

**MODULE -****3****ENVIRONMENT AND ECOSYSTEM**

**Environment:** Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness.

**Ecosystem:** Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.

**3.1 ENVIRONMENT****3.1.1 DEFINITION**

It deals with each problem that influences an organism. It is essentially a multidisciplinary technique that brings about an appreciation of our natural world and human impacts on its integrity. It is an applied science as it seeks practical answers to creating human civilization sustainable on this planet's finite resources.

**3.1.2 SCOPE**

Surroundings were originally a natural landscape like a forest, a river, a mountain, a desert, or a mixture of those components. Most of us live in landscapes which have been closely changed via human beings. Daily lives are linked with our environment and inevitably influences them. Reliance on nature is great to the point that we can't keep on living without ensuring the ecological assets- **Mother Nature**. Ill effects of rapid financial boom and development, brought about environmental degradation. Industrial improvement makes use of up massive amounts of natural resources.

**3.1.3 NEED FOR PUBLIC AWARENESS**

Earth's natural resources are dwindling and our surroundings is being progressively degraded by human activities, it's evident that measures have to be taken. Often feel that dealing with all that is something that the Government must do. Prevention of our surroundings degradation in which we have to all take part that need to become a part of all our lives. As an individual, we are able to play a significant role in environment management. It can be made conceivable through mass awareness. If every people feels powerfully regarding the environment, the press and media can boost our efforts. Politicians in a democracy respond completely to a powerful publicly supported movement. One can join an NGO that supports the cause of conservation. Each of us is in charge of spreading this message to as many individuals as possible.

**3.2 ECOSYSTEM**

"Ecosystem" may be a region with a particular and recognizable landscape type like forest, grassland, desert, land or coastal space. The geographical, climatic and soil traits form its non-living (abiotic) factor. The living a part of the environment is called its biotic element. This community of living organisms in conjunction with the non-living parts of their surroundings interact as a system.

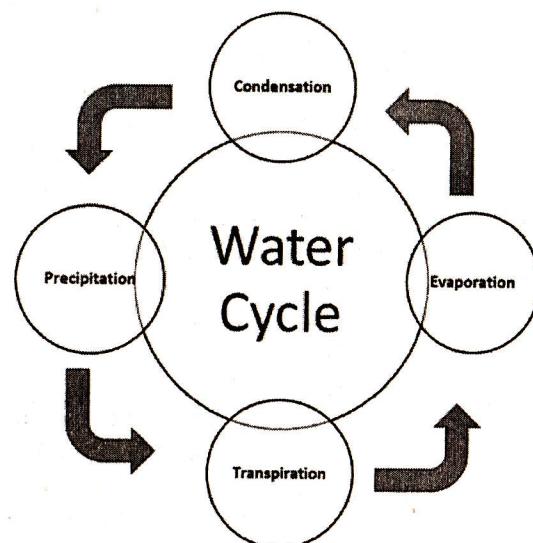
**3.3 ENERGY FLOW**

Every ecosystem has several interrelated mechanisms that affect human life. These are the **water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle**. While every ecosystem is controlled by these cycles, in each ecosystem its abiotic and biotic features are distinct from each other.

**3.3.1 WATER CYCLE**

When it rains, the water runs alongside the floor and flows into rivers or falls directly into the ocean. A part of the rainwater that falls on land percolates into the ground. This is stored underground all through the rest of the year. Water is drawn up from the ground by plant life together with the vitamins from the soil. The water is transpired from the leaves as water vapour and returned to the

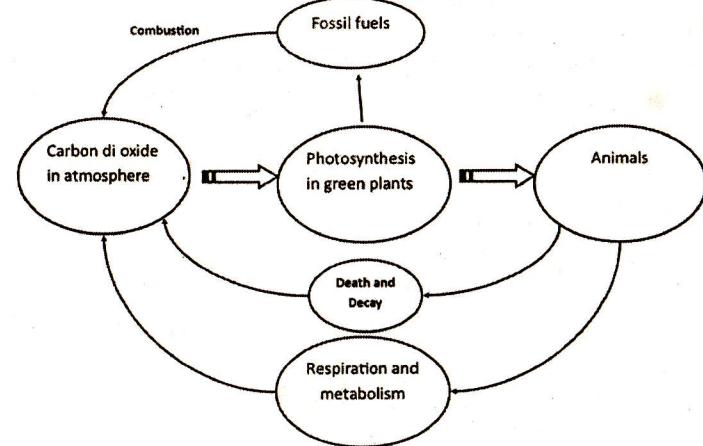
surroundings. The water is transpired from the leaves as vapour and returns back to the atmosphere. Because it is lighter than air, vapour rises and forms clouds. Wind blow the clouds for long distances and once the clouds rise higher, the vapour condenses and changes into droplets, that fall on the land as rain.



*Fig 3.1 Water Cycle*

### 3.3.2 CARBON CYCLE

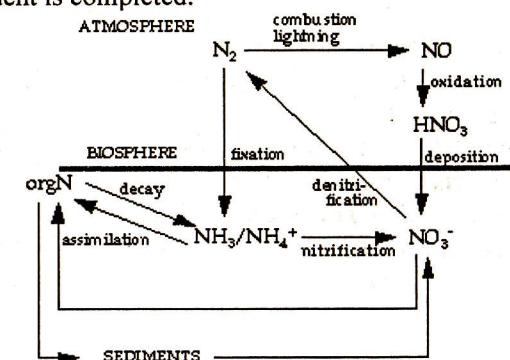
The carbon, which occurs in organic compounds, is included in both the abiotic and biotic components of the ecosystem. Plants use photosynthesis for their growth and improvement. In this procedure, vegetation releases oxygen into the ecosystem on which animals depend for their respiration. Herbivorous animals feed on plant cloth, that is utilized by them for strength and for their improvement. Both plants and animals release carbon dioxide during respiration. They also return fixed carbon to the soil in the waste they excrete. When plants and animals die they return their carbon to the soil. These processes complete the carbon cycle.



*Fig 3.2 Carbon Cycle*

### 3.3.3 NITROGEN CYCLE

Carnivorous animals feed on herbivorous animals that eat plants. When animals defecate, this waste material is broken down through worms and bugs typically beetles and ants. These little 'soil creatures' break the waste material into littler bits on which minute microorganisms and organisms can act. This material is hence separated further into supplements that plants can retain and use for their development. In this manner supplements are reused once again from creatures to plants. Thus the nitrogen cycle on which life is dependent is completed.

