oxidizing agent capable of combining with many organic compounds in cells and tissues as well as with rubber and other materials. O₃ and PAN are harmful to plants, animals and humans.

Biochemical effects : Oxidize cellular constituents. PAN and ozone toxicity is produced via generation of free radicals. The free radicals produced may damage DNA and thus alter cellular genetic integrity too.

The toxic effects of ozone are manifested after inhalation and absorption in the lungs causing accumulation of fluids in the lungs (pulmonary edema), naging lung capillaries and mortality if continued or high level exposures occur

5. Hydrocarbons (and other volatile organic compounds)

Characteristics: Very reactive. React with many kinds of compounds yielding many kinds of products. Volatile hydrocarbons and other organic compounds participate in atmospheric reactions generating ozone.

Biochemical effects : Some of these compounds can react with the constituents of the cells. Carcinogenic hydrocarbons like benzopyrene can react with DNA causing mutations and cancer.

6. Particulate Matter

Characteristics : Solid particles or liquid droplets including fumes, smoke, dust and aerosols. Solid particular can adsorb various chemicals.

Biochemical effects : Effects vary with the nature of the particles. Carbon particles and other particles cause scarring of lungs via complex walling off and fibrogenic reactions leading to a disease condition known as "pneumoconiosis". Particles carrying absorbed mutagens lead to damage of DNA in the lungs and elsewhere.

Effects of Air Pollutants on Man and his Environment

(1) Damage to materials. The materials that may be affected by air pollutants include metals; building materials, rubbers, elastomers, paper, textiles, leather, dyes, glass, enamels and surface coatings. The types of possible damage to these materials by air pollutants include corrosion, abrasion, deposition, direct chemical attack and indirect chemical attack.

(2) Damage to Vegetation. Air pollutants, such as sulphur dioxide, HF, particulate fluorides, smog, oxidants like ozone, ethylene (from automobiles), NO, chlorine and herbicide and weedicide sprays exert toxic effects on vegetation. The damage usually manifests in the form of visual injury such as chlorotic marking, banding, silvering or bronzing of the underside of the leaf. Retardation of plant growth may also occur in some cases.

(3) Damage to farm animals. Arsenic, lead and fluorides are the main pollutants which cause damage to livestock. These air-borne contaminants accumulate in vegetation and forage and poison the animals when they eat the contaminated vegetation.

(4) Darkening of sky and reduction in visibility. Sky darkening may be caused by heavy smoke and fog or by dust storms. The reduction in visibility may be due to smoke, fog and industrial fumes which contain particulates in the size range of 0.4 to 0.9 μ m that scatter light.

(5) Effect on human health and human activities. The effects of air pollution on humans, animals and vegetation has already been discussed in earlier sections. Air pollution can effect the health of workers within the industrial premises, causing absenteeism, sickness and drop in production

MEASURES TO CHECK AIR-POLLUTION

It is not easy to control/check air pollution at resonable cost, because it is not so simple. Our every life style/amentities of modern life is facing for air pollution. But we can check it or prevent by careful planning for industries, better design, operation of equipments and general awareness to do this. The following are the general methods of air pollution control :

1. Controlling the air pollution at source.
2. Site selection/Zoning
3. Controlling air pollution by devices/equipments/process modification.
4. Air pollution control by growing vegetation.
5. Air pollution control by Fuel selection and utilization.

1. Controlling of Air Pollution at Source

This is the best to check air pollution at source. This can be achieved by : (i) Modifying the process in such a way that pollutants do not form at all beyond the permissible limits.

(ii) Before release the pollutants, they should be reduced to tolerable levels by methods equipments to destroy, alter, trap or so.

To control or minimised air pollution at source, the following steps should be strictly follow :

(a) This step can also be done in two ways, 1st we should select the raw material in such a way to release minimum pollutants. The supplements may also be used if needed. Secondly use suitable fuels avoiding sulphur fuels. Non-essential ingredients are removed before processing of the raw material.

(b) Air pollution can easily be checked by using modified procedure or new process. Timely it should be monitored.

2. Site Selection/Zoning

- To instal the industry, site selection is important, which results in the production of single source of pollution. Control measure based on the knowledge of the mechanics of the atmosphere is called "Zoning".
- While setting the factories the meterological and micro-meterological conditions should be considered. Other factors such as facilities for as material supply, transport labour and market for products are also important for selecting the site of industry.

Controlling of Air Pollution by Devices/Equipments/Process Modifications

Large number of factories/industries release various types of gases, along with particulates which are measure source of air pollution. In order to prevent these pollutants two types of methods are used.

(A) Methods/Equipments used to Control gaseous Pollutants

For gaseous pollutants, following methods are generally used :

- (i) Absorption
- (ii) Adsorption
- (iii) Combustion
- (iv) Cold trapping or condensers
- (v) Others.

But the first three are in common use.

(i) Absorption : Scrubbers are mostly used for the removal of gaseous pollutants. They have suitable liquid as absorbent to remove or modify one or more of the pollutants present in the stream. Through scrubbers gaseous effluents are passed. The efficiency of gas absorption depend upon the following factors:

- (a) Chemical Activity of the gas pollutant.
- (b) The extent of the surface for contact.
- (c) The contact time.
- (d) The concentration of the absorbing medium.

This technique is used for removal of NO_x, H₂S, SO₂, SO₃ fluorides etc.

(ii) Adsorption : Here, the gaseous effluents are passed through porous solid adsorbent taken in suitable containers. The efficiency of adsorption depends upon the surface area per unit weight of the adsorbent. Constituents of the gas effluents are held at the interface of the adsorbent by chemisorption. When the effluents have higher concentration of NO_x, SO_x etc. the gases can be recovered economically and used for the manufacture of acids, i.e., HNO₃ & H₂SO₄, etc.

(iii) Combustion : The flame combustion or catalytic combustion of organic gaseous pollutants convert them into H₂O & CO₂. Flame combustion includes fume incinerators, steam injection while catalytic combustion is resorted to where lower temperature is needed.

(B) Methods/Equipments used to Control Particulate Emission

The particulate collection devices are based on the size, shape, properties of the particulate, which are generally originate from stationary and mobile sources.

The various methods are :

- (ii) Filtration
- (iii) Mechanical
- (iv) Precipitators
- (v) Scrubbers.

WATER POLLUTION

INTRODUCTION

Water is essential for the survival of any form of life. On an average, a human being consumes about 2 litres of water everyday.. About 80% of the earth's surface is covered by water. Some of water is available for drinking, agriculture, domestic and industrial consumption. The rest of the water is locked up in oceans as salt water, polar ice-caps and glaciers and underground. Owing to increasing industrialization on one hand and exploding population on the other, the demands of water supply have been increasing tremendously . Moreover, considerable part of this limited quantity of water is polluted by sewage, industrial wastes and a wide array of synthetic chemicals. The menace of water-borne diseases and epidemics still threatens the well-being of population, particularly in under-developed and developing countries. Thus, the quality as well as the quantity of clean water supply is of vital significance for the welfare of mankind. About 70% of all the available water in our Country is polluted

Municipal water is mainly used for drinking, cleaning, washing and other domestic purposes. The water that is fit for drinking purposes is called potable water.

Characteristics of potable water

1. It should be colourless, odourless and tasteless.
2. It should be free from turbidity and other suspended impurities.
3. It should be free from germs, bacteria and other pathogenic organisms.
4. It should not contain toxic dissolved impurities , such as heavy metals, pesticides, etc.
5. It should have a pH in the range 7-8.5.
6. It should be moderately soft, having hardness preferably in the range 50-100 PPM. Its hardness should not be above 150 PPM.
7. It should be aesthetically pleasant.
8. It should not be corrosive to the pipelines and should not cause any incrustations in the pipes.
9. It should not stain clothes.

Water Pollutants and their Sources

The various types of water pollutants are:

(a) Oxygen-demanding wastes. These include domestic and animal sewage, bio-degradable organic compounds and industrial wastes from food-processing plants, meat-packing-plants, slaughter houses, paper and pulp mills, tanneries etc., as well as agricultural run-off. All these wastes undergo degradation and decomposition by bacterial activity in presence of dissolved oxygen (D.O.). This results in rapid depletion of D.O. from the water, which is harmful to aquatic organisms.

(b) Disease-causing wastes. These include pathogenic microorganisms which may enter the water along with sewage and other wastes and may cause tremendous damage to public health. These microbes, comprising mainly of viruses and bacteria, can cause dangerous water-borne diseases such as cholera, typhoid, dysentery, polio and infectious hepatitis in humans. Hence, disinfection is the primary step in water pollution control.

(c) Synthetic Organic Compounds. These are the man-made materials such as synthetic pesticides, synthetic detergents (syndets), food additives, pharmaceuticals, insecticides, paints, synthetic fibres, elastomers, solvents, plasticizers, plastics and chemicals. These chemicals may enter the hydrosphere either by spillage during transport and use or by intentional or accidental release of wastes from their manufacturing establishments. Most of these chemicals are potentially toxic to plants, animals and humans.

(d) Sewage and agricultural run-off. Sewage and run-off from agricultural lands supply plant nutrients, which may stimulate the growth of algae and other aquatic weeds in the receiving water body. This unwieldy plant-growth results in the degradation of the value of the water body, intended for recreational and other uses.

(e) Oil . Oil pollution may take place because of oil spills from cargo oil tankers on the seas, losses during off-shore exploration and production of oil, accidental fires in ships and oil tankers, accidental or intentional oil slicks and leakage from oil pipe-lines, crossing waterways and reservoirs. Oil pollution results in reduction of light transmission through surface waters, thereby reducing photo-synthesis by marine plants. Oil pollution in Seas has been increasing due to the increase in oil based technologies, massive oil shipments, accidental oil spillages etc.

(2) Inorganic Pollutants

Inorganic pollutants comprise of mineral acids, inorganic salts, finely divided metals or metal compounds, trace elements, cyanides, sulphates, nitrates, organometallic compounds and complexes of metals with organics present in natural waters. The metal-organic interactions involve natural organic species, such as fulvic acids and synthetic organic species, such as EDTA. The heavy metals such as Hg, Cd and Lead, metalloids such as As, Sb and Se are most toxic. The water pollution by heavy metals occurs mostly due to street dust, domestic sewage and industrial effluents. Polyphosphates from detergents are also water pollutants.

(3) Suspended solids and sediments

Sediments are mostly contributed by soil erosion by natural processes, agricultural development, strip mining and construction activities. Suspended solids in water mainly comprise of silt, sand and minerals eroded from the land. Soil erosion by water, wind and other natural forces are very significant for tropical countries like India. It is estimated that 5.37 million Tonnes of NPK fertilizers are washed away in to the sea. Sediments and suspended particles exchange cations with the surrounding aquatic medium and act as repositories for trace metals such as, Cu, CO, Ni, Mn, Cr, and Mo.

(4) Radioactive Materials

The radioactive water pollutants may originate from the following anthropogenic activities:

- (a) Mining and processing of ores, e.g., Uranium tailings.
- (b) Increasing use of radioactive isotopes in research, agricultural, industrial and medical applications, e.g., I^{131} , P^{32} , Co^{60} , Ca^{45} , S^{35} , C^{14} , Ir^{132} and Cs^{137} .
- (c) Radioactive materials from nuclear power plants and nuclear reactors, e.g., Sr^{90} , Cs^{137} , Am^{241} , Pu^{248} .
- (d) Radioactive materials from testing and use of nuclear weaponry, e.g. Sr^{90} , Cs^{137} .

(5) HEAT. Considerable thermal pollution results from thermal power plants, particularly the nuclear-power-based electricity generating plants. In such industries, where the water is used as a coolant, the waste hot water is returned to the original water bodies. Hence the temperature of the water body increases. This rise in temperature decreases the DO content of water, which adversely affects the aquatic life.

Some important effects of various types of water pollutants are as:

(i) Tannery effluents contain several constituents which are deleterious, irrespective of the

fact that where they are discharged viz., into river, stream, sewer, land or sea.

(ii) It imparts persistent dull brown colour to the receiving water causing aesthetic and other problems described earlier.

(iii) Highly repulsive odour is imparted to the receiving water. The dissolved constituents like proteins are purifiable.

(iv) The acidic or alkaline effluents are corrosive to concrete and metal pipes. (v) Excess NaCl in the effluent is also corrosive and renders the receiving water unsuitable for irrigation

(vi) The effluents may contain pathogenic bacteria.

(vii) The dissolved chromium present is toxic to fish and aquatic life and thus affects the natural self-purification property of the stream.

(viii) The suspended solids such as hair, flesh, CaCO_3 , etc. interfere with aeration and photosynthetic activities of the aquatic flora.

(ix) If the wastewater is discharged into sewer, the suspended impurities such as CaCO_3 , hairs etc. may choke the sewerage pipes. The sulphides present in the wastewater cause "crown corrosion" to the concrete structures, etc.

(x) The chromium and sulfides present in the waste water being toxic to microorganisms disrupt the biological treatment operation such as trickling filtration. The suspended lime etc. also interfere with the biological activities in the sewage treatment plants.

(xi) The presence of excessive salt and Cr in the wastewaters may deteriorate the quality of the ground water in the affected areas.

CONTROL OF WATER POLLUTION

The control of water pollution is difficult, but we may try for its prevention and minimisations. Industrialised and Developing countries spend a handsome amount of their GNP (Gross National Product) on pollution control measures, but the problem is going to be worsening day by day. The before water pollution control are:

1. How pure the water should be?

2. How to prohibit the effluents and discharge in to water?

3. To what extent water quality be improved?

4. How to create public opinion against water pollution? Therefore, we should adopt the respective safety measures to achieve acceptable water quality at the least cost. Some of these are :

1. Scientific techniques are necessary to be adopted for the environmental control of catchment areas of rivers, lakes, ponds or streams.
2. Industrial plants should be based on recycling operations.
3. The possible reuse or recycle of treated sewage effluents and industrial wastes should be emphasized and encouraged.
4. Instead of throwing wastes in to water, the recycling should be done for better use. Gobar gas plant, composting, manufacture of hardboard, paper etc. such examples where respective waste can be used.
5. Minimum, appropriate quantity and concentration of Fertilizers, pesticide & insecticides should be used, because excess will cause pollution.
6. There should be propaganda for water pollution control, on radio, TV, Newspapers etc. because public awareness is a must.
7. Treatment plants should be constructed and Govt should also help by funding for domestic, sewage and industrial effluents.
8. Local authorities, Industrialists, Govt officials, with public participation should co-ordinate to find ways to control water pollution.
9. Water resources should be used in the best possible economic way.
10. To conduct seminars and training courses for helping those, who are directly or indirectly engaged in water management and water pollution control.

SOIL POLLUTION

INTRODUCTION

Soil is a very important constituent of the lithosphere. The word "Soil" is derived from a Latin word "Solum" which means earthy material in which growth of plants takes place. "Soil" may be broadly defined as the weathered layer of the earth's crust with living organisms and their products of decay.

The earth's crust basically consists of the following three rock types.

- 1. Igneous rocks** : These are formed by cooling and solidification of molten rock material called 'Magma'. Ex:- Basalt and Diorite.
- 2. Sedimentary rocks** : These are developed as a result of gradual accumulation, consolidation and hardening of products of weathering of mineral materials brought about by wind or waters. These rocks are characterized by the presence of distinct sedimentary layers. Ex :Lime stone, sand stone and shale.
- 3. Metamorphic rocks** : These are formed as result of metamorphosis of igneous and sedimentary rocks under the influence of high pressure and intense heat. Ex:- Quartzite, Slate, Marble and Schist.

Sources of Soil Pollution

Soil pollution differs from water pollution or air pollution, because the pollutants remain in direct contact with the soil for relatively longer periods and hence alter the chemical and biological properties of the soil. The hazardous chemical can also enter the human food chain from soil or water plants.

EFFECTS OF SOIL POLLUTANTS

“Soil Pollution” was originally defined as the contamination of the soil system by considerable quantities of chemical or other substances, resulting in the reduction of its fertility or productivity with respect to the qualitative and quantitative yield of the crops.

The major effects of various types of pollutants are given below:

(a) Effects of modern agricultural practices:

Synthetic Fertilizers : Synthetic fertilizers are employed to increase the soil fertility and crop productivity. Excessive and indiscriminate use of chemical fertilizers may result in the following undesirable effects:

(i) Wheat, maize, corn, etc. grown on soils fertilized with NPK fertilizers may result in considerable reduction in protein content of the crop.

(ii) Excessive use of nitrogenous fertilizers leads to the accumulation of nitrates in the soil which may contaminate the ground water. Nitrate concentrations exceeding 90 ppm in drinking water may lead to diarrhoea, blue Jaundice (Cyanosis) in children, "methemoglobinemia" (or blue baby syndrome) in infants. Further, the nitrates and nitrites entering the human body may be eventually converted nitroso amines and compounds which are suspected to cause stomach cancer.

iii) Vegetation growth in nitrate-rich soils may exert toxic effects in cattle.