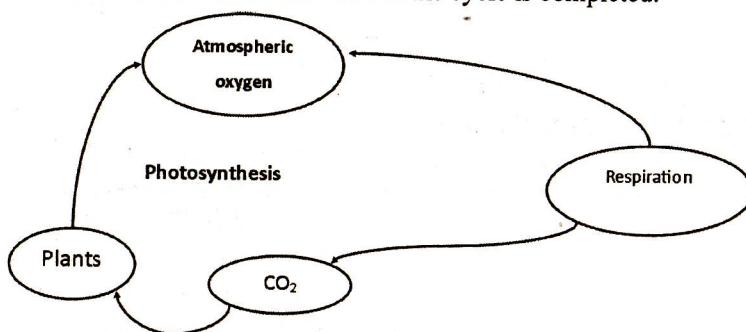


*Fig 3.3 Nitrogen Cycle*

### 3.3.4 OXYGEN CYCLE

The oxygen cycle is the biogeochemical cycle that portrays the development of oxygen inside and between its three principle stores: the (air), the biosphere (living things), and the lithosphere (earth's hull). The fundamental driving element of the oxygen cycle is photosynthesis, which is responsible for the modern Earth's atmosphere and life.

Plants are the main creators of oxygen within the atmosphere through photosynthesis. Here the tree makes use of daylight and carbon dioxide to supply electricity and releases oxygen. The animals breathe in the oxygen and then breathe out carbon dioxide. The plant can then use this carbon dioxide and the cycle is completed.



*Fig 3.4 Oxygen Cycle*

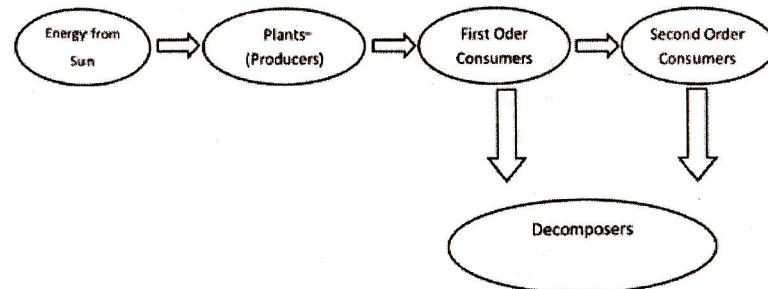
### 3.3.5 ENERGY CYCLE

The energy cycle is based totally on the flow of energy through the surroundings. Energy from sunlight is transformed via plants into developing new plant fabric which includes leaves, plants, fruit, branches, trunks and roots of vegetation, referred to as producers in the ecosystem. The herbivorous animals feed on these plants. The carnivores in turn depend on herbivorous animals on which they feed. Thus the unique plant and animal species are linked to one another through food chains.

The energy in the ecosystem can be depicted within the form of a food pyramid or energy pyramid. The food pyramid has a large base

of vegetation known as 'producers'. The pyramid has a narrower middle section that depicts the number and biomass of herbivorous animals, which might be called 'first order producers'. The apex depicts the small biomass of carnivorous animals called 'second order consumers'.

When plant life and animals die, this material is back to the soil after being damaged down into simpler substances by means of decomposers inclusive of bugs, worms, bacteria and fungi so that plant life can take in the vitamins via their roots. Animals excrete waste products after digesting food, which goes back to the soil. This links the energy cycle to the Nitrogen cycle.



*Fig 3.5 Energy Cycle*

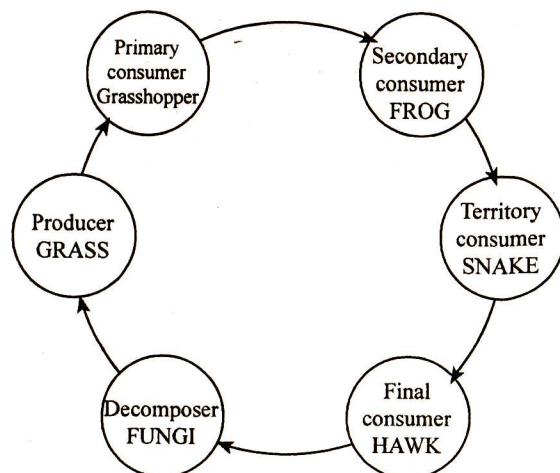
### 3.4 ECOLOGICAL SUCCESSION

Ecological succession is a process through which ecosystems tend to transform over a period of time. Succession can be related to seasonal environmental changes, which create adjustments in the community of plant life and animals residing in the surroundings. There is a tendency for succession to produce a more or less stable state at the end of the successional stages. The successive levels are associated with the manner wherein strength flows via the organic system

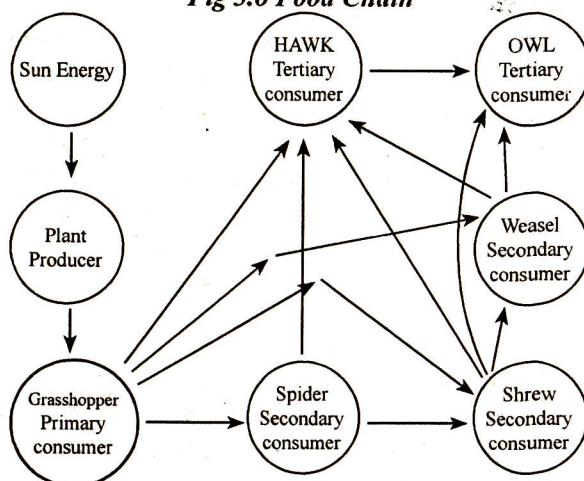
**Ex:** *Pond ecosystem* - fluctuation from a dry terrestrial habitat to the early colonisation stage by small aquatic species after the monsoon, which gradually passes through to a mature aquatic ecosystem, and then reverts back to its dry stage in summer where its aquatic life remains dormant.

### 3.5 FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

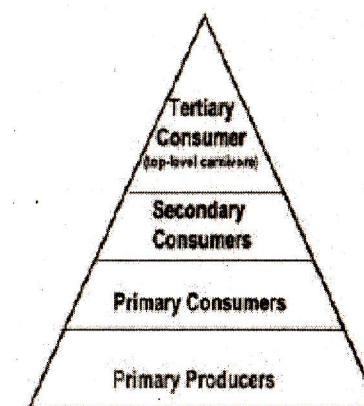
The transfer of energy from the source in plants through a series of organisms by eating and being eaten constitutes **food chains**. These food chains are not isolated sequences, but are interconnected with each other. This interlocking pattern is known as the **food web**. Each step of the food web is called a trophic level. These trophic levels together form the **ecological pyramid**.



**Fig 3.6 Food Chain**



**Fig 3.7 Food Web**



**Fig 3.7 Energy Pyramid**

### 3.6 ECOSYSTEMS

#### 3.6.1 FOREST ECOSYSTEM

Forests are formed by a community of plants which is predominantly structurally defined by its trees, shrubs, climbers and ground cover.

The forest ecosystem has two parts:

- **The non-living or abiotic aspects of the forest:** The type of forest depends upon the abiotic conditions at the site. Vegetation is specific to the amount of rainfall and the local temperature which varies according to latitude and altitude.
- **The living or the biotic aspects of the forest:** The plants and animals form communities that are specific to each forest type. The biotic component includes both the large (macrophytes) and the microscopic plants and animals.

#### Types of forest ecosystem

Forests in India can be broadly divided into Coniferous forests and Broad leaved forests.

**Coniferous forests:** Grow in the Himalayan mountain region, where the temperatures are low. These forests have tall stately trees with needle like leaves and downward sloping branches so that the snow can slip off the branches.

**Broadleaved forests:** They have several types, such as evergreen forests, deciduous forests, thorn forests, and mangrove forests. Broadleaved forests have large leaves of various shapes.

**Evergreen forests** grow in the high rainfall areas of the Western Ghats, North Eastern India and the Andaman and Nicobar Islands. These forests grow in areas where the monsoon lasts for several months. There is no dry leafless phase as in a deciduous forest. An evergreen forest thus looks green throughout the year. The trees overlap with each other to form a continuous canopy. Thus very little light penetrates down to the forest floor.

**Deciduous forests** are found in regions with a moderate amount of seasonal rainfall that lasts for only a few months. The deciduous trees shed their leaves during the winter and hot summer months. The forest frequently has a thick undergrowth as light can penetrate easily onto the forest floor.

**Thorn forests** are found in the semi-arid regions of India. The trees, which are sparsely distributed, are surrounded by open grassy areas. Thorny plants are able to conserve water.

**Mangrove forests** grow along the coast especially in the river deltas. These plants are able to grow in a mix of saline and fresh water. They grow luxuriantly in muddy areas covered with silt that the rivers have brought down. The mangrove trees have breathing roots that emerge from the mud banks.

**Conservation of forest ecosystem:** The forests can be conserved only when its resources are used carefully. This can be done by using alternate sources of energy instead of fuelwood. There is a need to grow more trees than are cut down from forests every year for timber. Afforestation needs to be done continuously from which fuelwood and timber can be judiciously used. The natural forests with all their diverse species must be protected as National Parks and Wildlife Sanctuaries where all the plants and animals can be preserved.

### 3.6.2 GRASSLAND ECOSYSTEM

A wide range of landscapes in which the vegetation is mainly formed by grasses and small annual plants form a variety of grassland ecosystems with their specific plants and animals. Grasslands cover areas where rainfall is usually low and/or the soil depth and quality is poor. The low rainfall prevents the growth of a large number of trees and shrubs, but is sufficient to support the growth of grass cover during the monsoon. Each grassland ecosystem has a wide variety of species of grasses and herbs.

#### TYPES OF GRASSLANDS

**The Himalayan pasture belt:** It extends upto the snowline. The grasslands at a lower level form patches along with coniferous or broadleaved forests. These Himalayan pastures have a large variety of grasses and herbs. There are also a large number of medicinal plants.

**The Terai:** This consists of patches of tall grasslands interspersed with a Sal forest ecosystem. The patches of tall elephant grass, are located in the low-lying waterlogged areas. The Sal forest patches cover the elevated regions and the Himalayan foothills. The Terai also includes marshes in low-lying depressions. This ecosystem extends as a belt south of the Himalayan foothills.

**The Semi-arid plains:** This is located in Western India, Central India and the Deccan are covered by grassland tracts with patches of thorn forest and are covered with seasonal grasses and herbs on which its fauna is dependent.

**The Shola grasslands:** It consist of patches on hillslopes along with the Shola forests on the Western Ghats, Nilgiri and Annamalai ranges. This forms a patchwork of grassland on the slopes and forest habitats along the streams and low lying areas.

**Conservation of grassland ecosystem:** Grasslands should not be overgrazed and areas of the grasslands should be closed for grazing. A part of the grassland in an area must be closed every year so that a rotational grazing pattern is established. Fires must

be prevented and rapidly controlled. To protect the most natural undisturbed grassland ecosystems, **Sanctuaries and National Parks must be created.**

### 3.6.3 DESERT ECOSYSTEM

Deserts and semi-arid areas are located in Western India and the Deccan Plateau. The climate in these vast tracts is extremely dry. This has sand dunes. There are also areas covered with sparse grasses and a few shrubs, which grow if it rains. The rainfall is scanty and sporadic. In an area it may rain only once every few years. Desert and semi-arid regions have a number of highly specialized insects and reptiles.

### 3.6.4 AQUATIC ECOSYSTEM

The aquatic ecosystems constitute the marine environments of the seas and the fresh water systems in lakes, rivers, ponds and wetlands. These ecosystems provide human beings with a wealth of natural resources. The aquatic ecosystems are classified into freshwater, brackish and marine ecosystems, which are based on the salinity levels.

**The fresh water ecosystems:** They have running water are streams and rivers. Ponds, tanks and lakes are ecosystems where water does not flow and have expanses of shallow water with aquatic vegetation, which forms an ideal habitat for fish, crustacean and water birds.

**Marine ecosystems** are highly saline, while brackish areas have less saline water such as in river deltas.

**Brackish water ecosystems** in river deltas are covered by mangrove forests and are among the world's most productive ecosystems in terms of biomass production. The largest mangrove swamps are in the Sundarbans in the delta of the Ganges.

### LIST OF QUESTIONS

1. Define Environment. Mention its scope. Discuss the need for public awareness.
2. Discuss how the water cycle ecosystem functions.
3. Elaborate how the nitrogen cycle ecosystem operates.
4. Discuss how oxygen cycle is utilized in the ecosystem.
5. Enumerate the utilization of carbon in ecosystem.
6. Write a short note on ecological succession.
7. What is a food chain, food web and ecological pyramid?
8. What is an ecosystem? Discuss forest ecosystem. Explain how conservation of forest can be done.
9. Describe grassland ecosystem. What are its types? How conservation of grassland can be made.
10. Write a short note on (i) Desert Ecosystem (ii) Aquatic Ecosystem.

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1. Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education by University grant commission and Bharathi Vidyapeeth Institute of environment education and Research, Pune
2. Introduction to Atmospheric Chemistry, by Daniel J. Jacob, Princeton University Press, 1999.
3. Environmental Studies, Raj Kumar Singh, Tata McGraw Hill India, 2012.