(iv) Excessive use of chemical fertilizers may enter the water bodies and contribute to "eutrophication". (Eutrophication is the excessive growth of algae and aquatic plants to undesirable levels).

(vi) Excessive use of chemical fertilizers may reduce the ability of plants to fix nitrogen.

(vii) Excessive quantities of potassium fertilizers in soils may reduce the quantities of valuable ascorbic acid and carotene in fruits and vegetables grown in such soils.

(vii) The large-sized fruits and vegetables grown in highly fertilized soils may be more vulnerable to attacks by pests and insects.

Pesticides

Pesticides pose potential hazard to animals, humans and aquatic life deleterious effect on soil fertility and crop productivity. Pesticides applied to crops are retained in the soil in considerable quantities. They enter into cyclic environmental processes such as absorption by soil, leaching by water, etc, and contaminate both lithosphere and

biosphere. Pesticides including herbicides, fungicides and rodenticides, are persistent pollutants.

The following types of pesticides are commonly used:

- (a) Chlorinated hydrocarbons (eg. DDT, Aldrin, Dieldrin, Lindane, BHC etc.)
- (b) Carbamate compounds (eg. Carbaryl or Sevin, Zectron etc.)
- (c) Organo-Phosphorous compounds (eg. Methyl or ethyl parathion, malathion, Guthion etc.)
- (d) Inorganic compounds (eg. As_2O_3 , PbO_2 , NiCl , CuSO_4 , etc)
- (e) Miscellaneous compounds (eg, Organic mercurials, 2,4-D; 2,4,5-T etc)

Some of the adverse effects of pesticides are given below:

- (i) Some arsenic pesticides may render the soil permanently infertile.
- (ii) Pesticide residues in soil may be taken up by plants and cause phyto-toxicity. They may enter the aquatic environment and enter the food chain.
- (iii) Pesticides such as, endrin, dieldrin, DDT, heptachlor etc. may seep through the soil and contaminate groundwater and surface waters. They may eventually contaminate drinking water supplies.
- (iv) Fruit, vegetables, rice, wheat, barley, maize etc. are known to contain considerable quantities of toxic pesticide residue such as of DDT, BHC and other organochloro pesticides.
- (v) Polychlorinated biphenyls (PCB) having half-life periods of about 25 years in soil are among the most hazardous soil pollutants. They may accumulate in soil and plants when they eventually enter the animal or human body, they may cause severe health disorders including eye damage, skin problems, nervous disorders, foetus deformities and liver or stomach cancer.
- (vi) Irrigated water from pesticide contaminated soils may evaporate and spread the toxic pesticide vapours in the atmosphere.
- (vii) DDT can enter the food chain and accumulate in human fats and may lead to disorders such as impotency.
- (viii) Persistent pesticides can damage human tissues and interfere with the normal metabolic activities by disturbing enzymatic functioning.
- (ix) Chlorinated pesticides and herbicides are hazardous soil pollutants which can affect the soil texture and damage the ecosystem.
- (x) Hunting birds feeding on grains contaminated with DDT are threatened of extinction.
- (xi) Organophosphate pesticides may cause muscular disabilities, tremors, and dizziness.
- (xii) Excessive use of synthetic pesticides may lead to defoliation of forests and adverse effect on fauna and flora.

xiii) Farm animals drinking stagnant water in fields sprayed by pesticides developed toxic symptoms and some mortalities were reported.

xiv) Farmers and farm workers are particularly prone to pesticide poisoning because of greater exposure while handling and spraying.

xv) Volatile pesticides may cause pollution of air in the surrounding areas.

(b) Effects of Industrial effulents

Solid, liquid and gaseous chemicals from various industries such as paper and pulp, iron and steel, fertilizers, dyes, automobiles, pesticides, tanneries, coal-based thermal power plants etc. contain a variety of pollutants such as heavy metals, solvents, detergents, plastics, suspended particulates and refractory chemicals.

(c) Effects of urban wastes

Millions of tonnes of urban waste are produced every year from critically polluted cities. The inadequately treated or untreated sewage sludge not only poses serious health hazards but also pollutes soil and decreases its fertility and productivity. Other waste materials such as rubbish, used plastic bags, garbage, sludge, dead animals, waste medicines, hospital wastes, skins, tyres, shoes, cans, etc.

Control of soil pollution

The major sources of soil pollution are the domestic wastes, industrial wastes and agricultural wastes including those toxic chemicals (eg. Pesticides) arising from modern agricultural practices. The various approaches to control soil pollution are as follows

- (1) Implementing stringent and pro-active population control programmes.
- (2) Launching extensive afforestation and community forestry programmes.
- (3) Implementing deterrent measures against deforestation.
- (4) Formulation of stringent pollution control legislation and effective implementation with powerful administrative machinery.
- (5) Imparting informal and formal public awareness programmes to educate people at large regarding the health hazards and undesirable effects due to environmental pollution. Mass media, educational institutions and voluntary agencies should be involved to achieve these objectives.
- (6) Banning the use of highly toxic and resistant synthetic chemical pesticides or at least regulating/restricting their use only for special purposes under thorough monitoring.
- (7) Encouraging the use of bio-pesticides in place of toxic chemical pesticides.
- (8) Conservation of soil to prevent the loss of precious top soil from erosion and to maintain it in a fertile state for agricultural purposes.

MARINE POLLUTION

Seas are the main source of food and earnings for persons living in coastal areas. When the marine water is polluted it effects the animals and other food chain components. Researches shows that many marine animals secrets the medicinal chemicals which are useful to mankind and other living organisms. When water will be polluted it will effect the animals present in seas.

Sources of marine Pollution

The main sources of marine pollution are:

1. Rivers are the main source of marine pollution. They carry wastes in their drainage and joins the sea/ocean. The drainage include sewage sludge, industrial effluents, detergents, agrochemicals, plastics, metal scraps etc.
2. Many big cities and industries are situated along the coast line. Every large amount of wastes from hotels, wastes effluents mixed with detergents, sewage from corporations and industries, other wastes from human activities are mixed in sea water.
3. Ships which carry toxic substances, lubricating oil, paints heavy oils, fuels, automotive materials and other chemicals from one place to another, some times by accident or by leakages pollute the marine water.
4. Testing of atomic weapons, space aircrafts, missiles (generally developed country do this) and other radioactive wastes when dumped in seas, causes heavy loss to aquatic biota.
5. Harmful effluents from nuclear power stations or from other scientific organizations like BARC in India, chemical industries, fertilizers, Pesticide and insecticide industries when mixed in marine water causes harmful effects to marine life.
6. Marine pollution also caused by oil drilling in seas, tourism activities and heat released from industries. etc.

Effects of marine pollution:

The major effects of marine pollution are as follows:

1. Oil is most dangerous pollutant when afloat on sea or mixed with water a great threat to marine life specially fish, birds, invertebrates and algae. Thousands of birds killed every year because once they oiled, seldom survived despite efforts to clean themselves.
2. Oil of sea also effects sensitive flora and fauna, phytoplankton, zooplankton and other animals. In Alaska, Brittany (France), Elbe (Germany) thousands of birds died by oil spillage.
3. Plastic or plastic materials when dumped into sea by commercial ships or from drainage, animal take it through their food in stomach. It causes ulcer and reduces hunger.

4. Marine pollution affects the food chain in seas. Serious diseases like cancer are caused when affected animals are taken by man from ocean.

5. Detergents, either from cleaning up the spills or from drainage, also responsible for high mortality of marine life.

6. Heavy metals (like lead and mercury), factory materials, mineral oils, acids and other biocides are also measure threat to marine life when mixed with sea water.

Control of marine pollution:

The control of marine pollution can be studied in following two steps: 1. Steps already in operation pollution

(i) Port authorities are alert and introduced antipollutant measures by creating pollution cell. But deeper check the in sea coastal guards are doing this job.

(ii) Various research organizations, institutions are working in this field to marine pollution

(iii) In most of the countries (India too), the monitoring and survey in operation to control the marine pollution.

(iv) Authorities are taken care of effective measures to check the oil leakage from ships and tankers.

(v) Urban and coastline corporations are trying to check the dumping of wastes from human activities & Municipal etc. solid waste management is helping to recycle or reuse.

Suggesting steps to control marine pollution

(1) Dumping of oil ballest, hazardous and toxic substances, gases from radioactive labs into sea, should be banned or should be properly treated before dumping.

(2) Drainage, sewage sludge and effluents from industries should not be discharged in to rivers which joins sea.

(3) Developmental activities on coastal areas should be minimised.

(4) Toxic pollutants from industries and treatment plants should not be discharged into sea.

(5) Ships and ports should have certain facilities for reducing pollution.

(6) Certain biological and other methods should be followed to restore species diversification and ecobalance in the water body to prevent pollution.

(7) Effective measures should be developed to check the leakage in ships and oil tankers.

(8) Nuclear explosions and other nuclear activities in sea should be minimized.

(9) Wastes from municipal, industries, sewage and thermal power stations should be recycled for reutilization. Such plants should be developed. Some are in operation.

(10) We should develop awareness in people to reduce the amount of waste in their daily life.

(11) Drilling should not be allowed in coastal areas.

NOISE (SOUND) POLLUTION

The term 'noise' may be defined as an unwanted sound at a wrong time and a wrong place. Whether a given sound is wanted or unwanted may depend upon the person involved, the loudness, the rhythm, and the length of time for which one is exposed to it.

Sound intensity measured Decibel (dB) = $10 \log \frac{\text{Sound intensity measured}}{\text{Reference sound intensity}}$

Effects of Noise

(a) Physiological Effects:

The acute effects caused by noise depend upon the pressure and frequency about. At high levels of about 150 dB, immediate permanent hearing impairment may be caused. At sound levels in the range of 120-150 dB, effects on respiratory system, dizziness, disorientation, loss of physical control, other physiological changes resulting from stress, nausea and vomiting may be caused.

(b) Psychological effects

Although there is little specific evidence regarding the onset of mental or nervous illness caused by noise, some reports are available to indicate temporary effects such as deterioration in concentration and even mental disorientation at high noise levels.

(C) Hearing Loss

Prolonged exposures to loud noise can cause temporary or permanent loss of hearing. People working in noisy places such as industrial establishments, factories etc. often suffer from temporary loss of hearing. If the loudness of noise is moderate or the duration of exposure is short, the damage is only temporary.

(d) Other health effects of noise pollution: Loud noise affects sleep, concentration and work or performance of an individual. Work which needs a high degree of skill and precision is considerably affected. It may cause headache, irritability and fatigue. It is interesting to note that our optical system is considerably affected by noise pollution.

Prevention and Control of Noise Pollution

Loud noise is the form of pollution which often causes much public concern. Therefore, necessary steps have to be taken to control the noise pollution. Some of these are :

1. Reduction of noise at the source of its origin: Often a little precaution can reduce much of the noise pollution caused by loud noise. This can be achieved by replacement of noisy devices or machines with quieter ones. Noise level can be reduced effectively by replacement of noisy and rattling parts, providing better

cushioning to check the vibrations, proper oiling and greasing to ensure smooth running and using effective silencers etc.

2. Application of sound proofing techniques to muffle down loud noises: Sound waves are absorbed by porous material such as perforated sheets and other objects. Just as putting cotton plugs in the ears reduces noise level for the individual concerned, sound barriers placed around the source of origin of loud noises drastically reduce the intensity of sound on the other side of the obstacle.

3. Keeping residential localities free of noisy industries, busy highways, aerodromes etc. Residential localities should be established away from noisy industries, busy highways, aerodromes or else these noisy establishments should be developed away from quiet residential areas. Industrial units can be displaced to some industrial area whereas by passes may be developed to divert busy railway tracks and highways away from domestic establishments. Only that part of traffic should be allowed to get into a residential area which is barely necessary.

4. Enactment of strict legislation and its effective compliance: In most of the countries our own, legal framework against noise pollution has been developed. However, in most of the cases little efforts are made to enforce only effective compliance of these rules much of the nuisance of noise pollution shall automatically be curtailed.

5. Noise control methods in industrial plants

Excessive noise is produced from various types of machines, petrol and diesel engines, electric motors, construction site equipment, pumps and pumping systems, compressed air systems, hydraulic systems, air distribution system, industrial fans, etc. It is always advantageous, economical and effective to identify the noise sources and noise problems right in the design and erection stages and incorporate the necessary noise control measures rather than attending to the problems at a later stage.

The following four approaches are available for noise control :

Approaches Noise Control

(1) Modifying some of the present practices and procedures in order to minimize the noise. Ex: Reducing automobile traffic, outlaying sirens, discouraging stereos without headsets, using glue instead of rivets, etc.

(2) Shielding the sources of noise generation.

Ex: Use of sound-absorbing motor mountings, better installation, better design, use of motor enclosures, use of vibration damping or absorbing materials in automobiles and dishwashers, etc.

(3) Shielding the noise receiver.

Ex: Using earplug, control booths, etc. (4) Shifting noisy sources and things away from people Ex: Isolating airports, industrial complexes, etc. Obviously, some of the above measures can be implemented successfully only if they are mandatory.

THERMAL POLLUTION

The term Thermal Pollution has been used to indicate the detrimental effects of heated effluents discharged by various power plants. It denotes the impairment of quality and deterioration of aquatic and terrestrial environment. Various Industrial plants like thermal, atomic, nuclear, coal fired plants, oil field generators and mills utilize water for cooling purposes.

Thermal Pollution: It can be defined as:

1. The warming up of an aquatic system to the point where desirable organisms are adversely affected.
2. Addition of excess of undesirable heat to water that makes it harmful to man, animal, plant or aquatic life or other wise causes significant dangers to the normal activities of aquatic communities in water.
3. Heated effluents either from natural or man made sources, contaminated with water supplies, may be harmful to life because of their toxicity, reduction in Dissolved Oxygen (D.O.), aesthetically unsuitable and spread diseases.
4. It reduces the number of aquatic species and destroys the balance of life in streams as is evidenced by the biological indices of community and diversity.
5. It is a by-product of rapid and unplanned industrial progress and over population.

SOURCES OF THERMAL POLLUTION

The accelerated pace of development, rapid industrialization and extensive population density have increased demand of thermal power plants. Human activities, today, are constantly adding pollutants to air and water at a higher rate. The following sources contribute to thermal pollution:

1. Nuclear Power Plants: Nuclear power plants, including nuclear experiments and explosions, discharge a lot have unutilized heat into nearby water streams. Emissions from nuclear reactors and processing instruments are also responsible for increasing the temperature of water bodies. Heated effluents from power plants at 10°C higher than the coolant receptor and severely affect the aquatic flora and fauna discharges effluent having drainage from hospitals, institutes, discharged

2. Coal-fired Power Plants: Some thermal power plants ultimately temperature difference of 15°C between effluent and water body. The Thermal power plants utilize coal as fuel and they constitute the major source of thermal pollutants. The heated coils are cooled with water from nearby like or river and discharge the hot water back to the receptor water body and thereby increasing the temperature of the nearby water. The heated effluent decreases the content of dissolved oxygen of water. It results into killing of fish and other marine organisms.

3. Industrial Effluents: Industries generating electricity, like coal as fuel and Nuclear powered thermal plants, require huge amounts of cooling water for heat removal. Other industries like textiles, paper and pulp as well as sugar also release heat in water but to a much lesser extent.

4. Hydro-electric Power: The generation of hydroelectric power, sometimes, results in negative loading in water systems. Apart from electric power industries, various factories with cooling contribute to thermal loading. It has been reported that about 18% more heat is given to cooling ponds in nuclear power plants than any other plant of equivalent size.

5. Domestic Sewage: Domestic sewage is commonly discharged into rivers, lakes and canals with or without waste treatment. The municipal sewage normally has a higher temperature than receiving water. The discharged water not only raises the stream temperature to a measurable extent but also creates numerous deleterious effects on aquatic biota.

EFFECTS OF THERMAL POLLUTION:

The various effects of the thermal pollution

1. Reduction in Dissolved Oxygen: Concentration of dissolved oxygen decreases with increase in temperature of water. For example, the D.O. content is 14.6 ppm in water at a temperature of 32°F and 6.6 ppm at 64°F. Thus cold-water fish, which requires about 6 ppm to survive, would not tolerate the high water temperatures. If they remained in the area they would die of oxygen starvation. Since the aquatic biota live acrobically, so a healthy stream should have an adequate supply of dissolved oxygen.

2. Change in Water Properties: A rise in temperature changes the physical and chemical properties of water. The vapour pressure increases sharply, while the viscosity of water decreases. The decrease in density, viscosity and solubility of gases increases the settling speed of suspended particles, which seriously affect the food supply of aquatic organisms.