## MODULE -

# 4

## ENVIRONMENTAL POLLUTION

**Environmental Pollution:** Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies.

Pollution is the impact of undesirable changes in our surroundings that affect plants, creatures and individuals. Pollution is the introduction of contaminants into a natural atmosphere that causes instability, disorder, harm or discomfort to the ecosystem. Pollution can appear as chemical substances or energy such as noise, heat or light.

During the last few decades we have contaminated our air, water and land on which life itself depends with a variety of waste products. Pollutants include solid, liquid or gaseous substances present in greater than natural abundance produced due to human activity, which have a detrimental effect on our environment. The nature and amount of a pollutant determines the severity of detrimental effects on human health. Even a small concentration of pollutants in the air becomes more significant in comparison to the similar levels present in food. Pollutants that enter water have the ability to spread to distant places especially in the marine ecosystem.

### 4.1 TYPES OF POLLUTION

- Air pollution
- Water pollution
- Soil Pollution

### ENVIRONMENTAL POLLUTION

- Marine Pollution
- Thermal Pollution

### 4.2 AIR POLLUTION

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment. Air may get polluted by natural causes such as volcanoes, which release ash, dust, sulphur and other gases.

#### 4.2.1 SOURCES OF AIR POLLUTION

Pollutants that are emitted directly from identifiable sources are produced both by natural events (for example, dust storms and volcanic eruptions) and human activities (emission from vehicles, industries, etc.). These are called **primary pollutants**. There are five primary pollutants that together contribute to a large extent to air pollution. These are carbon oxides (CO and CO<sub>2</sub>), nitrogen oxides, sulphur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter.

Pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called **secondary pollutants**. These are sulfuric acid, nitric acid, carbonic acid.

**Carbon monoxide** is a colourless, odourless and toxic gas produced when organic materials such as natural gas, coal or wood are incompletely burnt. Vehicular exhausts are the single largest source of carbon monoxide.

**Sulphur oxides** are produced when sulphur containing fossil fuels are burnt.

**Nitrogen oxides** are found in vehicular exhausts. Nitrogen oxides are significant, as they are involved in the production of secondary air pollutants such as ozone.

**Hydrocarbons** are a group of compounds consisting of carbon and hydrogen atoms. They either evaporate from fuel supplies or are remnants of fuel that did not burn completely. Hydrocarbons are washed out of the air when it rains and run into surface water. They cause an oily film on the surface and react to form secondary pollutants.

**Particulates** are small solid materials (for example, smoke particles from fires, bits of asbestos, dust particles and ash from industries) dispersed into the atmosphere. The effects of particulates range from soot to the carcinogenic (cancer causing) effects of asbestos, dust particles and ash from industrial plants that are dispersed into the atmosphere. Repeated exposure to particulates can cause them to accumulate in the lungs and interfere with the ability of the lungs to exchange gases.

**Lead** is a major air pollutant that remains largely unmonitored and is emitted by vehicles.

#### 4.2.2 EFFECTS OF AIR POLLUTION

**Living Organisms:** Prolonged exposure to air pollutants can breakdown natural defences of the body causing or contributing to diseases such as lung cancer, asthma, chronic bronchitis and emphysema. Chronic exposure causes a condition similar to bronchitis. Suspended particles aggravate bronchitis and asthma. Exposure to these particles over a long period of time damages lung tissue and contributes to the development of chronic respiratory disease and cancer.

**Plants:** When some gaseous pollutants enter leaf pores they damage the leaves of crop plants. Chronic exposure of the leaves to air pollutants can break down the waxy coating that helps prevent excessive water loss and leads to damage from diseases, pests, drought and frost.

**Materials:** Air pollutants break down exterior paint on cars and houses. All around the world air pollutants have discoloured irreplaceable monuments, historic buildings, marble statues, etc.

#### 4.2.3 CONTROL MEASURES

Air pollution can be controlled by two fundamental approaches: preventive techniques and effluent control.

One of the effective means of controlling air pollution is to have proper equipment in place. This includes devices for removal of pollutants from the flue gases through **scrubbers, closed collection recovery systems** through which it is possible to collect the pollutants before they escape, **use of dry and wet collectors, filters, electrostatic precipitators**, etc. Providing a greater height to the stacks can help in facilitating the discharge of pollutants as far away from the ground as possible. Industries should be located in places so as to minimize the effects of pollution after considering the topography and the wind directions.

#### 4.3 WATER POLLUTION

Water pollution is the contamination of water bodies e.g. lakes, rivers, oceans, aquifers and groundwater. Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds.

##### 4.3.1 CAUSES OF WATER POLLUTION

There are several classes of common water pollutants. These are **disease-causing agents (pathogens)** which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes. Human wastes contain bacteria. Large amounts of human waste in water, increases the number of these bacteria which cause gastrointestinal diseases.

The next category water pollutants are **oxygen depleting wastes**. These are organic wastes that can be decomposed by aerobic (oxygen requiring) bacteria. Large populations of bacteria use up the oxygen present in water to degrade these wastes. In the process this degrades water quality. The amount of oxygen required to break down a certain amount of organic matter is called the biological oxygen demand (BOD). The amount of BOD in the water is an indicator of the level of pollution.

The third category of pollutants are **inorganic plant nutrients**. These are water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. They may interfere with the use of the water by clogging water intake pipes, changing the taste and odour of water and cause a build-up of organic matters.

The fourth category are **water soluble inorganic chemicals** which are acids, salts and compounds of toxic metals such as mercury and lead. High levels of these chemicals can make the water unfit to drink, harm fish and other aquatic life, reduce crop yields and accelerate corrosion of equipment that use this water.

#### **4.3.2 EFFECT OF WATER POLLUTION**

The main problem caused by water pollution is that it kills organisms that depend on these water bodies. Pollution disrupts the natural food chain as well. Pollutants such as lead and cadmium are eaten by tiny animals. Later, these animals are consumed by fish and shellfish, and the food chain continues to be disrupted at all higher levels. Ecosystems can be severely changed or destroyed by water pollution. Groundwater contamination from pesticides causes damage within wildlife in ecosystems. Sewage, fertilizer, and agricultural run-off contain organic materials that when discharged into waters, increase the growth of algae, which causes the depletion of oxygen. The low oxygen levels are not able to support most indigenous organisms in the area and therefore upset the natural ecological balance in rivers and lakes. Drinking contaminated water causes skin rashes and health problems like cancer, typhoid fever and stomach sickness in humans. Water pollution causes flooding due to the accumulation of solid waste and soil erosion in streams and rivers. Oil spills in the water causes animal to die when they ingest it or encounter it. Oil does not dissolve in water so it causes suffocation in fish and birds.

#### **4.3.3 CONTROL MEASURES OF WATER POLLUTION**

The foremost necessity is prevention, setting up effluent treatment plants and treating waste through these can reduce the pollution load in the recipient water. The treated effluent can be

reused for either gardening or cooling purposes wherever possible. Use environment friendly household products, such as washing powder, household cleaning agents etc. Excessive use of pesticides and fertilizers should be avoided. Don't throw litter into rivers, lakes or oceans and dispose it at designated bins. Suspended, solid particles and inorganic material can be removed by the use of filters. Use of biological filters and processes can naturally degrade the organic waste material.

#### **4.4 SOIL POLLUTION**

Soil is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life. Soils vary in their content of clay (very fine particles), silt (fine particles), sand (medium size particles) and gravel (coarse to very coarse particles). The relative amounts of the different sizes and types of mineral particles determine soil texture.

**Soil erosion** can be defined as the movement of surface litter and topsoil from one place to another. While erosion is a natural process often caused by wind and flowing water it is greatly accelerated by human activities such as farming, construction, overgrazing by livestock, burning of grass cover and deforestation.

#### **4.4.1 CAUSES AND EFFECTS OF SOIL POLLUTION**

Loss of the topsoil makes a soil less fertile and reduces its water holding capacity. The topsoil, which is washed away, also contributes to water pollution clogging lakes, increasing turbidity of the water and also leads to loss of aquatic life.

**Industrial Activity:** Industrial activity has been the biggest contributor to the problem. Most industries are dependent on extracting minerals from the Earth. Whether it is iron ore or coal, the by products are contaminated and they are not disposed of in a manner that can be considered safe and makes it unsuitable for use.

**Agricultural Activities:** Chemical utilization has gone up tremendously since technology provided us with modern pesticides and fertilizers. They contain chemicals that are not produced in nature and cannot be broken down by it. As a result, they seep into the ground after they mix with water and slowly reduce the fertility of the soil. Other chemicals damage the composition of the soil and make it easier to erode by water and air. Plants absorb many of these pesticides and when they decompose, they cause soil pollution since they become a part of the land.

**Waste Disposal:** While industrial waste is sure to cause contamination, there is another way in which we are adding to the pollution. Every human produces a certain amount of waste products by way or defecation. While much of it moves into the sewer system, there is also a large amount that is dumped directly into landfills. Even the sewer system ends at the landfill, where the biological waste pollutes the soil and water. This is because our bodies are full of toxins and chemicals which are now seeping into the land and causing pollution of soil.

**Accidental Oil Spills:** Oil leaks can happen during storage and transport of chemicals. This can be seen at most of the fuel stations. The chemicals present in the fuel deteriorates the quality of soil and make them unsuitable for cultivation. These chemicals can enter into the groundwater through soil and make the water unsafe for consumption.

**Acid Rain:** Acid rain is caused when pollutants present in the air mixes up with the rain and returns on the ground. The polluted water could dissolve away some of the important nutrients found in soil and change the structure of the soil.

#### 4.4.2 CONTROL MEASURES OF SOIL POLLUTION

It is essential that proper soil conservation measures are used to minimize the loss of top soil. There are several techniques that can protect soil from erosion. The most commonly employed methods include the two types of treatment that are generally used.

pipe line

- Area treatment which involves treating the land
- Drainage line treatment which involves treating the natural water courses

**Continuous contour trenches** can be used to enhance infiltration of water reduce the runoff and check soil erosion. It involves shallow trenches dug across the slope of the land and along the contour lines basically for the purpose of soil and water conservation. They are most effective on gentle slopes and in areas of low to medium rainfall.

**Live check dams** which barriers created by planting grass, shrubs and trees across the gullies can be used for this purpose.

**A bund constructed out of stones** across the stream can also be used for conserving soil and water.

#### 4.5 MARINE POLLUTION

It is defined as the discharge of waste substances into the sea resulting in harm to living resources, hazards to human health, hindrance to fishery and impairment of quality for use of sea-water. Marine pollution is associated with the changes in physical, chemical and biological conditions of the sea water.

##### 4.5.1 CAUSES OF MARINE POLLUTION

The most obvious inputs of waste are through pipes directly discharging wastes into the sea. municipal waste and sewage from residences and hotels in coastal towns are directly discharged into the sea.

Pesticides and fertilizers from agriculture which are washed off the land by rain, enter water courses and eventually reach the sea.

Petroleum and oils washed off from the roads enter the sewage system. When storm water overflows, these materials are carried into rivers and eventually into the seas.

Ship accidents and accidental spillages at sea can be very damaging to the marine environment. They may contain heavy metals and other contaminants are often dumped out to sea.

Offshore oil exploration and extraction also pollute the seawater to a large extent.

#### **4.5.2 EFFECTS OF MARINE POLLUTION**

Apart from causing eutrophication a large amount of organic wastes can also result in the development of red tides. Many important commercially important marine species are also killed due to clogging of gills or other structures. Oil slicks damage marine life to a large extent. Salt marshes, mangrove swamps are likely to trap oil and the plants, which form the basis for these ecosystems thus suffer.

*respiratory organs of fish*

#### **4.5.3 CONTROL MEASURES OF MARINE POLLUTION**

Reducing the pollution load on marine waters is through the introduction of sewage treatment plants. This will reduce the biological oxygen demand (BOD) of the final product before it is discharged to the receiving waters.

**Primary treatment:** These treatment plants use physical processes such as screening and sedimentation to remove pollutants that will settle, float or, that are too large to pass through simple screening devices. After screening the wastewater passes into a grit chamber. The detention time is chosen to be long enough to allow lighter, organic material to settle. From the grit chamber the sewage passes into a primary settling tank (also called as sedimentation tank) where the flow speed is reduced sufficiently to allow most of the suspended solids to settle out by gravity. If the waste is to undergo only primary treatment it is then chlorinated to destroy bacteria and control odours after which the effluent is released.

**Secondary treatment:** The main objective of secondary treatment is to remove most of the BOD. There are three commonly used approaches: trickling filters, activated sludge process and oxidation ponds.

A trickling filter consists of a rotating distribution arm that sprays liquid wastewater over a circular bed of 'fist size' rocks or other coarse materials. The spaces between the rocks allow air to circulate easily so that aerobic conditions can be maintained. The individual rocks in the bed are covered with a layer of slime, which consists of bacteria, fungi, algae, etc. which degrade the waste trickling through the bed.

In the activated sludge process, the sewage is pumped into a large tank and mixed for several hours with bacteria rich sludge and air bubbles to facilitate degradation by micro-organisms. The water then goes into a sedimentation tank where most of the microorganisms settle out as sludge.