3. Increase-in Toxicity: The rising temperature increases the toxicity of the poison present in water. A 10°C rise in temperature doubles the toxic effect of Potassium cyanide, while an 80°C rise in temperature triples the toxic effect of O-Xylene causing massive mortality of fish. In

digestion, excretion and overall development of aquatic organisms. The temperature changes totally disrupt the entire ecosystem. Sharp changes in temperature are often destructive. Because, the life of aquatic animals involves several chemical reactions and the rate of these reactions vary according to changes in temperature.

5. Interference with Reproduction: In fishes, several activities like nest building, spawning, hatching, migration and reproduction etc. depend on some optimum temperature. For instance, the maximum temperature at which lake trout will spawn successfully is 8.9°C. The warm water not only disturbs spawning but also destroys the laid eggs.

6. Variations in Reproductive Rate: The increase in temperature triggers deposition of eggs by female. The triggering is particularly dramatic in estuarine fish, which spawn in four hours after the water temperature reaches critical level.

7. Changes in Metabolic Rate: Fishes show a marked rise in basal rate of metabolism with temperature to the lethal point. The respiratory rate, oxygen demand, food uptake and swimming speed in fishes increase.

8. Increased Vulnerability to disease: Activities of several pathogenic microorganisms are accelerated by higher temperature. Hot water causes bacterial disease in certain fishes such that they fail to develop eggs above critical temperature.

9. Invasion to destructive organisms: Thermal pollutants may permit the invasion of organisms that are tolerant to warm waters and highly destructive e.g. invasion of ship worms into New Jersey's Oyster Creek.

10. Undesirable Changes in Algae Population: The life in an ecosystem is greatly influenced by the algal growth. Excess nutrients from the washout waters from farmlands, thermal plants cause an excessive algal growth with consequent acceleration of eutrophic and other undesirable changes.

11. Destruction of Organisms in Cold Water: The volume of water required for cooling purposes from a stream is enormous. Unfortunately many of plankton, small fish, insect larvae that are sucked into the condenser along with cooling water are killed by the thermal shock, increased pressure and water viscosity.

12. Biochemical Oxygen Demand: When the temperature of stream carrying biodegradable organic matter rises, the intensified action of aquatic organisms causes B.O.D. to be accomplished at a lower temperature. When the temperature of stream carrying biodegradable organic matter rises fish death may occur due to synergistic action, which is caused due to accelerated chemical or biochemical action.

13. Effect on Marine Life: Temperature plays an important role in affecting the physiology, metabolism, growth and development of marine animals. Sea organisms are poikilothermic i.e. their body temperature varies with the surrounding water. Some marine creatures cannot tolerate wide changes of temperature, so they die at higher temperature.

14. Effect on Bacteria: Due to the heated discharges from the industries and plants (industrial), the bacteria are severely damaged. The effect includes coagulation of body Protein, melting of cell fats, toxic action of metabolic products etc.

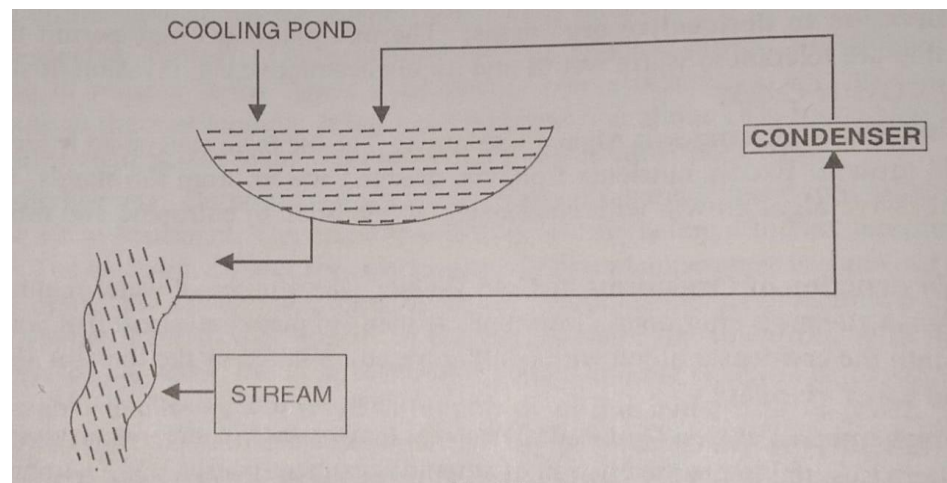
CONTROL OF THERMAL POLLUTION

Heat must be removed from the condenser cooling waters prior to their disposal into water bodies. The major principles involved in the process of heat loss are:

1. Conduction
2. Convection
3. Radiation
4. Evaporation

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

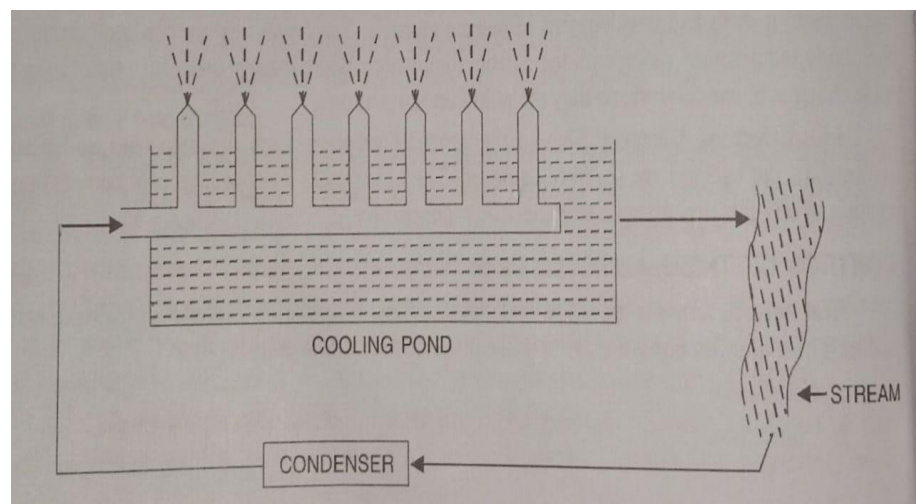
(1) COOLING PONDS :



The water from the condensers is stored in the earth like ponds where natural evaporation brings down the temperature. The water is recirculated again.

(2) SPRAY PONDS:

In spray ponds, the water is sprayed in the cooling ponds with the help of spray nozzels to convert it into fine droplets which provide more surface area to facilitate efficient heat transfer to atmosphere.



(3) Cooling Towers:

WET COOLING TOWERS:

In wet cooling towers, the heated water is brought in direct contact with continuously flowing air. The evaporation brings down the temperature. To increase the surface

area of contact, the water is broken down into droplets by use of spray nozzles or by splashing it on the packing or baffles in the cooling towers.

(4) To handle large quantities of heated effluents, large tanks or reservoirs should be constructed to retain the water for a little longer time. When water cool down to a tolerable temperature, it may be released.

(5) The heated effluents discharged from the chemical industries and thermal power plants can be put in to certain beneficial uses like green house, frost protection during colds, aquaculture, heating the buildings etc.

NUCLEAR HAZARDS

- A number of atoms possess the ability to emit radiations and thereby cause radioactive pollution. Radiations originate from instability of the nuclei of an atom which loses sub-nuclear particles and energy to acquire a stable state i.e radioactivity. It is the state of nuclei which is responsible for the phenomenon. Neutrons and protons constitute the nucleus while electrons revolve round the nucleus (units outer orbits).
- When the number of protons are equal to number of electrons, the chemical properties shall remain the same. Neutrons and protons constitute the mass while electrons constitute charge to the element.
- Thus Radioactive element is defined to be the collection radioactive mass with the same charge of the nucleus. The radioactive atom has the same charge of the nucleus and the same mass is called Radioactive isotope. The Radioactivity of a radioactive substance is expressed by the number of nuclear transformations in unit time.

A radio isotope is characterized by the following properties:

- (i) Half life period.
- (ii) Mode of decays.
- (iii) Energy of radiations.
- (iv) Definite energy state

Radiation is the emission of rays and particles or release of energy from the source (atom). There are two types of radiations ionizing and non-ionizing radiations. These radiations destroy the organic molecules of which the body cells are composed. If ion pairs enter into a living protoplasm, they damage it and the damage is proportional to the number of ion-pairs absorbed. The following types of radiations are given out when an element transmutes or decays.

(1) Emission of alpha (α) particles. Alpha particles are nothing but Helium nuclei. Emission of alpha particle will change into elements of lower atomic number. These are deflected by electric and magnetic fields. They are to show moving, strongly ionizing, weakly penetrating and stopped by 80 mm of air.

(ii) Emission of Beta particles (β) :- Emission of Beta particle changes into another element with a higher atomic number. Beta particles are high velocity electrons. Strongly deflected in electric and magnetic fields. The penetrating power of Beta particles varies with the energy of particles.

(iii) Emission of Gama rays (γ):- These are high energy electromagnetic radiations. Can penetrate several cm. of Lead sheet depending upon the energy. These are undeflected in magnetic fields.

Radioactive decay is a spontaneous process arising from nuclear instability.

Sources of Radio Active Pollution

The two main sources of radioactive pollution are, natural and man made.

NATURAL SOURCES

- The natural sources of radioactivity are considered mainly of the cosmic from the space, and the naturally occurring radio isotopes present in the environment and those contained within the body of the organisms.
- The cosmic radiations are of extra terrestrial origin, which probably arise from the sun or even beyond it. They are consisted of particles of very high energy, primarily of protons and some heavy nuclei.
- These cosmic particles collide with the gas molecules of the upper atmosphere bringing about intense ionization in gases accompanied with the formation of secondary cosmic rays composed mainly of neutrons, mesons, and gamma rays. Eventually a complex mixture of particles reaches the earth as cosmic rays. These particles also form substantial quantities of ^3H and ^{14}C in the atmosphere.

Man-Made Source

Man causes radioactive pollution by testing of nuclear weapons, establishment of nuclear power plants, mining and refining of plutonium, and thorium, and preparation of radioactive isotope.

1. Nuclear weapons

Testing of nuclear arms comprises:

- (a) The use of Uranium 235 and Plutonium 239 for fission.
- (b) Hydrogen or lithium as fusion material.

Atomic explosions are uncontrolled chain reactions. They give rise to very large neutron flux conditions that cause other materials in the surrounding environment to become radioactive. Huge clouds of fine radioactive particles and gases are thrown up in the environment and are carried away to distant areas by the agency of wind. Gradually they settle down on earth as fall out or are brought down by rain.

2. Atomic Reactors and Nuclear Fuel

The most common fuel used for fission in the nuclear power plants are uranium, thorium and plutonium. Uranium undergoes several processes, right from its mining to its inception into the reactors. The spent materials obtained from the reactors, after the energy has been utilized, are reprocessed to recover unburnt uranium, plutonium and some other important isotopes, which can be used in medicine or for some other useful purposes.

3. Radioactive Isotopes

Radioactive isotopes such as ^{125}I , ^{14}C and ^{32}P , and their compounds find wide usage in scientific research institutions contain varying amounts of radioactive materials. When this waste water reaches the different water sources such as rivers, streams, lakes etc. through the sewers they cause water pollution. Radioactive iodine and phosphorus also enter the food chain through water and may finally reach man through fish etc.

4. Other Sources

During different medical treatments, varying concentrations of radiations enter the human body for instance, X-rays are common for detecting skeletal disorders, and therapy for cancer patients often includes radium and other isotope radiations.

Damages to a Biological System

Most of the damages caused by radioactive pollutants stem from their capacity to produce high energy radiations, which are very harmful to a living system. There are two main modes in which radioactive pollution can be dangerous to a biological system.

- (i) Damages caused by radiations from outside source.**
- (ii)** Damages caused by radiations from sources inside the body.
- (iii)** Damages caused by Radiations at different levels

(i) Damages at Molecular level

Damages to macromolecules such as enzymes, DNA, RNA etc. through ionization crosslinkages within and between two affected molecules.

(ii) Damages at sub-cellular level

Damages to cell-membranes nuclei, chromosomes such as fragmentation, mitochondria etc. **(iii) Damages at cellular level**

Inhibition of cell division death, decay and transformation to malignant state.

(iv) Damages to Tissues and Organs

Disruption of such systems as central nervous system, loss of sight, inactivation of bone marrow activity resulting in blood cancer malignancy and ulceration of intestinal tract.

(v) Damages to an Individual and whole population

- Death or shortening of life due to radiations changes in characteristics due to mutations. In human beings exposure of radiations results in little visible effects in early stages. But after 12-24 hours injury symptoms manifest themselves.
- This includes reddening of skin, anemia, anorexia. Vomiting, and diarrhoea and with heavy doses, blister formation, pigmentation of skin, burning sensation all over the body, loss of sight etc. It must be noted that for all this there is no cure available. Once a person is exposed to radiation he has to bear its consequences. Medical aid can do little.

HAZARDS ASSOCIATED WITH RADIO ACTIVE POLLUTION

Major hazards associated with radio-active pollution can be summed up as follows:

(1) No physical, chemical or biological process can influence the process emissions. The unstable nuclei have to decay and acquire a stable state.

(2) A number of radio-active isotopes have a very long half-life takes 14,000,000,00 years to lose half of its radio-activity . Half of Uranium-235 ($^{92}\text{U}235$) takes 710,000 years to disintegrate. Half of Neptunium-237 ($^{93}\text{Np}237$) decays in 21,00,000 years. This makes these radio-active wastes almost a permanent hazard for the biosphere.

(3) Most of the radiations have a high penetrating power. Thick sheets of steel, cement concrete walls etc, can not contain them. They can easily penetrate to deep seated organs and cause injury.

(4) Nucleic acids (DNA and RNA) effectively absorb these radiations. Even low level radiations which do not cause any visible damage are completely absorbed by nuclear material which causes carcinogenic, mutagenic and teratogenic effects.

(5) A biological system is unable to distinguish between a radio-active and a normal isotope of an element as their physical and chemical properties are similar. Radio-active isotopes are therefore, absorbed and incorporated within the bodies of living organisms as normal isotopes are. This lodges a radio-active source within the body of the organism itself.

(6) Like any other element radio-active isotopes are also absorbed, accumulated and biomagnified thousands of times. Thus the entire food chain becomes contaminated. Organisms at higher trophic levels may, therefore, receive a highly concentrated source of radio-active material through their food supply.

(7) There is no other way to dispose off these hazardous wastes except to store them for thousands or millions of years away from living beings. This is too long a period on human scale of time. Even the safest burial places for radio-active wastes, which represent the best of human efforts, have shown signs of leakage. At present it appears very difficult, though not impossible to store radio-active wastes away from the biosphere for such long periods.

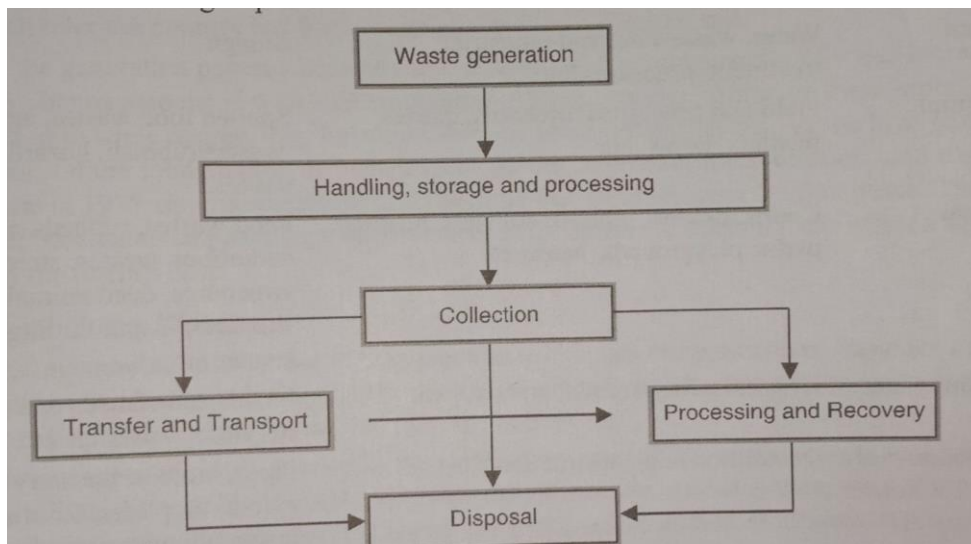
(8) In spite of all these hazards, nuclear reactors and tests are still continuing and an increasingly large amount of radio-active wastes is accumulating every day while no solution to the problem of their safe disposal is in sight till date

SOLID WASTE MANAGEMENT

Any material that is thrown away or discarded as useless and unwanted by human or animal activities is considered as solid waste. In earlier period, the disposal of solid waste was simple but now a days it is a great challenge. The management of waste is the fundamental concern of the activities encompassed in solid waste management. The purpose of the study of solid wastes

- (i) Identify the various types of solid wastes and their sources.
- (ii) Examine the composition of wastes.
- (iii) Consider the elements involved in their management.