Oxidation ponds are large shallow ponds approximately 1 to 2 metres deep where raw or partially treated sewage is decomposed by microorganisms.

#### **4.6 NOISE POLLUTION**

Noise is undesirable and unwanted sound. Noise may not seem as harmful as the contamination of air or water but it is a pollution problem that affects human health and can contribute to a general deterioration of environmental quality.

##### **4.6.1 CAUSES OF NOISE POLLUTION**

There are several sources of noise pollution that contribute to both indoor and outdoor noise pollution. Noise emanating from factories, vehicles, playing of loudspeakers during various festivals can contribute to outdoor noise pollution while loudly played radio or music systems, and other electronic gadgets can contribute to indoor noise pollution.

##### **4.6.2 EFFECTS OF NOISE POLLUTION**

**Physical health:** The most direct harmful effect of excessive noise is physical damage to the ear and the temporary or permanent hearing loss. Below a sound level of 80 dBA hearing loss does not occur at all. However temporary effects are noticed at sound levels

between 80 and 130 dBA. A sound level of 150 dBA or more can physically rupture the human eardrum. The degree of hearing loss depends on the duration as well as the intensity of the noise. In addition to hearing losses excessive sound levels can cause harmful effects on the circulatory system by raising blood pressure and altering pulse rates.

**Mental health:** Noise can also cause emotional or psychological effects such as irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise.

#### 4.6.3 CONTROL MEASURES OF NOISE POLLUTION

There are four fundamental ways in which noise can be controlled: Reduce noise at the source, block the path of noise, increase the path length and protect the recipient. In general, the best control method is to reduce noise levels at the source.

Source reduction can be done by effectively muffling vehicles and machinery to reduce the noise. In industries noise reduction can be done by using rigid sealed enclosures around machinery lined with acoustic absorbing material. Another best method of noise source reduction is regular and thorough maintenance of operating machinery. Noise levels at construction sites can be controlled using proper construction planning and scheduling techniques.

### 4.7 THERMAL POLLUTION

Thermal pollution is the act of altering the temperature of a natural water body, which may be a river, lake or ocean environment.

**Definition-**The discharge of warm water into a river is usually called a thermal pollution.

#### 4.7.1 CAUSES OF THERMAL POLLUTION

It occurs when an industry removes water from a source, uses the water for cooling purposes and then returns the heated water to its source. Power plants heat water to convert it into steam, to drive the turbines that generate electricity. the steam is condensed into water after it leaves the turbines. This condensation is done

by taking water from a water body to absorb the heat. This heated water is discharged back into the water body. This condition chiefly arises from the waste heat generated by an industrial process such as certain power generation plants. There can be significant environmental consequences of thermal pollution with respect to surface receiving waters such as rivers and lakes; in particular, decrease in biodiversity and creation of an environment hospitable to alien aquatic species may occur.

#### 4.7.2 EFFECTS OF THERMAL POLLUTION

The warmer temperature decreases the solubility of oxygen and increases the metabolism of fish. This changes the ecological balance of the river. Sudden changes in temperature caused by periodic plant shutdowns both planned and unintentional can change result in death of these fish that are acclimatized to living in warmer waters. Due to decrease in Dissolved Oxygen levels there is suffocation of plants and animal species which creates anaerobic conditions. The sudden change in the temperature causes harm to the aquatic organisms. The heated water is used for irrigation purposes to extend plant growing seasons.

#### 4.7.3 CONTROL MEASURES OF THERMAL POLLUTION

Thermal pollution can be controlled by passing the heated water through a cooling pond or a cooling tower after it leaves the condenser. The heat is dissipated into the air and the water can then be discharged into the river or pumped back to the plant for reuse as cooling water.

One method is to construct a large shallow pond. Hot water is pumped into one end of the pond and cooler water is removed from the other end. The heat gets dissipated from the pond into the atmosphere.

A second method is to use a cooling tower. Here warm waters coming from the condenser is sprayed downward over vertical sheets or baffles where the water flows in thin films. Cool air enters the tower through the water inlet that encircles the base of the tower and rises upwards causing evaporative cooling. The waste heat is

dissipated into the atmosphere about 100 m above the base of the tower. The cooled water is collected at the floor of the tower and recycled back to the power plant condensers.

#### 4.8 SOLID WASTE MANAGEMENT

Waste, which is non-affective and comes from city, town or village as domestic and biomedical waste is termed as **solid waste**. The process of transportation, storage, collection and processing of solid waste in a protective and economic manner is termed as **Solid Waste Management(SWM)**.

##### 4.8.1 NATURE OF THE PROBLEM

- SWM is a civic problem and it has to evolve optimally &continuously to serve the future generation.
- Solid wastes if unchecked can not only be a health hazard but will impart multidimensional threats.
- A complete and environmentally sound SWM requires effective contribution from all those who are involved in this problem.
- Everyone is involved in solid waste generation problem so everyone should be involved in the proper disposal of it.

##### 4.8.2 SWM TECHNIQUES

An integrated waste management strategy includes three main components:

1. Source reduction
2. Recycling
3. Disposal

**Source reduction** is one of the fundamental ways to reduce waste. This can be done by using less material when making a product, reuse of products on site, designing products or packaging to reduce their quantity.

**Recycling** is reusing some components of the waste that may have some economic value. Recycling has readily visible benefits such as conservation of resources reduction in energy used during manufacture and reducing pollution levels.

**Disposal** of solid waste is done most commonly through a sanitary landfill or through incineration. A modern sanitary landfill is a depression in an impermeable soil layer that is lined with an impermeable membrane.

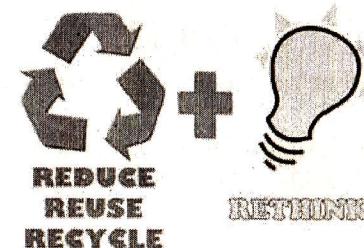


Fig 4.1 Strategy for Solid Waste Management

Even though landfilling is an economic alternative for solid waste disposal, it has become increasingly difficult to find suitable landfilling sites that are within economic hauling distance and very often citizens do not want landfills in their vicinity.

##### Methods include Incineration and Vermi composting

**Incineration** is the process of burning municipal solid waste in a properly designed furnace under suitable temperature and operating conditions. Incineration is a chemical process in which the combustible portion of the waste is combined with oxygen forming carbon dioxide and water, which are released into the atmosphere. However, extensive air pollution control equipment and high-level technical supervision and skilled employees for proper operation and maintenance is required.