The activities involved with the management of solid wastes from the point of generation to have been grouped in to six Functional Elements



'The total quantum of solid waste generated in an area depends upon its population and urbanization. Solid wastes generation is directly related with income. Higher the income greater is the waste generation.

Sources of solid wastes

Sources of solid wastes can be clarified in to following categories:

1. Residential
2. Commercial
3. Municipal
4. Industrial
5. Open areas
6. Treatment plants

7. Agriculture
8. Hazardous wastes
9. Construction sites

TYPES OF SOLID WASTES:

Garbage: Food wastes are the animal, fruit, or vegetable residues resulting from preparation, cooking, and eating of foods. It is also known as garbage. Rubbish: Rubbish consists of combustible and non-combustible solid wastes of households, institutions, commercial activities, etc, excluding food wastes or other highly perishable materials. Paper, Cardboard, Leather etc.,

Ex, Combustible- Non-Combustible -Aluminium cans, tin cans, glass etc. Ashes and Residues: Materials remaining from the burning of wood, coal coke and other combustible wastes are categorized as ashes and residues.

Demolition and Construction wastes:

Wastes from buildings and other structures are classified as demolition wastes. Wastes from the construction, remodeling, and repairing of individual residences, commercial buildings, and other structures are classified as construction waste.

Wastes such as street sweepings, roadside litter, catch basin debris, dead animals and abandoned vehicles are classified as special wastes.

Agricultural Wastes

Wastes and residues resulting from diverse agricultural activities-such as the planting and harvesting of rice, field, and tree and vine crops, the production of milk, the production of animal for slaughter, and the operation of feed lots are collectively called agricultural wastes. **Hazardous wastes:**

Chemical, biological, flammable, explosives, or radioactive waste that are harmful to human, plant or animal life are classified as hazardous wastes.

Collection of Solid Wastes:

Collection of solid wastes in urban areas is difficult and complex because the generation of residential and commercial-industrial solid wastes is a diffuse process that takes place in every home, every apartment building, and every commercial and industrial facility as well as in the streets, parks, and even the vacant areas of every community. The mushroom like development of suburbs all over the country has further complicated the collection task.

Effects of Solid Wastes

- The accumulation of waste at any place is a bad and risky situation. Varieties of microorganisms like bacteria, fungi, viruses, worms etc creep in to the accumulated waste and start its decomposition. Later on they grow and increase in number.

- Various types of germs develop in the waste. They reach us through air, water and food. Most of the infectious diseases like cholera, diarrhoea, dehydration etc. spread in these ways.
- Air pollution, water pollution and soil pollution are caused due to the accumulation of different types of wastes. Harmful fumes from industries and other waste effects eyes, skin, historical moments etc. Asbestos particles from Asbestos Industry causes Asbestosis. Accumulation of heavy metal particles cause serious health hazards. Mercury can cause Minamata disease.
- Waste material when accumulated here and there disturbs the drainage system. Decomposing wastes reach underground and contaminate underground water and soil.

Special Wastes:: Management of solid waste Waste management is the collection, transport, processing or disposal of waste as to reduce their effects on local environment and community . Because it can not be stopped absolutely materials so

Methods of solid waste disposal.

There are following methods:

(a) Physical removal.- It is generally done by manual activities like, collection of wastes and sorting out in to reusable, decomposable and non decomposable. Then disposal becomes easy. Dustbins should be used in homes, offices and dispose accordingly i.e. to kabadi or for reuse, recycle. Some Municipals are also doing such jobs.

(b) Dumping- Transfer of solid waste from place of collection to the site of disposal is called dumping. Corporations and Municipal bodies collect and dump them on some suitable and safe site located far away from human habitation.

(C) Compaction and Bailing- The solid wastes are often spread on a plane and hand surface and later pressed by bulldozer. This is called compaction. These compacted layers are rolled and piled. This is called bailing. Now such compacted and bailed solid wastes are dumped for decomposition.

(2) 3R or Reduce, Reuse and Recycle of solid waste

(A) Reduce of waste material- We should reduce the household waste by using maximum part of the goods. Before throwing out side, we should select the parts for Reuse/Recycle. When we purchase the things, avoid polythene and heavy packages.

Hazardous waste can be controlled by reduction at source. We should suggest friends, relatives to save all clean papers and other various means to save paper. Gaseous wastes are generally removed through combustion, absorptions and adsorption techniques. There should be proper cooperation and co-ordination among individuals, local bodies and Govt Institutions for proper waste management in an area. Reduced demand for any metallic product will decrease the mining of their metal and cause less production of waste. Thus, every individual has a responsibility of creating less waste and managing its properly.

(B) Reuse of waste materials.

After selecting the waste (which can be reused) use after the proper treatment. We should not use, cups, plates, utensils, napkins etc of paper. If they are of permanent nature, therefore, they can be reused after washing. Plastic bags, wrap, foils, rotten articles should not be used.

We should use refillable lighters, containers, and other usable items. We should discourage use and throw policy. Sell or donate goods instead of throwing them out. Furniture, clothes and other repairable articles should be reused after repair instead of throwing. We should develop quality of borrow, share and rent in ourselves.

(C) Recycling of waste materials. Sewer and other drainage systems are associated with sewage treatment devices that centralize toxic effects of sewage before releasing it to the local water systems. Principal operations of solid waste disposal incorporate composting, sanitary, land filling, thermal process or incineration.

(1) Sewage treatment.

It is done through following steps:

(a) Neutralized sewage

(a)The sewage is sent through setting chambers, where lime is mixed with it. Thus it becomes neutralized and most of the sediment is removed.

(b)Neutralized sewage is passed through Upflow Anaerobic Sludge Blanket (UASB). Here, decomposable material is decomposed through bacterial activities in absence of oxygen. After that water is passed through aeration tanks where air and bacteria are mixed.

(c) Dissolved substances are removed by processes like chlorination, evaporation, exchange technique and absorption.

The treated water is used accordingly.

ii) Pulverisation:- The volume of solid waste is reduced through grinding or smashing for easy handling to transport and disposal.

(iii) Composting :-The process of making manure of decomposable waste with the help of microbial activities is called as composting. It is of two types Aerobic i.e. in presence of air and Anaerobic i.e. in absence of air. For this different size pits are dug in the ground and all the biodegradable solid, semi solid wastes are dumped and fully filled pits are covered with a layer of soil. Water is added time to time. The average time for composition is 1-6 months.

Sanitary Landfilling: In this process solid wastes are scientifically filled in to low lands. As all this wastes can not be recycled or burnt, there will be always a need for land fill. In sanitary landfills, garbage and other waste is spread out in their layers, compacted and covered with clay or plastic foam. The process of filling is done in such a way that wastes can not create any type of hazard to public health.

(IV) Thermal process : Burning of solid waste under controlled conditions is called as thermal process. The heat produced in this process may be utilized. It is carried out in both the presence and absence of air.

ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

Pollution and poverty are complimentary to each other. Some time people forced to go with the path of pollution. Illiteracy is another factor in the prevention of pollution. Unlimited desires, selfishness, urbanization, industrialisation, deforestation, to increase the life style etc. are some of big factors which are main cause of pollution. For that the need is to understand first, apply then be a lesson for others. Gandhiji was not an environmentalist but was for the concept of sustainable development

In short, an individual can do as following safety measures to prevent the pollution –

(1) One should start first in the field of environmental awareness to protect the pollution.

(2) We should go place to place to teach the lesson of awareness and prepare volunteers. (3) Give the message to save environment through papers, magazines, T.V. and radio.

(4) To promote for plantation and conservation of forest.

(5) To organize seminars, on the subject related to pollution.

(6) One should go in rural areas during festivals, functions, local gatherings, and religious occasions to convince people for prevention of pollution.

(7) Awareness is very effective in childhood, hence we should go to schools, organize rallies to teach the lesson of environment.

(8) World forest day, world environmental day and other such function should be organized for general awareness. On these functions, Govt. should also take interest in this regard but we should not depend on Govt.

(9) Population growth should be reduced.

(10) We should use and promote mass transport system. If possible go on foot or use bicycle for short distances.

(11) We should not use materials containing CFC eg Refrigerators, Cups, etc.

(12) We should discourage the use of more fertilizers insecticides and pesticides but should encourage the use of bio fertilizers.

DISASTER MANAGEMENT

FLOOD

- As floods are one of the very few well recorded natural phenomena, the catastrophic damages caused by them attracted focused attention in recent decades. With increasing population pressure and accelerated economic development, the adverse effects of floods are being increasingly felt now.
- The term Flood is generally defined as a relatively high flow or stage in a river and the inundation of low land which might result therefrom. In a broader sense

the term flood is used to convey all their outfalls into main rivers, outflow due to jamming or blocking of rivers by landslides and inadequate drainage to carry away surface water speedily. Coastal floodings are also covered.

- In India vast stretches of land are submerged under water and other adverse effects are caused, such as destruction or damage to houses, property, bridges roads and other means of communication lives lost etc. year after year.
- The disastrous floods of 1954 and the immediate succeeding years resulted in the initiation of organized and coordinated flood management efforts to mitigate the problem.

CAUSAL PHENOMENA AND CHARACTERISTICS

- Flood are natural phenomena characteristic of all rivers. As is known, the rainfall in India is largely dependant on the monsoons and cyclonic depressions. Most of the rainfall is received during the southwest monsoon season during which heavy spells of rain are often experienced in the catchment over the period of a few days at a time.
- It could therefore be said that high rainfall coupled with inadequate channel capacity leads to flooding. Choking of rivers beds by natural causes or artificial obstructions aggravate the problem.

VULNERABILITY

- An extreme natural phenomenon capable of causing disaster (leading to loss of lives or damage to property) is known as a natural hazard. The process of identifying the probability of occurrence of a natural hazard of a given intensity at a specific location, based on an analysis of natural processes and site conditions is termed Hazard assessment.
- Vulnerability indicate the conditions (physical, socioeconomic/political) which increase the community's susceptibility to disaster or which adversely affect its ability to respond to events. It thus gives an idea of the expected degree of damage to a construction or an economic activity when exposed to a natural hazard of a given intensity.
- Risks are the probable losses in a given area or to an infrastructure system caused when the hazard materializes. The type and degree of flooding is influenced by many factors. The principal factors can be classified to fall under three groups.

(1) climatological conditions.

(2) hydrological and environmental conditions

(3) local geomorphology off the flood plain In addition, coastal flooding also depends on the coastal configuration and tidal

ADVERSE EFFECTS OF FLOODS

All over the world, and throughout history, natural disasters have imposed human suffering and extracted heavy toll of losses. Recent instances have revealed that it is

not merely the developing countries that have so suffered. The loss in some of the highly developed Nations is mind boggling notwithstanding the high standards of construction and extensive protection measures that they had undertaken.

Apart from the casualties, injuries and disablement, many sections of the population get affected by the floods. Cropped area gets submerged, eroded and strewn with sand leading to loss of crop production and consequential disruptions. Many houses are destroyed completely; others are damaged. Damage and loss to public and private utilities and industrial disruptions occur. Breakdown of economic activities occurs with corresponding loss of wealth.

The statistics compiled suffer from one disabilities and many suggestions for better compilation of flood damages have been also offered. Moreover damage figures compiled by interested parties or even the Govt. for other purposes may not indicate the precise picture of losses. However the broad figures as indicated above serve the purpose of indicating the order of losses. In any case the exact assessment of the comprehensive loss to the economy of the Nation or to the individuals is a near impossible task.

EARTHQUAKE

- Earthquakes are considered to be one of the most dangerous and destructive natural hazards. The commencement of this phenomenon is usually sudden with little or no warning.
- It is not yet possible to predict earthquakes and to make preparation against damages and collapse of buildings and other man-made structures.
- Actually earthquake consists of a sudden shaking (vibrations) of ground caused by disturbances in the earth's crust.
- An earthquake generates a set of horizontal and vertical vibrations of the ground which are random in character.
- Earthquakes may be defined as a natural phenomenon which tends to create panic due to the trembling vibrations of sudden undulation of a portion of earth's crust caused by splitting of a mass of rock (Tectonic) or by volcanic or other disturbances.

GENERAL CHARACTERISTICS

Impact of Earthquakes is sudden with little or no warning. However, following a major Earthquake, the after-shocks may give warning of a further earthquake. On some occasions, an earthquake may be preceded by a less intense tremors or foreshocks.

. It is not yet possible to predict magnitude, time and place of occurrence of an earthquake.

- The onset is usually sudden.
- Earthquake prone areas are generally well identified and well known on the basis of geological features and past occurrences of earthquakes.

- Major effects arise mainly from ground movement and fracture or slippage of rocks underground. The obvious effects include damage (usually very severe) to buildings and infrastructures alongwith considerable casualties.

. On the average about 18000 people die each year due to this disaster throughout the world.

- About 200 large magnitude earthquake ($M > 6.0$) occur in a decade. a

- The world's earthquake problem seems to be increasing with the increased population, high rise buildings and crowded cities.

PRE-CURSORS INSTRUMENTAL AND NON-INSTRUMENTAL

- We have already stated that it is not yet possible to predict earthquakes. However, sometimes there are some indication that would indicate that perhaps an earthquake would occur. Such indications are called “precursors”.
- There could be either instrumental, i.e., those that are measured by instruments or non-instrumental, i.e. those which can only be perceived and not measured. Needless to say, the non-instrumental precursors are more subjective.

VULNERABILITY

- Disasters result from vulnerable societies being exposed to a hazard. There can be physical vulnerability, social vulnerability and economic vulnerability on account of an earthquake disaster.
- Physical vulnerability relates to buildings, infrastructure and agriculture. The vulnerability of buildings is dependent on their sets, shape, materials used, construction techniques, maintenance and proximity of buildings to others. The weightage attached to each factor will vary according to the characteristics of the particular earthquake.
- Infrastructure may be considered in three broad groups: transport systems (roads, railways. bridges, airports, port facilities): utilities (water, sewerage and electricity); telecommunications; dams and flood protection embarkments.

Social Vulnerability

Records of past earthquake disasters suggest that the following groups of people are particularly at risk and require special attention:

- Single parent families:
- Women, particularly when pregnant or lactating.
- Mentally and physically handicapped people:
- Children, and
- The elderly.

Poor people are less concerned with infrequent hazards. If there are groups whose livelihoods are at risk, living or working in densely populated areas, with low

perceptions of risk and without institutional support, the cumulative effect would be high social vulnerability.

ECONOMIC VULNERABILITY

- It measures the risk of hazards causing losses to economic assets and processes. It focuses only valuating the direct loss potential (i.e. damage or destruction of physical and social infrastructure and its repair or replacement cost, as well as crop damage and losses to the means of production); indirect loss potential (i.e. the impact on cost production, employment, vital services and incomeearning activities); and secondary effects (epidemics, inflation, income disparities and isolation of outlying areas).
- With the insights provided by economic vulnerability analysis, it is possible to estimate direct and indirect losses and to design ways and means to mitigate them in relation to the estimated costs of relief/recovery actions and mitigation measures required.

IMPACT AND EFFECTS

In general terms, typical impacts and effects of earthquake disasters tend to be :

- Loss of Life.
- Injury
- Damage to and destruction of property.
- Damage to and destruction of subsistence and cash crops.
- Disruption of production.
- Disruption of lifestyle.
- Loss of livelihood.
- Disruption to essential services.
- Damage to national infrastructure and disruption to administrative and organizational systems.
- National economic loss.
- Sociological and psychological after-effects.

The following problem areas need particular attention in case of Earthquake disasters: Severe and extensive damage, creating the need for urgent counter measures, especially search and rescue, and medical assistance.

- Difficulty of access and movement.
- Widespread loss of or damage to infrastructure, essential services and life support systems.
- Recovery requirements (i.g., restoration and rebuilding) may be very extensive and costly.

. Occurrence of earthquakes in areas where such events are rather rare may cause problems due to lack of public awareness.

NATURE OF DAMAGE

Damages due to earthquakes are the related terms and depends upon various factors listed below:

- (a) Nature of earthquake.
- (b) Geological and soil conditions
- (c) Quality of construction.
- (d) Sociological factors.

CYCLONE

- Cyclones are one of the most disastrous natural hazards in the tropics and are responsible for deaths and destruction more than any other natural calamities. Cyclones bring with them extremely violent winds, heavy rain causing floods and storm tides causing coastal inundation.
- Cyclones form over the warm ocean waters (sea surface temperature of the order of 26°C or 27°C) little away from the equator within the belt of 30°N and 30°S. In our area, cyclones form in the Bay of Bengal and the Arabian sea. As they move westward or northwestward, those forming in the Bay of Bengal come to the Indian territory while those forming in the Arabian Sea generally go away from India but sometimes they turn around to hit Gujarat.

RISK REDUCTION PROCESSES

- The prevention of tropical cyclone formation is not within the realm of possibility. However, the loss of human lives and destruction of properties can be minimized by adopting prescribed short and long term measures for risk reduction.
- While cyclone warning system is the most important constituent of short term risk reduction measures against cyclone disaster, the risk assessment of tropical cyclone falls under long term measures.
- As prevention of formation of tropical cyclone is not in the realm of possibility, some structural and non-structural preventive measures of long term nature can be undertaken to mitigate the suffering of cyclone affected people.
- Structural measures like construction of cyclone shelters, embankments, dykes, reservoirs and coastal afforestation are some of the long-term risk reduction measures for cyclone disasters. Creation of proper awareness, training and education of people in the vulnerable communities, introduction of insurance can be some of the non-structural measures.

EFFECTS

Severe tropical cyclones are responsible for large casualties and considerable damage to property and agricultural crop.

The destruction is confined in the coastal districts and the maximum destruction being within 100 km from the centre of the cyclones and on the right side of the storm track. Principal dangers from a cyclones are:

- (i) very strong winds
- (ii) torrential rain, and
- (iii) high storm tides. Most casualties are caused by coastal inundation by storm tides.
- (iv) Maximum penetration of storm surges varies from 10 to 20 km inland from the coast.
- (v) Heavy rainfall and floods come next in order of devastation.

LANDSLIDES

- Often it is not realized that a large part of India consists of mountainous terrain. In the north, there is the extensive Himalayan mountain system extending all along from the west to the east. Its lofty peaks rise to more than 8000 metres height.
- The middle ranges of the Himalayas 5000 metres high on the average while the foothills rise to about 6000 metres. The Himalayas abound in glaciers and are the origin of many rivers and streams. There is abundant rainfall and snowfall often accompanied by strong winds.
- The peninsular region of India starts from the Vindhya ranges and consists of the Deccan Plateau which slopes eastwards.
- On its edges, this great plateau is bound by the mountain the Eastern Ghats and the Western Ghats. The Nilgiri mountains are in the southern parts of the ranges plateau. The west-central parts of the country have the ranges of the Aravali mountains.

LANDSLIDES IN INDIA

- Landslides affect the remotely located, often isolated, small communities in villages or hamlets in the mountain regions of the country where external assistance takes time to reach in times of emergency when the normally difficult terrain and tracks may become almost impossible to negotiate.
- Many a times, even the information about the occurrence of such events and the damage done takes days to reach the district and state headquarters. Because of these reasons, landslides and snow avalanches assume the status of major natural disasters even though the affected area and population may be rather small.

Incidence of landslides in India

Region	Incidence of Landslides
Himalayas	High to very high
Northeastern Hills	High
High Western Ghats and the Nilgiris	Moderate to high
Eastern Ghats	Low
Vindhyachals	Low

Kind and Magnitude of Damage

There is no doubt that anything that comes in the ways of a landslide will suffer severe damage and may even be totally buried or wiped out. Anything located on top of a landslide will also not survive when the rock or mud slips out from below it.

Landslides : More often, the major landslides are combinations of rockslide and rockfall. They all involve movement of mass (soil, debris or rock). The process of movement of mass may vary from slow soil creep to abrupt and sudden rockfall. Landslides, also known as landslips, range from low angle and rather slow slides to sudden vertical falls.

Based on the type of movement, relative rate of movement and kind of material involved, landslides can be designated into 5 kinds as follows:

- Slump with earthflow
- Debris slide
- Debris fall
- Rock slide
- Rock fall

Landslides are also known to result in blocking of streams or overflowing of lakes thus causing flash floods because large volumes of debris falling in a lake or reservoir cause its water to overflow or the temporarily blocked stream may suddenly release the huge quantity of impounded water to cause a devastating flash flood downstream.

Relief and Rehabilitation

Essentially, the relief steps comprise the following:

- (1) Search and Rescue
- (2) Medical assistance to the injured
- (3) Disposal of the dead
- (4) Food and water

- (5) Emergency shelter for the homeless
- (6) Opening up access roads if blocked; and restoration of communication channels
- (7) Psychological counseling of the survivors who have lost their close relatives
- (8) Repair of houses and facilities
- (9) Assistance (technical and financial) to restart economic activity to restore regular work and income
- (10) Reconstruction through proper planning.

We have already discussed the relief steps in the preceding section. As regards the long-term measures, these will comprise the following:

- (1) Reducing the hazard proneness of the site through engineering measures such as strengthening or modifying the slopes, removing fragile and unstable portions, securing snow accumulations by snow fences, snow nets or by cribbing, and improvement of drainage.
- (2) Stopping indiscriminate quarrying and mining in mountain areas.
- (3) Afforestation of zones prone to landslides so that trees and vegetation provide a binding force to prevent slippage of debris, rock, and snow.
- (4) Creation of a voluntary, community based preparedness system of watch, monitoring and alert. This will not only be useful in times of a disaster but will provide enough self confidence (and thereby self reliance) which is an essential objective of an effective rehabilitation programme.
- (5) Provision of assistance for economic rehabilitation by arranging work, employment loans, and grants.

In the extreme case of severe damage to a community by a landslide or snow avalanche, the site may be rendered totally unusable. In that case, rehabilitation takes the form of relocation and reconstruction. In such an event, the new site should be carefully chosen so as to minimize vulnerability and risks.

Unit 6: Social issues and the Environment

UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT

- More and more natural resources were consumed in the process of satisfying the rapidly growing needs of the habitat. Every development activity has some impact on the environment.
- For meeting the needs, the human cannot live without the developmental activities. Consequently, there is need to continue developmental activities in such a way that environment should not be polluted at least.
- Unsustainable development means the development of a few privileged nations both in science and technology. Such developments are at the cost of our life supporting systems like air, water, soil and over exploitation of our natural resources which may lead to the collapse of the inter-related systems of the earth.

There are two aspects of sustainable development:

(i) Inter-generational equity - This emphasizes that we should stop over-exploitation of resources, reduce waste discharge and emissions and maintaining an ecological balance. It expects to hand over a safe healthy and resourceful environment to the future generations.

(ii) Intra-generational equity - This emphasizes that technological development should support economic growth of the poor countries so as to reduce the wealth gap within and between the nations.

Measures for sustainable development - There are following major measures for sustainable development:

1. To promote environmental education and awareness - From childhood, we should develop a feeling of belongingness to earth. This can be possible by introducing environment as a subject in education from primary stage. Media can also be helpful in developing such feelings.

2. Three 'R' approach - Three 'R' means, Reduce, Reuse and Recycle. We should reduce the excessive use of natural resources, but use them again and again instead of passing it on to the waste stream. Recycle the materials to reduce pressure on our existing natural resources.

3. Appropriate technology - The technology should use less resources and produce minimum waste. It is one which is locally adaptable, eco-friendly, resource efficient and culturally suitable.

4. To utilize resources as per carrying capacity of the environment - Sustainability of a system depends largely upon the carrying capacity of the system. If carrying capacity of a system is crossed, environmental degradation starts and continues till it reaches a point of no return. Carrying capacity has two basic components.

(i) Supporting Capacity - It is formed of productive and protective systems

(ii) Assimilative Capacity - It is formed of the systems which utilize the wastes produced by human activities.

Urban Problem Related to Energy

- Urban areas are developing very fast. In most of cities there is influx of populations from surrounding areas, mostly in search of employment and better living conditions. Therefore, it is difficult to accommodate all the industrial, commercial and residential facilities within limit. As a result, cities are spreading in to sub-urban or to rural areas. Uncontrolled population, irregular development are the main factor for receding facilities in urban areas.
- Energy is required in every walk of life like industry, transport, defence, agriculture, trade, education, domestic etc. Cities are the main centres of economic growth. Hence, energy is the most important input for development.
- The energy requirements of urban population are much higher than that of rural ones. Energy problems become more severe due to the limited amount of non-renewable resources of energy.

There are following main causes of energy problems.

1. Increasing use of energy for domestic and commercial purposes (due to increased population and industrialization).
2. Industrial plants using big proportion of energy.
3. Non-renewable resources of energy like coal, petroleum and natural gas are decreasing.
4. Increasing of transport means.
5. Decreasing production of Hydroelectricity due to insufficient rains.
6. Transmission loss due to defected power distribution system.

There are following steps to solve the energy related problems.

1. To control urbanization.
2. To develop renewable resources of energy like solar radiation, wind power, hydel power, nuclear power, bio mass etc. These are pollution free also.
3. Non-renewable energy resources should be used only when no non-conventional source of energy is available.
4. Welcoming the awareness programs to save energy.
5. Effective measures for transition loss and energy theft.

WATER CONSERVATION

- Water is needed in almost every sphere of human activity. Without water life is not possible. In many aspects the properties of water are unique. It is called universal solvent. No other liquid can replace

- it. The global distribution of fresh water on earth's crust including ground water and water present as its vapours in atmosphere.

Water is required for direct consumption or indirectly for washing, cleaning, cooling, transportation or even for waste disposal. Important sectors of human activity, which require water can be grouped as:

1. Irrigation
2. Industries
3. Live stock management
4. Thermal power generation
5. Domestic requirements
6. Hydroelectric generation, fisheries navigation and recreational activities.

The following steps should be taken for conservation of water.

1. Water economy, Re-use and Recycling. If water meters are installed and charged properly, the consumption of water in domestic establishments, livestock management and industries shall drastically decline. The heated water from thermal power plants, where large amount of water is needed, may be utilized elsewhere after proper cooling. The same is true for many industries, water used once may be used again for another purposes.

2. Agricultural runoffs from fields. This can be used to irrigate cropland down the stream, while an efficient use of water with conditions of proper drainage can significantly reduce the agricultural runoffs.

3. Efficient distribution system. Water resources are not distributed evenly. Some localities have plenty of water and others have little. Many river basins have plenty of water, which flows down un-used to the sea. Surplus of one basin can be used to make up the deficit at another.

4. Enhancement of surface storage capacity. About 27000 Cubic kms of fresh water which rush down to the oceans through stream and rivers are of no use to the mankind. We can store this water in tanks, reservoirs, dams for further use in drier seasons.

5. Reduce evaporation losses. Water losses through evaporation and seepage are enormous both from the reservoirs and distribution system. It should be reduced.

6. Improvement of underground storage capacity. The fresh water is stored in underground deposits. Every year about 10-15% of the total precipitation enters the ground water table. These deposits regularly feed streams and rivers during the drier periods. These deposits are cheap and easily obtainable.

7. Desalination of Sea Water. A huge store of water exists in our oceans. If the salt content of the sea water is removed, we can use it. This can be done by desalination plants.

8. Afforestation and Reforestation of hill slopes to check loss of water in floods.

9. Artificial rain making and precaution of water pollution.

RAIN WATER HARVESTING

- Water is an essential natural resource for sustaining life and environment. So Conservation and preservation of water resources are urgently required to be done. Water management has always been practiced in our communities since ancient times, but today this has to be done on priority basis.
- The ministry of Water resources in India is endeavouring to make rain water harvesting a part of every day life in our villages and cities as a people's movement, and this will go a long way in the management of ground water as a sustainable resource.
- Government and the people join hands for creating awareness of the importance of rain water harvesting with the main objective of adopting these measures and techniques throughout the country.
- A judicious mix of ancient knowledge, a modern technology, public and private investment, and above all, people's participation will go a long way in reviving and strengthening water- harvesting practices throughout the nation.

Rainwater harvesting is categorized into domestic rain water harvesting and rain water harvesting for agriculture, erosion control, flood control and aquifer replenishment.

Domestic rain water harvesting, also known as roof water harvesting or roof top rain water harvesting is the technique through which rain water is captured from roof catchments and stored in tanks or reservoirs.

Rain water harvesting systems, both small and large, consists of six basic components.

- (a) Catchment area/roof, the surface upon which rain falls.
- (b) Gutters and downspouts, the transport channels from catchment surface to storage.
- (c) Leaf screens and roof washers, which are systems that remove contaminants and debris.
- (d) Cisterns or storages tanks, where rain water is stored.
- (e) Water treatment, the filters and equipment as well as additives to settle, filter and disinfect.

The main causes of fall in ground water levels are:

- (a) Overexploitation or excessive pumping either locally or over large areas to meet increasing water demands.
- (b) Non-availability of other sources of water. Therefore, sole dependence is on ground water.
- (c) Unreliability of municipal water supplies both in terms of quality and quantity, driving people to their own sources.

(d) Misuse of ancient means of water conservation like village ponds, baolis, percolation tanks and therefore, higher pressure of ground water development.

The main effects of overexploitation of ground water resources are:

- (a) Drastic fall in ground water levels in some areas.
- (b) Drying up of the wells/bore wells.
- (c) Enhanced use of energy.
- (d) Deterioration in ground water quality.
- (e) Ingress of sea water in coastal areas.

The method and technique include:

- (a) Roof top rain water harvesting and its recharge to underground through existing wells or bore wells or by constructing new wells, bore wells, shafts, spreading basins, storm water drains etc.
- (b) Harnessing runoff in the catchments by constructing structures such as gabions, check dams, percolation trenches, sub-surface dykes etc.
- (c) Impounding surplus runoff in the village catchment and water sheds in village ponds and percolation tanks.
- (d) Recharging treated urban and industrial effluents underground by using for direct irrigation or through recharge ponds or wells etc.

The main objectives of rain water harvesting are :

- (a) To restore supplies from the aquifers depleted due to over exploitation.
- (b) To improve supplies from aquifers lacking adequate recharge.
- (c) To store excess water for use at subsequent times.
- (d) To improve physical and chemical quality of ground water.
- (e) To reduce storm water run-off and soil erosion.
- (f) To prevent salinity ingress in coastal areas.
- (g) To increase hydrostatic pressure to prevent or stop land subsidence.
- (h) To recycle urban and industrial waste waters etc. ponds,
- (i) To rehabilitate the existing traditional water harvesting structures like village percolation tanks, baolis, tanks etc.
- (j) To convert the traditional water harvesting structures into ground water recharge facilities with minor scientific modifications and redesigning.
- (k) To use the existing defunct wells and bore wells after cleaning and also the operational wells as recharge structures.

The expected advantages of rain water harvesting are:

- (a) Rise in ground water levels in wells.
- (b) Increased availability of water from wells.
- (c) To prevent decline in water levels.
- (d) Reduction in the use of energy for pumping.
- (e) Reduction in flood hazards and soil erosion.
- (f) Improvement in water quality.
- (g) Arresting sea water ingress.
- (h) Assuring sustainability of the ground water abstraction sources and consequently the village and town water supply systems.
- (i) Mitigating the effects of droughts and achieving drought proofing.

WATERSHED MANAGEMENT

- Watershed is a drainage area on earth's surface from which runoff, resulting from precipitation flows past a single point in to a large stream, a river, a lake or the ocean. It is a geo-hydrological unit and drains at a common point, has been accepted world over as a scientific unit for area development.
- The watershed can range from a few square kilometre to few thousand square kilometre in size. Damodar Valley Corporation in 1949 adopted first Integrated Watershed Management. Watershed development is the rational utilization of natural resources of soil water and vegetation for increasing and stabilizing the productivity of land on a sustainable basis.
- The development of watershed will result in increase in sub soil water regime, recharge of wells.
- The watershed based development approach is undoubtedly an agreeable concept to set the goal. But this demands a massive people's movement to make the village community self reliant.
- The watersheds are very often found to be degraded due to uncontrolled, unplanned and unscientific land use activities like over grazing, deforestation, mining, soil erosion, industrialization etc.

Objectives of watershed management.

Watershed management is the rational use of land and water resources for optimum production causing minimum damage to the resources.

The main objectives of watershed management are as :

1. To increase agricultural production i.e. increasing the availability of fodder, fuelwood, timber and raw materials for industries.
2. The rational utilization of natural resources like water soil and vegetation.
3. To minimize the risks of floods, droughts and landslide.

4. To Manage the watershed for developmental activities like domestic water supply, irrigation, hydropower generation.
5. To develop the rural areas and their lifestyle.

Under the development of national policy, the watershed management was included in fifth Five Year Plan. Now a days, a number of national watershed development programmes are in progress. Various measures are necessary for watershed management.