**Vermi Composting** involves collection of all dead and dry leaves and twigs to decompose and are broken down by organisms such as worms and insects, and is finally broken down by bacteria and fungi, to form a dark rich soil-like material called compost. These organisms in the soil use the organic material as food, which provides them with nutrients for their growth and activities. These nutrients are returned to the soil to be used again by trees and other plants. This process recycles nutrients in nature. This soil can be used as a manure for farms and gardens.

#### 4.9 ROLE OF INDIVIDUAL IN PREVENTION OF POLLUTION

Concepts that help individuals contribute towards a better quality of our environment and human life include

- Develop respect for all forms of life.
- Plant trees wherever you can and more importantly take care of them. They reduce air pollution.
- Reduce the use of wood and paper products wherever possible.
- Do not buy furniture, doors, window frames made from tropical hardwoods such as teak and mahogany. These are forest based.
- Reduce the use of fossil fuels by either walking up a short distance using a car pool, sharing a bike or using public transport. This reduces air pollution.
- Shut off the lights and fans when not needed.
- Don't use aerosol spray products and commercial room air fresheners. They damage the ozone layer.
- Use rechargeable batteries.
- Try to avoid asking for plastic carry bags when you buy groceries or vegetables or any other items. Use your own cloth bag instead.
- Use sponges and washable cloth napkins, dish towels and handkerchiefs instead of paper ones
- Don't use throwaway paper and plastic plates and cups when reusable versions are available.
- Recycle all newspaper, glass, aluminium and other items accepted for recycling in your area.
- Set up a compost bin in your garden or terrace and use it to produce manure for your plants to reduce use of fertilizers.
- Do not litter the roads and surroundings.

Take care to put into practice what you preach. *ENVIRONMENT PROTECTION BEGINS WITH YOU.*

#### 4.10 POLLUTION CASE STUDIES

1. Bhopal gas tragedy
2. Love canal tragedy

3. Arsenic pollution in ground water
4. Chernobyl nuclear disaster

##### 4.10.1 DONORA AIR POLLUTION DISASTER

- Donora (Pennsylvania, USA) is a mill town - Steel mill, Zinc smelter, Sulphuric Acid plant.
- Donora is in a valley on Monongahela river surrounded by steep hills on each side of the river.
- 25-31 October 1948 - fog due to accumulation of cold air due to inversion. Inversion is trapping of cold layer below the warm layer.
- Effect of inversion- Top fog layer reflected away the solar radiation during day time.
- Insufficient heat to break the inversion
- Pollutants of the mills got trapped in lower layer and remained for 4 days.
- 6000 of 14000 people living in Donora fell ill, 20 died.

##### 4.10.2 BHOPAL GAS TRAGEDY

- 2-3rd December 1984 – Union Carbide Company, Bhopal – major disaster. UCC Manufactured Carbaryl pesticide using Methyl Isocyanite(MIC).
- Cause of accident - Accidental entry of water in processing tank -Overheating of mixture - Failure of cooling system- Safety Devices in not working condition - EXPLOSION.
- 40 tons of MIC leaked into atmosphere.
- Lungs, eye and skin damage in 40km<sup>2</sup> area. 5100 people died. 250000 people got exposed to MIC. 65000 people suffered from severe diseases. 1000 people became blind.
- \$570 million to clean up and settlement of damages all because of lack of safety measurements in proper working condition.

##### 4.10.3 LOVE CANAL TRAGEDY

- Love Canal was built by William Love in suburb of Nigeria falls, New York. It was later dug up and used to dump sealed steel drums of chemical wastes by Hooker chemicals corporation (1942-1953).

- In 1953 the site was covered with clay and top soil and sold to city board of education. Elementary school and houses were built.
- 1976- residents complain about foul smell. Children playing in canal area received chemical burns.
- Cause- steel containers got corroded- leaking of chemicals into storm sewers, basement of homes and school playgrounds.
- Remedy-
  1. Wastes were pumped to the new treatment plant
  2. Families were relocated.

#### 4.10.4 ARSENIC POLLUTION IN GROUND WATER

- West Bengal and Bangladesh are severely infected by toxic heavy metal Arsenic(study report of 1978- west Bengal) (1993- Bangladesh)
- Residents have been taking low doses of Arsenic for 10-14 years through contaminated water.
- Result-white/black spots called Melanosis affecting the skin - Leprosy like skin lesions on palms and soles. Eventually rotting into ulcers. Long exposure results in cancer. Affected people are socially boycotted.
- 24-Parganas, Hooghly, Murshidabad districts are the most Arsenic risk zone.
- Cause- excess use of lead Arsenate, copper arsenate as pesticides in summer paddy and jute crops.
- Short term remedy-contaminated tube wells in the state are being painted red whereas safe water tube wells are painted green for the use of people.

#### 4.10.5 CHERNOBYL NUCLEAR DISASTER

- Worst nuclear disaster-26 April 1986 in Chernobyl, Ukraine.
- The power plant designed to produce 1000MW electrical energy, was working continuously for 2 years. Shut down on 25th April for normal repair work.
- Due to faulty shutting down process - SEVERE EXPLOSION
- Severity- 1000 tonne steel concrete lid blew off - Fire started- Temperature rose to 2000°C - Fuel and Radioactive debris

- spread out on volcanic cloud – neighbouring countries Poland, Sweden, Denmark and Norway were also affected.
- Damage-506000 people were affected - Risk of severe diseases like cancer and leukaemia- People also suffered from anaemia, loss of hair, damaged skin - 2000 people died – Flora and fauna destroyed -agriculture produces were damaged for years.
  - Future precaution- nuclear energy is a cheap, non-polluting source of energy but lack of proper care and safety measures can create huge disasters.

#### LIST OF QUESTIONS

1. Discuss briefly the causes, effects and control measures of air pollution.
2. Enumerate the water pollution causes and its effects. Mention the control measures that can be initiated for mitigating the same.
3. Elaborate the causes, effects and control measures of (i) Soil Pollution (ii) Noise Pollution (iii) Thermal Pollution
4. Discuss Solid Waste Management techniques.
5. Enumerate the role of an individual in prevention of pollution.
6. Discuss any two case studies related to pollution of environment in detail.