Some of them are :

1. Scientific mining and quarrying must be done in the watershed areas because hills loose stability and get disturbed by improper mining.
2. Water harvesting in the watersheds to be used in dry season .
3. Afforestation and agro forestry (crop plantation) should be promoted to prevent runoffs loss and soil erosion and increase soil moisture. Woody trees like Eucalyptus and Lencaena should be grown in between crops to reduce the runoffs and loss of fertile soil in high rainfall areas.
4. some mechanical measures like terracing, bunding, bench terracing, contour cropping etc. are used to minimize runoff and soil erosion in the slopy regions of watersheds.
5. To promote soil binding plants like Vitex.
6. People's participation should be ensured including farmers and tribals in the water shed management programmes. This can be done by properly educating people about the campaign or paying some incentives.

The Himalayas are one of the most critical watersheds in the world. Most of the watersheds of our country lie in this region. Successful watershed management has done at Sukhomajri and Panchkula with the active participation of the local people.

Resettlement and rehabilitation of people: Its problems and concerns

- Some times for the development of projects like construction of dams, mining, creation of parks etc. and during natural calamities like Earthquake, Landslides, Volcanos, Floods, Droughts, Cyclones, the problems of resettlement and rehabilitation arise. For example recently the Tsunami cyclone affected thousands of families and during construction of Indira Sagar dam in Khandwa district of Madhya Pradesh thousands of families were displaced and rehabilitated near Chanara and other places.
- This caused permanent loss of the benefits and facilities. This disturbed Socio-economic and ecological base of local community which are generally forest and tribal people.

Families are disintegrated and also lost ancestral link between people and the environment. Various types of projects result in the displacement of native people are :

1. Displacement due to Dams. Universe without energy is not imaginable. The most easily accessible and eco-friendly form of renewable energy is hydropower. Water is scarce natural resource and India is blessed with it. Hence it has to judiciously harnessed and managed for welfare of all living beings. India's exploitable hydropower potential is 84044 MW.

Case Study

INDIRA SAGAR PROJECT (ISP) - Indira Sagar Project (1000 MW) is in Khandwa district of MP. It is constructed, operate and maintain by Narmada Hydroelectric Development Corporation (NHDC). Narmada is bestowed with rich potential of 29 major, 135 medium and 3000 minor projects. The reservoir of ISP Dam is largest reservoir in India with storage capacity of 12.22 BM of water for irrigation of 2.70 lakh Ha. A total of villages and people affected by this project. They were given plots, transportation grant, shifting facilities, agricultural land and other compensation. A separate township CHANERA was developed for displaced people. Under this project 26000 Ha area is proposed for irrigation, 564 villages to be benefited by irrigation. This will cause the production of 4.00 lakh tonnes of food grains and 10.55 lakh tonnes of other crops every year additionally.

REHABILITATION.

- The United Nations Universal declaration on Human Rights (Article 25(1) has declared that "Right to housing is basic human right".
- This suggest better rehabilitation, adequate compensation, job opportunities, civic amenities and religious and cultural benefits. Therefore, National Rehabilitation Policy is needed to honour the human rights of the displaced people. Govt. under Land Acquisition Act 1894 has power to vacate the land from people by giving notice for Govt. use.

For displaced persons in case of Indira Sagar Dam, the following compensations for resettlement and rehabilitation were given :

1. Developed plot or Rs 20,000 for purchase of plot for one family.
2. Rehabilitation grant of Rs 18700/- or 9350/- as per status of PAFs.
3. Transportation grant Rs 5000/- for shifting of one family.
4. Allotted 2-8 hectares of agriculture land per family or land compensation.
5. Attractive compensation for house, trees, wells and other structures.
6. At the plot sites, developed roads, water supply to lights, schools, health centres, worship places, panchayats, community centres, shops etc.
7. R and R work is being executed smoothly.
8. Additionally more benefits were given.
9. Professional training being given to project affected families at I + 1 Narmada Nagar.
10. Central school (Kendriya Vidyalaya started in June 01)

11. Different socio-economic upliftment programmes such as free medical check up, vaccination, training programmes are being organized.

ENVIRONMENTAL ETHICS

Issues and possible Solutions

- The issues, principles and guidelines relating to human interaction with their environment OR human obligations towards the environment and living beings are called Environmental Ethics or Earth Ethics.
- Ethics constitute the basic codes of civilized behaviour, without which our environment as we know would be impossible. Such rules embody the basic constraints each of us agrees to practice in relationship with others. Ethical codes can be of help in most instances that confront us, but dilemmas do arise in which it seems there are no suitable alternatives.
- We can see that our acts will follow what we think i.e. human-centric thinking or earth centric thinking. The first view urges us to march ahead gloriously to conquer the nature and establish our supremacy over nature through technological innovations, economic growth and development, while second urges us to live on this earth as a part of it, like any other creation of nature and live sustainably.
- Human beings are over exploiting the natural resources and polluting the environment. These human acts are very dangerous and may lead to environmental crisis.

In relation to environmental protection or in need of environmental ethics two world views

1. Eco-centric worldview. This states that earth resources are limited, and they are not for human beings alone but for all species. So we have to draw our requirements from environment, but not to that extent it degrades the environment. A healthy economy depend upon the healthy environment, therefore, success of mankind depend upon how we cooperate with nature while trying to use the resources of nature.

2. Anthropocentric World view. It states that man is the most important species of nature. Earth has an unlimited supply of resources. Most of the industrial societies believe in this view. So the success & healthy economy of mankind depend upon how nicely man derives benefits from nature.

To check the environmental crisis, we must follow the certain environmental ethics for better future. Some of them are -

1. One should love and honour the earth.
2. We should celebrate the turning of the seasons of the earth.
3. Do not waste or exploit the natural resources.
4. To bring about awareness regarding conservation of life support systems.

5. Our should be fair in sharing of resources.
6. We should respectful to plants and animals which provide us food.
7. We should conserve the ecosystem and promote appropriate sustainable development.
8. We should not do anything at the cost of nature.

CLIMATE CHANGE

- Though climate is an average weather of an area or environmental factors of an area. These include quantity of light, temperature, humidity, wind, gases, water etc which average for about 30 yrs.
- Thus the changes in environmental conditions of an area over long period of time is called climate change. These changes effect the agriculture, migration of animals, hydrological cycle, thermal gradient between the poles and equator, wind pattern, distribution of rainfall etc.
- The scientific and technological revolution has given multiple facilities to mankind, but at the same time man-made (Anthropogenic) activities are responsible for depletion of resources and upsetting the delicate balance between the various components of the environment.
- They are, excessive use of fossils fuels, deforestation, desertification, loss of fertility of soil, rapid industrialization, increase of automobiles. Changes in the atmosphere conditions resulting in to serious problems like green house effect, depletion of ozone layer and rise of world temperature etc.
- The global change in temperature will not be uniform everywhere and will fluctuate in different regions. The places at higher latitudes will be warmed up more during late autumn and winter than the places in tropics. Poles may experience 2 to 3 times more warming than the global average, while warming in tropics may be only 50 to 100°C on an average. The increased warming at poles will reduce the thermal gradient between the equator and high latitude regions, decreasing the energy available to the heat engine that drives the global weather machine. This will disturb the global pattern of winds and ocean currents as well as the timing and distribution of rainfall. Shifting of ocean currents may change the climate of iceland and Britain, it may result in cooling at a time when rest of the world warms.

GLOBAL WARMING

- The average global temperature is 15°C. The lower most layer of atmosphere i.e., troposphere, traps the heat by a natural process due to the presence of certain gases called Greenhouse gases.
- They are carbon dioxide, ozone, methane Nitrous oxide, Chlorofluorocarbons (CFCs) and water vapours. In absence of these gases the temperature (15°C) would have been - 18°C. Thus warming of the earth's climate owing to the increased concentration of green house gases is called Greenhouse effect.
- Therefore, this effect contributes a temperature rise to the tune of 33°C. These gases act like the glass in the botanical greenhouse trapping the reradiated heat near the earth's surface and warming the planet.

- These gases along with water vapour and clouds absorb the infrared radiation, trapping heat near the earth's surface. The two predominant greenhouse gases

(1) the water vapours whose level in the troposphere has relatively remained constant is controlled by hydrological cycle while

(2) CO₂ whose level has increased is controlled by the global carbon cycle. Other gases whose levels have increased due to human activities are methane, NO and CFCs. Deforestation has also elevated levels of CO₂.

GREEN HOUSE GASES

The greenhouse gases present in the troposphere and resulting in an increase in the temperature of air and the earth are discussed here.

CARBON DIOXIDE (CO₂) - The CO₂ is considered as the most dominant factor responsible for the greenhouse effect. The troposphere contains only 0.0375% CO₂ (by volume) and its amount is controlled by carbon cycle.

CHLORO FLUORO CARBONS (CFCs) - The main sources of CFCs include leaking air conditioners and refrigerators, evaporation of industrial solvents, production of plastic foams, aerosols, propellants (CFC-11) etc.

The concentration of CFCs is rising nearly 5% per year. CFCs trap heat 20,000 times more efficiently than CO₂ and also destroy the ozone layer, thus posing a serious twofold environmental problem.

METHANE (CH₄) - It is produced in a number of ways including the action of anaerobic bacteria on vegetation, decomposition of organic matter, incomplete combustion of vegetation, natural gas pipeline leaks, burning of biomass during production and uses of oil and natural gas and petroleum oil etc. It is rising approx. 2% every year. It absorbs 20-25% times more heat than CO₂.

NITROUS OXIDE (N₂O) –

- It is released from nylon products, from burning of biomass and fuels (specially coal). From breakdown of fertilizers in soil, livestock wastes and nitrated contaminated ground water, nylon products etc.
- It is responsible for about 6% of global warming. Besides trapping heat in the troposphere it also depletes ozone in the stratosphere. It absorbs about 250 times more heat than CO₂. The N₂O concentration in atmosphere is 0.3 ppm and is increasing 0.2% annually

OZONE - It comes mostly from hydrocarbons and nitrogen oxides. It causes irritation to eyes and respiratory organs. It decreases the resistance power to infections and aggravates illness.

IMPACT OF GLOBAL WARMING

(i) Climatic change (Increase in global temperature) - Increase in the level of greenhouse gases causes global warming, which has affected the global climate. This effect

will increase in future. According to IPCC (1996) the world climate has warmed from 0.3 to 0.6°C during the last century.

(ii) Effect on Sea levels - Rising temperatures will cause glaciers to melt and the polar ice caps to shrink. As a result sea level may rise by 0.2 - 1.5 m over the next 50 - 100 yrs. It is proved that sea level have already risen by 10 - 25 cm. If it continues, many low lying areas may be submerged in near future, and it is possible to destroy 20% - 80% of the coastal wetland..

(iii) Reduction of Biodiversity - As we have discussed, increased temperatures, inundation of some coastal biological communities and changes in the pattern of distribution of many species over a long period of time are likely to cause reduction in biodiversity in aquatic and terrestrial ecosystems.

(iv) Effect on Agriculture - There are different views regarding the effect of global warming on agriculture. It may be positive or negative. However, the effects of this change will vary for C₃ (i.e. wheat, rice and beans) and C₄ (e.g. maize, millet and sugarcane) plants.

(v) Effect on human health - The global warming will lead to changes in the rainfall pattern in many areas, thereby effecting the distribution of vector borne diseases like malaria filariasis, elephantiasis etc. Warmer temperature and more water stagnation would favour the breeding of mosquitoes, snails and some insects, which are vectors of such diseases.

(vi) Effect on Arctic ecosystems - Global climate change will have profound effects on arctic ecosystems. Tundra is more sensitive to global climate change than most other ecosystems on earth. According to Shaver et al 1992 warmer temperature may increase primary production, thereby increasing Carbon input and soil respiration hence increasing carbon output.

(vii) Ecological disturbance - Global warming increases the desert. It increases temperature in North America, South Africa, Mexico, India and other countries. Changes of hurricanes, cyclones and floods will be more which will damage the lagoons, estuaries and coral reefs. Global warming may cause extinction of more than one million species of animals and plants by 2050 A.D.

MEASURES TO CHECK GLOBAL WARMING

To check the global warming following steps are necessary –

- (1) Plant more trees (Afforestation)
- (2) Control population growth.
- (3) Cut down the current rate of CFCs and fossil fuel.
- (4) Use of non-conventional source of energy.
- (5) Shift from coal to Natural gas.
- (6) To trap and use methane as a fuel.

- (7) Reduce beef production.
- (8) Efficiently remove CO, from smoke
- (9) Use photosynthetic algae to remove atmosphere CO₂
- (10) Adopt sustainable agriculture.
- (11) Use energy more efficiently.

ACID RAIN

Normal rain water is always acidic because of the fact that CO₂ present in the atmosphere gets dissolved in it forming carbonic (H₂CO₃) acid. Because, the presence of SO₂ (Sulphur Dioxide) and NO₂ (Nitrogen Oxide) gases as pollutants in the atmosphere, the pH of the rain water is further lowered (as low as 2.4). This is known as Acid rain.

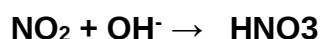
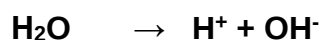
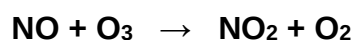
How does acid come from

- Acidification of environment is a man-made phenomenon. No doubt that most acid come from human activities i.e. cars, houses, factories, power stations etc.
- There has always been some acid in rain, coming from volcanos, swamps and planktons in the oceans, but scientists know that it has increased very sharply over the past 200 years.
- The acidity is mainly associated with the transport and subsequent deposition of oxides of sulphur, nitrogen, and these oxidative products. These oxides are produced by combustion of fossil fuels, smelters, power plants, automobile exhausts, domestic fires etc.

How acid rain is formed

In high temperature combustion processes most of the nitric oxide originates from atmosphere and some Nitric oxide also released by burning of wood and as a result of microbial nitrification in the soil. Lightning is another source of Nitric oxide.

In day time Nitric oxide is oxidized by oxygen, ozone

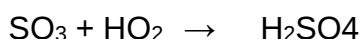
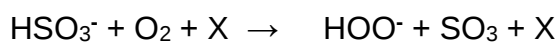


Similarly, formulation of H₂SO₄ acid in the atmosphere can take place with a wide range of reduced as well as partially oxidised Sulphur compounds, H₂S, CS₂ etc. These compounds are released from oceans and soil under reducing conditions. The production of H₂SO₄ from SO₂ may take place homogeneously in the gas phase as :

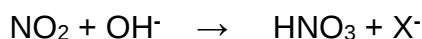
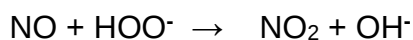


Where X = O₂ or N₂ in atmosphere.

The HSO₃⁻ so formed can undergo a number of reactions, some of which produce sulphuric acid.



The hydroperoxy radical HOO^- can also react to give HNO_3



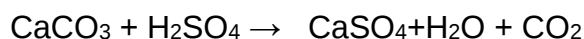
Thus a number of reactions are taken place, forming different acids.

Effects of acid rain

Acid rain exerts both direct and indirect effects on the organisms and materials it comes in contact with. The dry deposition attacks building material, steel and other metals. Some of the effects may be described as :

1. A significant reduction in fish population accompanied by decrease in the variety of species in food chains have been observed.
2. Adirondack ponds having high acidity levels, were among the first to lose fish population.
3. Different species reacts differently to acidified lakes. Adult fish can survive in more concentration aluminium than dry fish.
4. Many bacteria and blue green algae are killed due to acidification, disrupting the whole ecological balance.
5. In 1958 at Europe pH of rain water was 5.0 and in Netherland (1962) was 4.5. It damaged the leaves of plants and trees.
6. Forests of West Germany, Switzerland, Czechoslovakia, Swedish were severely affected by acid rain.
7. In North America and Europe, acid rain destroyed crops and forests, reducing agricultural productivity
8. Acid rain has retarded the growth of pea, beans, radish, potato, spinach, carrots etc.
9. Modern researches show that acid rain leaches Potassium, Calcium, Magnesium etc essential elements from the top soil.
10. Acid lakes have low levels of phytoplankton.

Lime stone attacked as :



The attack on marble is termed as Stone-leprosy.

14. The Taj Mahal in agra is suffering from SO_2 , H_2SO_4 and other fumes, pollutants released from Mathura refinery.

15. Acid rain corrodes houses, monuments, statues, bridges, fences, railways etc.
16. Acidification can play havoc with human nervous, respiratory and digestive systems by making the person an easy pray to neurological diseases.

OZONE LAYER DEPLETION

Stratosphere - Troposphere is the part of atmosphere where humans live and other life processes also occur. The stratosphere is the region of space between approximately 15-50 kms above the earth's surface. The gas molecules in the stratosphere act as absorbing centres, moderating the transmission of the solar radiation to the earth. The qualitative as well as quantitative effect of this is an important determining factor with respect to life processes.

CREATION OF OZONE LAYER

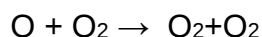
- Ozone is naturally occurring gas found through out atmosphere, with a maximum mixing ratio at the altitude ranging from 15-30 km above the earth. This region is known as ozone layer.
- Ozone can be toxic to plants and animals but increased concentration has a profound beneficial effect. Both, atmosphere and earth surface are subjected to radiation from sun.
- These certain radiations are absorbed by atmospheric gases leading to ionization or dissociation of gases. In the lower mesosphere, atmospheric oxygen gets dissociated and subsequently combines with molecular oxygen forming ozone in stratosphere.

FORMATION OF OZONE

- In the lower mesosphere, the atmospheric oxygen absorbs UV radiation < 240 nm and photo dissociates in to two oxygen atoms.
- These atoms subsequently combine with molecular oxygen of upper stratosphere producing ozone. Ozone is also capable of absorbing short wave length UV radiations releasing oxygen atoms.



Decomposition $\text{O}_3 + h\nu (\lambda = 230 - 320 \text{ nm}) \rightarrow \text{O}_2 + \text{O}$



- This mechanism does not necessarily upset the ozone equilibrium because ozone (loss) is compensated by creation of ozone. As a result ozone occurs in 10 ppm concentration in the form of layer in stratosphere.
- The thickness of ozone layer is measured in Dobson units (DU), where 1 DU = 0.01 mm of the compressed gas 0°C and 760 mm mercury pressure. The average thickness of ozone layer in stratosphere has been estimated to be about 230 DU. It varies marginally with latitude.

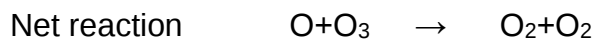
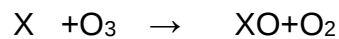
MECHANISM OF OZONE DEPLETION

There are two processes

1. Natural process
2. Anthropogenic process

1. Natural process: A dynamic equilibrium existing between the production and decomposition of ozone molecule constitutes one of the most important mechanism. The heat generated during the reaction causes a rise in temperature. Secondly, the photochemical process absorbs most of the harmful solar UV radiations.

2. Anthropogenic process - Some of the natural species moving in to stratosphere has been augmented in recent years by a number of human activities. Many of the processes, which are responsible for ozone layer depletion share a general mechanism of the type –



The most of the common species (above x) have been identified to be free radicals like HO_x, NO_x and ClO_x

EFFECTS OF OZONE DEPLETION

(1) With the ozone layer depletion, there is danger of the increase in the flux of ultraviolet radiation over earth's biosphere. They are harmful for man's life.

(2) UV radiations effects biological systems in two ways - one is confined to patches of skin while the other develops in the immune system as a whole.

(3) These kinds of skin cancer, Basal cell carcinoma, squamous cell carcinoma and melanoma caused by UV rays.

(4) UV radiations cause sun burns, leukaemia and breast cancer.

(5) UV radiations absorbed by cornea and lens in the eye leading to Photokeratitis and cataracts.

(6) Ozone at ground level of low concentration) exerts its toxic effects directly on the lungs.

(7) Ozone exposure has been shown to be associated with lung cancer, DNA breakage.

(8) Photochemical smog is the measure cause of ozone exposure causing urban air pollution posing a threat to human health.

(9) Many micro- phytoplankton's would die because of their exposure to UV solar radiation. The marked reduction in the productivity of phytoplankton's would in turn adversely effect zoo planktons.

(10) The loss of fish population would directly effect the inhabitants of coastal areas.

NUCLEAR ACCIDENTS AND HOLOCAUST

- Japanese towns of Hiroshima and Nagasaki . The first atom bomb was exploded about 580 metres in the atmosphere over ill fated Hiroshima on August 6, 1945. the second atom bomb was detonated 507 metres high in air over Nagasaki.
- At least 100,000 people were reported killed, severely injured and missing in Hiroshima alone, where the bomb virtually demolished all structures and buildings in about 15 square km. area. In Nagasaki 49000 civilians were killed, injured and disappeared while an area of 6 to 7 km. was devastated.
- The atom bomb exploded on Hiroshima used Uranium (U – 235) with a half life period of 8.5×10^8 years, while the Nagasaki bomb had plutonium (Pu - 239) as an explosive man-made radio-nuclide with half life of 24,000 years.

Case study

CHERNOBYL ACCIDENT

- Chernobyl was the first officially acknowledged nuclear accident in USSR and first reported to the world. April 26, 1986 was a sad day for nuclear power generation when a major accident occurred at 1.23 A.M. in the nuclear reactor at Chernobyl, in the Ukraine area of the Soviet Union.
- It resulted in clouds of radioactive smoke over a large area in Scandinavian countries which are 2000 km. away in the Russian region itself. There was a devastating fire in the reactor which caused few casualties and severe damage to the nuclear plant.
- On finding the fire uncontrollable the soviet authorities sought the help of West Germany and other nuclear nations to tackle the situation. Presumably, the core of the nuclear reactor had melted.
- The explosion at the Chernobyl power plant in Soviet Ukraine, USSR confirmed the worst nuclear disaster. Poor design of the reactor magnified with operator negligence caused the havoc. The operators ignored warnings from various sensors and even disconnected the emergency core cooling systems.

Neutrons went out of control and enormous steam built up in pipes. The explosion sent the graphite slabs of the reactor core through the roof, setting it a fire and spewing radioactive materials around the world.

THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT 1981

- With increasing industrialization and the tendency of the majority of industries to congregate in areas which are already heavily industrialised, the problem of air pollution had begun to be felt in the country.
- The various pollutants discharged from certain human activities connected with traffic, heating, use of domestic fuel, refuse, incinerations etc. also have detrimental effects on the health of the people as also on animal life, vegetation and property.

- In view of decisions taken at the June 1972 United Nations Conference held at Stockholm, the Govt. decided to implement those decisions related to the preservation of the quality of air and control of air pollution.
- Accordingly the Air (Prevention and Control of Pollution) Bill was introduced in the parliament and passed by both the houses of parliament.
- It came into force on the 16th day of May 1981 as THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT 1981 (14 of 1981). Its amendment act 1987 (47 of 1987) came into force.

THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981 (14 OF 1981) [29TH MARCH 1981]

An Act to provide for the prevention, control and abatement of air pollution, for the establishment, with a view to carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards, powers and functions relating thereto and for matters connected therewith.

(v) the form and the manner in which appeals may be preferred, the fees payable in respect

CENTRAL AND STATE BOARDS FOR THE PREVENTION AND CONTROL OF AIR POLLUTION

Central pollution control board - The Central Pollution Control Board constituted under section 3 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), shall, without prejudice to the exercise and performance of its power and functions under the Act, exercise the powers and perform the functions of the Central Pollution Control Board for the prevention and control of air pollution under this Act.

State Pollution Control Boards - In any State in which the water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), is in force and the State Government has constituted for that state a State Pollution Control Board under section 4 of that Act, such State Board shall be deemed to be the State Board for the Prevention and Control of Air Pollution constituted under section 5 of this Act, and accordingly that State Pollution Control Board shall, without prejudice to the exercise and performance of its powers and functions under that Act, exercise the powers and perform the functions of the State Board for the prevention and control of air pollution under this Act].

POWERS AND FUNCTIONS OF BOARDS

Functions of Central Board –

(1) Subject to the provisions of this Act, and without prejudice to the performance of its functions under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), the main functions of the Central Board shall be to improve the quality of air and to prevent, control or abate air pollution in the country.

(2) In particular and without prejudice to the generality of the foregoing functions, the Central Board may

(a) advise the Central Government on any matter concerning the improvement of the quality of air and the prevention, control or abatement of air pollution;

(b) plan and cause to be executed a nation-wide programme for the prevention, control or abatement of air pollution;

(c) co-ordinate the activities of the State Boards and resolve disputes among them;

(d) provide technical assistance and guidance to the State Boards, carry out and sponsor investigations and research relating to problems of air pollution and prevention, control or abatement of air pollution;

(e) plan and organize the training of persons engaged or to be engaged in programmes for the prevention, control or abatement of air pollution on such terms and conditions as the Central Board may specify;

(f) organize through mass media a comprehensive programme regarding the prevention, control or abatement of air pollution;

(g) lay down standards for the quality of air;

(h) collect and disseminate information in respect of matters relating to air pollution;

(i) perform such other functions as may be prescribed.

(3) The Central Board may establish or recognize a laboratory or laboratories to enable the Central Board to perform its functions under the section efficiently.

(4) The Central Board may

(a) delegate any of its functions under this Act generally or specially to any of the committees appointed by it;

(b) do such other things and perform such other acts as it may think necessary for the proper discharge of its functions and generally for the purpose of carrying into effect the purposes of this Act.

Functions of State Boards - (1) Subject to the provisions of this Act, and without prejudice to the performance of its functions, if any, under the Water (Prevention and Control of Pollution) Act, 1974), the functions of a State Board shall be

(a) to plan a comprehensive programme for the prevention, control or abatement of air pollution and to secure the execution thereof;

(b) to advise the State Government on any matter concerning the prevention, control or abatement of air pollution;

(c) to collect and disseminate information relating to air pollution;

(d) to collaborate with the Central Board in organising the training of persons engaged or to be engaged in programmes relating to prevention, control, or abatement of air pollution and to organise mass-education programme relating thereto;

(e) to inspect, at all reasonable times, any control equipment, industrial plant or manufacturing process and to give, by order, such directions to such persons as it may consider necessary to take steps for the prevention, control, or abatement of air pollution;

(f) to inspect air pollution control areas at such intervals as it may think necessary, assess the quality of air therein and take steps for the prevention, control or abatement of air pollution in such areas;

(g) to lay down, in consultation with the Central Board and having regard to the standards for the quality of air laid down by the Central Board, standards for emission of air pollutants into the atmosphere from industrial plants and automobiles or for the discharge of any air pollution into the atmosphere from any other source whatsoever not being a ship or an aircraft;

PREVENTION AND CONTROL OF AIR POLLUTION

(i) Power to declare air pollution control areas.

(ii) Power to give instructions for ensuring standards for emission from automobiles.

(iii) Restrictions on use of certain industrial plants.

(iv) Persons carrying an industry etc, not to allow emission of air pollutants in excess of the standard laid down by State Board.

(v) Power to take samples of air or emission and procedure to be followed.

(vi) Reports of analysis.

(vii) Appeals,

PENALTIES AND PROCEDURE

Failure to comply with the provisions of section 21 or section 22 or with the directions issued under section 31A –

(1) Whoever fails to comply with the provisions of section 21 or section 22 or directions issued under section 31A, shall, in respect of each such failure, be punishable with imprisonment for a term which shall not be less than one year and six months but which may extend to six years and with fine, and in case the failure continues, with an additional fine which may extend to five thousand rupees for every day during which such failure continues after the conviction for the first such failure.

(2) If the failure referred to in sub-section (1) continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which shall not be less than two years (but which may extend to seven years and with fine.)

Penalties for certain acts - Whoever -

(a) destroys, pulls down, removes, injures or defaces any pillar, post or stake fixed in the ground or any notice or other matter put up, inscribed or placed, by or under the authority of the Board, or

(b) obstructs any person acting under the orders or directions of the Board from exercising his powers and performing his functions under this Act, or

- (c) damages any works or property belonging to the Board , or
- (d) fails to furnish to the Board or any officer or other employee of the Board any information required by the Board or such officer or other employee for the purpose of this Act, or
- (e) fails to intimate the occurrence of the emission of air pollutants into the atmosphere in excess of the standards laid down by the State Board or the apprehension of such occurrence, to the State Board and other prescribed authorities or agencies as required under sub-section (1) of section 23, or
- (f) in giving any information which he is required to give under this Act, makes a statement which is false in any material particular, or
- (g) for the purpose of obtaining any consent under section 21, makes a statement which is false in any material particular, Shall be punishable with imprisonment for a term which may extend to two to three months or with fine which may extend to (ten thousand rupees) or with both.

THE WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

- As a result of growth of industries and the increasing tendency to urbanization the problem of pollution of rivers and streams had assumed considerable importance.
- It had become essential to ensure that the domestic and industrial effluents are not allowed to be discharged in to the water courses without adequate treatment. To draw a draft enactment for the prevention of water pollution a committee was set up in 1962. Later on a draft bill was prepared and put up for consideration at the joint session of Central Council of local self Govt., ministers of Town and Country planning held in 1965.
- After long discussion, some resolutions were passed by the legislatures of some states. To give effect to these resolutions, the Water (Prevention and Control of Pollution) bill was introduced in the parliament, and having been passed by both the houses, received the assent of the President on 23 March 1974.
- It came on the Statute book as THE WATER (PREVENTION AND CONTROL OF POLLUTION) ACT 1974 (6 OF 1974). Later on, it was amended twice (44 of 1978) and (53 of 1988).

POWERS AND FUNCTIONS OF BOARDS

Functions of Central Board - (1) Subject to the provisions of this Act, the main function of the Central Board shall be to promote cleanliness of streams and wells in different areas of the States.

In particular and without prejudice to the generality of the foregoing function, the Central Board may perform all or any of the following functions, namely:

- (a) advise the Central Government on any matter concerning the prevention and control of water pollution;
- (b) co-ordinate the activities of the State Boards and resolve disputes among them;

(c) provide technical assistance and guidance to the State Boards, carry out and sponsor investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution;

(d) plan and organize the training persons engaged or to be engaged in programmes for the prevention, control or abatement of water pollution on such terms and conditions as the Central Board may specify;

(e) organize through mass media a comprehensive programme regarding the prevention and control of water pollution:

(f) collect, compile and publish technical and statistical data relating to water pollution and the measures devised for its effective prevention and control and prepare manuals, codes or guides relating to treatment and disposal of sewage and trade effluents and disseminate information connected therewith;

(g) lay down, modify or annul, in consultation with the State Government concerned, the standards may be laid down for the same stream or well or for different streams or wells, having regard to the quality of water, flow characteristics of the stream or well and the nature of the use of the water in such stream or well or streams or wells;

Functions of State Board - (1) Subject to the provisions of this Act, the functions of a State Board shall be

(a) to plan a comprehensive programme for the preventions, control or abatement of pollution of streams and wells in the State and to secure the execution thereof;

(b) to advise the State Government on any matter concerning the prevention, control or abatement of water pollution;

(c) to collect and disseminate information relating to water pollution and the prevention, control or abatement thereof;

(d) to encourage, conduct and participate investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution;

(e) to collaborate with the Central Board in organizing the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of water pollution and to organize mass education programmes relating thereto;

(f) to inspect sewage or trade effluents, works and plants for the treatment of sewage and trade effluents and to review plans, specifications or other data relating to plants set up for the treatment of water, works for the purification thereof and the system for the disposal of sewage or trade effluents or in connection with the grant of any consent as required by this Act;

(g) to lay down, modify or annul effluent standards for the sewage and trade effluents and for the quality of receiving waters (not being water in an inter-State stream) resulting from the discharge of effluents and to classify waters of the State;

(h) to evolve economical and reliable methods of treatment of sewage and trade effluents. having regard to the peculiar conditions of soils, climate and water resources of different regions and more especially the prevailing flow characteristics of water in streams and wells which render it impossible to attain even the minimum degree of dilution:

(i) to evolve methods of utilization of sewage and suitable trade effluents in agriculture:

(j) to evolve efficient methods of disposal of sewage and trade effluents on land, as are necessary on account of the predominant conditions of seant stream flows that de no provide for major part of the year the minimum degree of dilution;

(k) to lay down standards of treatment of sewage and trade effluents to be discharged into any particular stream taking into account the minimum fair weather dilution available in that stream and the tolerance limits of pollution permissible in the water of the stream, after the discharge of such effluents;

(l) to make, vary or revoke any order -

- (i) for the prevention, control or abatement of discharges of waste into streams or wells;
- (ii) requiring any person concerned to construct new systems for the disposal of sewage and trade effluents or to modify, alter or extend any such existing system or to adopt such remedial measures as are necessary to prevent, control or abate water pollution;

(m) to lay down effluent standards to be complied with by persons while causing discharge of sewage or sullage or both and to lay down, modify or annul effluent standards for the sewage and trade effluents;

(n) to advise the State Government with respect to the location of any industry the carrying on of which is likely to pollute a stream or well;

(o) to perform such other functions as may be prescribed or as may, from time to time, be entrusted to it by the Central Board or the State Government.

The Board may establish or recognize a laboratory or laboratories to enable the Board to perform its functions under this section efficiently, including the analysis of samples of water from any stream or well or of samples of any sewage or trade effluents.

PENALTIES AND PROCEDURE

1. Failure to comply with directions under sub-section (2) or sub-section (3) of section 20, or orders issued under clause (C) of sub-section (1) of section 32 or directions issued under sub-section (2) of section 33 or section 33A -

(1) Whoever fails to comply with the direction given under sub-section (2) or sub-section (3) of section 20 within such time as may be specified in the direction shall, on conviction, be punishable with imprisonment for a term which may extend to three months or with fine which may extend to ten thousand rupees or with both and in case the failure continues , with an additional fine which may extend to five thousand rupees

for every day during which such failure continues after the conviction for the first such failure.