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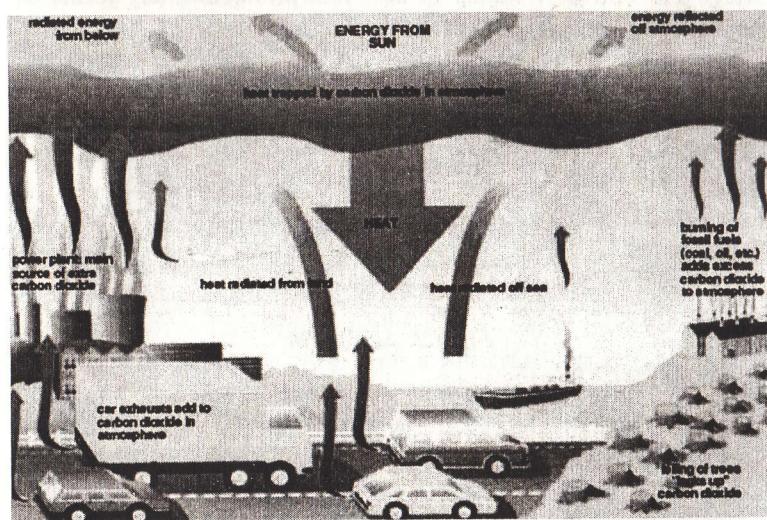
**MODULE -****5****SOCIAL ISSUES AND THE ENVIRONMENT**

**Social Issues and the Environment:** Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.

**5.1 CLIMATE CHANGE**

The average temperature in several regions has been increasing in recent decades. The worldwide average surface temperature has increased by  $0.2^{\circ}\text{C}$  to  $0.6^{\circ}\text{C}$  over the last century. Many nations have experienced increases in rainfall, especially within the international locations located inside the mid to high latitudes. In a few regions, such as parts of Asia and Africa, the frequency and depth of droughts are found to increase in current decades. All these are signs that the earth is unwell. Its weather is changing, making it extra hard for mankind to survive. The earth is losing its ability to balance itself owing to the imbalances created by human activities. Studies conducted by Intergovernmental Panel on global climate change (IPCC) have shown that within the close to future, the worldwide mean surface temperature can rise by  $1.4^{\circ}\text{C}$  to  $5.8^{\circ}\text{C}$ . Warming is greatest over land areas and at high latitudes. The frequency of weather extremes is likely to increase floods or drought. Global mean sea level is projected to rise by 9 to 88 cm by the year 2100.

Human societies are seriously tormented by extremes of climate like droughts and floods. This is often a serious concern for human health. To a large extent, public health depends on safe potable water, plenty food, secure shelter, and sensible social conditions. All these factors are damaged by global climate change. Fresh water components can be significantly affected, reducing the supply of smooth water for consuming and washing in the course of drought and floods. Water can be infected and sewage systems can be damaged. The danger of increased spread of infectious diseases increases. Food and water shortages may additionally lead to conflicts with critical implications for public health. Changes in climate will boom the spread of sickness, including malaria to regions which lack a strong public fitness infrastructure.

**5.2 GLOBAL WARMING**

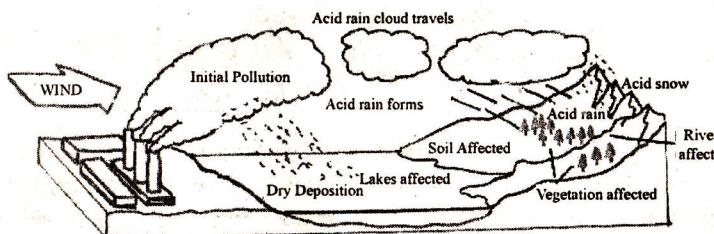
**Fig 5.1 Global Warming**

About 75% of the sun power achieving the Earth is absorbed on the earth's surface which increases its temperature. Whatever is left of the warmth transmits back to the atmosphere. Some of the heat is trapped through greenhouse gases, often by carbon dioxide. As greenhouse emission is discharged by numerous human activities, it's quickly increasing and causing global warming. Human

activities for the duration of the last few decades of industrialization and population boom have polluted the atmosphere and affecting the weather. Carbon dioxide within the surroundings has expanded by 31% since pre-industrial times, inflicting greater heat to be trapped inside the lower atmosphere.

### 5.3 ACID RAIN

When fossil fuels consisting of coal, oil and natural gas are burnt, chemical substances like sulfur dioxide and nitrogen oxides are produced. These chemicals react with water and different chemical substances in the air to form sulfuric acid, nitric acid and other harmful pollution like sulfates and nitrates. These acid pollutants unfold upwards into the atmosphere and are carried via air currents, to eventually return to the ground in the form of acid rain, fog or snow. The corrosive nature of acid rain produces many forms of environmental damage.



*Fig 5.2 Acid Rain*

#### 5.3.1 EFFECTS

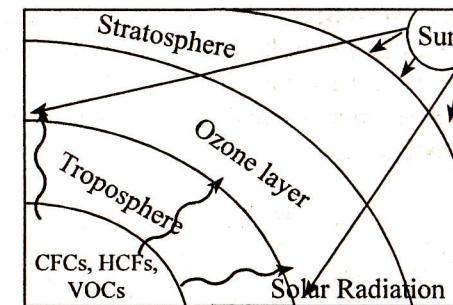
- Acid rain is known to cause widespread environmental damage.
- Acid rain dissolves and washes away vitamins in the soil which are essential for plants.
- Acid rain indirectly affects plants by removing nutrients from the soil during which they grow.
- Acid rain that falls or flows as  $H_2O$  to reach rivers, lakes and wetlands, causes the water in them to become acidic. This affects plant and animal life in aquatic ecosystems.
- Acid rain also has far achieving effects on flora and fauna. The entire food chain is disrupted, in the end endangering the whole atmosphere.

- Acid rain and dry acid deposition damages buildings, vehicles, and other systems made from stone or steel.

### 5.3.2 PREVENTION

Way to stop the formation of acid rain is to lessen the emissions of sulfur dioxide and nitrogen oxides into the surroundings. This may be achieved by using the use of much less energy from fossil fuels in power plants, automobiles and industry. Switching to cleaner burning fuels is the other way.

### 5.4 OZONE LAYER DEPLETION



*Fig 5.3 Ozone Layer Depletion*

Ozone is made by the action of daylight on  $O_2$ . It forms a layer 20 to 50 kms over the surface of the earth. This action takes place naturally within the atmosphere, however is extremely slow. Ozone gas is extremely toxic with a powerful odour. It is a type of oxygen that has three particles in every atom. It is taken into consideration as a pollutant at ground level and constitutes a health risk by inflicting respiratory ailments like allergies and bronchitis. It also causes harm to vegetation and leads to a deterioration of certain materials like plastic and rubber. Ozone within the upper environment is important to all existence because it protects the earth from the sun's harmful ultraviolet radiation. The ozone layer within the upper atmosphere absorbs the sun's ultraviolet radiation, preventing it from reaching the earth's surface. This layer within the atmosphere protects life on earth from the harmful UV radiation from the sun. chlorofluorocarbons or CFCs, that were used as