(2) Whoever fails to comply with any order issued under clause (C) of sub-section (1) of section 32 or any direction issued by a court under sub-section (2) of section 33 or any direction issued under section 33A shall, in respect of each such failure and on conviction, be punishable with imprisonment for a term which shall not be less than one year and six months but which may extend to six years and with fine, and in case the failure continues, with an additional fine which may extend to five thousand rupees for every day during which such failure continues after the conviction for the first such failure.

(3) If the failure referred to sub-section (2) continues beyond a period of one year after the date of conviction, the offender shall, on conviction, be punishable with imprisonment for a term which shall not be less than two years but which may extend to seven years and with fine.

2. Penalty for certain acts -

(1) Whoever -

(a) destroys, pulls down, removes, injures or defaces any pillar, post or stake fixed in the ground or any notice or other matter put up, inscribed or placed, by or under the authority of the Board, or

(b) obstructs any person acting under the orders or directions of the Board from exercising his powers and performing his functions under this Act, or **(c)** damages any works or property belonging to the Board, or

(d) fails to furnish to any officer or other employee of the Board any information required by him for the purpose of this Act, or

(e) fails to intimate the occurrence of any accident or other unforeseen act or event under section 31 to the Board and other authorities or agencies as required by that section, or

(f) in giving any information which he is required to give under this act, knowingly or wilfully makes a statement which is false in any material particular, or

(g) for the purpose of obtaining any consent under section 25 or section 26, knowingly or wilfully makes a statement which is false in any material particular, shall be punishable with imprisonment for a term which may extend to three months or with fine which may extend to [ten thousand rupees) or with both.

(2) Where for the grant of a consent in pursuance of the provisions of section 25 or section 26 the use of meter or gauge or other measure or monitoring device is required and such device is used for the purposes of those provisions, any person who knowingly alters or interferes with that device so as to prevent it from monitoring or measuring correctly shall be punishable with imprisonment for a term which may extend to three months or with fine which may extend to [ten thousand rupees] or with both. or wilfully

3. Penalty for contravention of provisions of section 24 - Whoever contravenes the provisions of section 24 shall be punishable with imprisonment for a term which shall not be less than one year and six months) but which may extend to six years and with fine.

4. Penalty for contravention of section 25 or section 26 - Whoever contravenes the provisions of section 25 or section 26 shall be punishable with imprisonment for a term which shall not be less than [one year and six months] but which may extend to six years and with fine.

5. Enhanced penalty after previous conviction - If any person who has been convicted of offence under section 24 or section 25 or section 26 is again found guilty of an offence involving contravention of the same provision, he shall, on the second and on every subsequent conviction, be punishable with imprisonment for a term which shall not be less than [two years] but which may extend to seven years and with fine;

Provided that for the purpose of this section no cognizance shall be taken of any conviction made more than two years before the commission of the offence which is being punished.

6. Penalty for contravention of certain provisions of the Act - Whoever contravenes any of the provisions of this Act or fails to comply with any order or direction given under this Act, for which no penalty has been elsewhere provided in this Act, shall be punishable with imprisonment which may extend to three months or with fine which may extend to ten thousand rupees or with both and in the case of a continuing contravention or failure, with an additional fine which may extend to five thousand rupees for every day during which such contravention or failure continues after conviction for the first such contravention or failure.]

7. Publication of names of offenders.

8. Offences by companies.

9. Offences by Govt. Departments. Cognizance of offences. servants.

10. Cognizance of offences. servants.

11. Members, officers and servants of boards to be the public servants.

PUBLIC AWARENESS

Environmental pollution, environmental degradation, environmental deterioration, environmental crisis etc. are few words which becoming day by day a subject of concern in every walk of life. This is all due to industrialization, rapid population growth, urbanization, changing life style etc. The formulation of various acts and legislations to control pollution and conserve or protect environment, underlines the will and concern of the Government.

Methods -

To protect and conserve the environment is the basic duty of all sections of people because environment belongs to all and every individual matters. Instead of searching the solution, it is necessary to find the permanent solution of environmental and ecological problems. It can be done by following means.

(1) Through mass-media - There are various means of mass communication to educate, entertain & give information's, instructions etc. to people. Radio was the first. Next is T.V. in terms of its reach to the masses.

(2) Through Education - Students are the back bone of a country. If environmental education is started from grass root level i.e. from childhood stage, it will give good results. It will be done through formal and informal environmental education. A welcome step to introduce environmental studies paper at collage level by Government by the directive of Supreme Court is good in the direction of awareness.

(3) Through rallies, orientation and training programmes: - To promote environmental awareness, environmental rallies with posters, handbills, programmes may be organized on certain occasions like 5th June as world environmental day and is week of October as wild life week. Some training programmes, orientation, workshops, seminars, meetings based on environment awareness may be organized for decision makers, planners, leaders also, so that they can also spread the message to protect & conserve the environment.

(4) Through voluntary organizations and NGOs - Due to having link between people and Government some voluntary organizations and non-Government organizations can play an important role in the direction of environmental awareness in people by organizing educational, religious, plantation, musical, competitions (essay, drawing, oral) etc. programmes. These organizations can also advise the government to implement effective programmes for environmental awareness.

(1) Bombay Natural History Society (BNHS).

(2) Wild Life Preservation Society of India. (WPSI)

(3) Worldwide Fund for Nature - India (WWF - India).

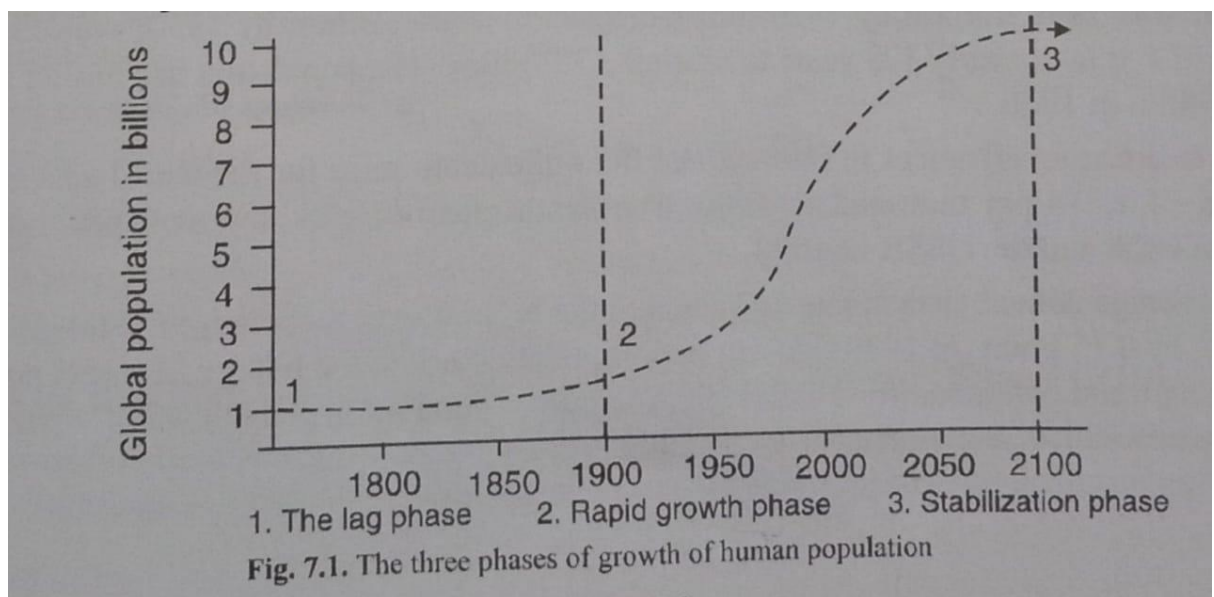
(4) Centre for Science and Environment (CSE)

Unit 7: Human population and the environment

POPULATION GROWTH

The most important features of population is the growth i.e. the capacity of increase in individual members. By measuring the size or density of a given population from time to time, we can get rate of increase and can also predict future changes in its size. It can be defined in following

(a) Logistic growth : When a population is allowed to grow in a limited space (environment) it shows logistic growth. If we plot a graph between number of bacteria or cells against time, we typical S shaped sigmoid curve called population growth curve.



It has four phases i.e. 1st phase shows slow rate called lag period, second is accelerating stage followed by a phase of extremely rapid population. The last phase is accelerating multiplication followed by equilibrium phase where is essentially no net change in population called saturation level or carrying capacity. It is represented by letter K.

The logistic equation shows density dependent growth i.e. growth of a simple population in a limited space with limited resources. It may be written as

$$\frac{dN}{dt} = \gamma N \left(1 - \frac{N}{K}\right)$$

where $\frac{dN}{dt}$ rate of growth of population

γ = intrinsic rate of increase (per individual of population)

N = Population size (No. of organisms in population at time t)

K = Carrying capacity of population

$(1 - N/K)$ = density-dependent factor.

(b) Exponential Growth : When a population growth curve quickly begins to rise very steeply, the population shows exponential growth. It is J shaped (Fig. 7.1). A population growing exponentially increases accordingly to the equation

$$N_t = N_0 e^{rt}$$

Where N_t = The number of individuals in the population after t units of time

N_0 = initial population size ($t = 0$)

r = exponential growth rate

e = the base of the natural logarithm

(c) Geometric Growth : Geometric growth may be defined as the population growth in which the rate of increase is proportional to the number of individuals in the population at the beginning of the breeding session. When young ones are added to the population only at specific times of the year during well defined reproductive periods, the population is said to have geometric growth. The equation for this is

$$N_t = N_0 \lambda$$

Where λ = the geometric growth rate.

POPULATION EXPLOSION FAMILY WELFARE PROGRAMME

- Previously this programme was known as National Family Planning Programme. In the year 1977 the name was changed to National Family Welfare Programme. Family planning programme was launched in India in 1952. India was the first country to do so.
- Beginning of the programme was modest, i.e., establishment of few FP clinics, distribution of FP educational material, training of health functionaries and research. During the third 5-year-plan (1961-66) family planning was declared as centre of planned development.
- Then the emphasis was shifted from clinic approach to extensive education approach (i.e., motivating people about small family norm). A separate Department of Family Planning was created in 1966 in the Ministry of Health.
- In 1972, the MTP Act was passed. In April 1976, National Population Policy was framed. During the emergency period (1976), forcible sterilisation campaign led to the defeat of Congress in 1977 elections.
- In June 1977, new Janata Government formulated a new population policy and made family planning as voluntary and renamed it as Family Welfare Programme.

Importance of Family Welfare Programme

1. The family welfare programme occupies an important position in the nation's socioeconomic development.

2. Indian population which was 34 crores in 1947 has crossed 100 crore mark by 2000 AD. India has only 2.4% of world's land area but it supports about 15.5% of world's population.

3. India's population is increasing by 1.8 crores every year. To check this galloping growth, the country has laid down long-term demographic goal of achieving an NRR of one by the year 2000 AD.

4. Acceptance of the family welfare services is made voluntary.

5. The programme was 100% centrally sponsored scheme. FP programme was integrated the MCH services.

ORGANISATIONAL SET UP

1. Central level

At central level Central Cabinet Subcommittee is present. It is headed by Prime Minister. Next level is Population Advisory Council. This is headed by Union Minister of Health and Family Welfare. Members are representatives of various professional bodies and some technical persons. Next level is Central Family Welfare Council, which is headed by union minister and ministers of and family welfare of all states. It coordinates the work of the programme.

2. State level

Ministry of Health and Family Welfare is the apex organization at the state level. This is headed by the minister of health and family welfare of the respective state. At the state level the family welfare work is organised by State Family Welfare Bureau. The State Family Welfare Bureau has three wings:

(a) Administrative wing (headed by state family welfare officer and associated by some officers)

(b) Education and information wing (headed by mass media information officer)

(c) Field operation and evaluation wing (headed by statistical officer).

3. District level

- At district level the work of family welfare is organized by District Family Welfare Bureau. has three wings like the state level.
- At some districts Regional Family Welfare Training Centres are present. These will undertake training of medical officers and para-medical staff.
- In rural areas the family welfare work is looked after by rural family welfare centres attached to PHC while in urban areas urban family welfare centres will look after this work.

At village level the MPWA(F) and MPWA(M) are mainly responsible for the programme. They will take the assistance of CHG, TBA and anganwadi workers.

5. Village level

At village level the MPHA(F) and MPHA(M) are mainly responsible for the programme. They will take the assistance of CHG, TBA and anganwadi workers

Goals of National Population Policy

1. NRR 1 (which implies two-child norm)
2. Birth rate 21/100 population
3. Death rate 9 per 1000 population
4. Raising couple protection rate to 60%
5. Reduction of family size to 2.3 live births.
6. Decrease the IMR to 60 per 1000

Programme Strategies

1. Integrated approach
2. Cafeteria approach
3. Welfare approach
4. At risk approach

VALUE EDUCATION

- Man acts to satisfy his needs or wants. Anything which satisfies human need becomes thereby a thing of Value. It is the element of desirability and satisfaction that is common to all values, material or non-material.
- In psychology the term value is generally employed to designate a dominant interest, motive or broad evaluative attitude. Value has been defined variously by different educationists, but on the whole, it is interpreted to be either a set of feeling or an action. Human behaviour is governed by his values. These are socially approved desires or goals, conceptions or standards by which things are approved or disapproved.
- Value is a dynamic term used in different aspects. Indian philosophy has used it in sense of state free from pleasure and pain, psychologists in the sense of "psychic energy", sociologists in the sense of "use of time, energy and money for certain ends. The last theory is named as "Integral theory".
- The progress and development of a nation depends upon the quality of the values cherished by its citizens. One of the serious criticism against our educational system is that it lacks value orientation. Our 1986 National Policy on Education and its modifications have strongly advocated value education.

IMPORTANT VALUES

Important values may be described as follows

(i) Religious Value : It is defined in terms of faith in God. The outward acts of behaviour expressive of this value are going on pilgrimage, is linking in simple life,

having faith in religious leaders, worshipping God and speaking the truth. Students (Higher studies) prefer least the religious value.

(i) Social Value : It is defined in terms of cherity, kindness, love and sympathy for the people, efforts to serve God through the service of mankind, sacrificing personnel comforts and gain to relieve the needy and affected of their misery.

(iii) Democratic Value : This value is characterized by respect for individuality, absence of discrimination among persons on the basis of sex, language, religion, caste, colour, race and family status, ensuring equal social, political and religious rights to all and respect for all democratic institutions.

(iv) Aesthetic Value : It is characterized by appreciation of beauty, from proportion and harmony, love for fine arts, drawing painting, music, dance, sculpture, poetry and architecture, love for literature, decoration and the surroundings. It is also the least preferred values in schools.

(v) Economic Value : This value stand for desire for money and material gains. A man with high economic value is guided by consideration of money and material gain in the choice of his job.

(vi) Knowledge Value : This value stand for love of knowledge or theoretical principles of an activity and love of discovery of truth. A man with this value considers a knowledge of theoretical principles underlying a work essential for success in it. He values hard work in studies.

(vii) Hedonistic Value : It is the conception of desirability of loving pleasure and avoiding pain. For a hedonist the present is more important than the future. He indulges in pleasure of senses and avoids pain.

(viii) Power Value : It is defined as the conception of desirability of ruling over others and also of leading others. A man with this value prefers a job where he gets opportunity to exercise authority over the others.

(ix) Family Prestige Value : It is defined as the conception of desirability of such items of behaviour roles, functions and relationship as would become one's family status. It implies respect for roles which traditionally charateristic of different castes of Indian society.

(x) Health Value : It is the consideration for keeping the body in a fit state for carrying out one's normal duties and functions. It also implies the consideration for self preservation.

Role of Information Technology in Environment and Human Health

- Just as chemical or metallurgical or electrical technologies enable the processing of raw materials in to usable goods, to satisfy man's and societies needs, so does information technology (IT) help the storage, processing, transmission and exploitation of information to satisfy a person's, company's, society's or Govt's needs for information. Information covers voice as in telephony, text as in fax, images as in video and data as between computers.

- Information is knowledge and knowledge is power. Knowledge plus experience is wisdom and it is the wise use of information that gives advantage to those who have information. in extending man's mind or
- Information technology as commonly pictured by computers brain or intellectual power. Information technology devices like microprocessors and becoming mass appliances from pace makers for the heart, hearing aids and efficiency enhances in automobile engines and devices to steer space vehicles on the moon. Like banking, trading, learning and teaching, sectors of human activity, Information technology has tremendous use in the