UNIT-III

ENVIRONMENTAL POLLUTION, GLOBAL ENVIRONMENTAL ISUES AND CONTROL MEASURES

3.1 ENVIRONMENTAL POLLUTION

INTRODUCTION:

According to **ODUM (1971)**, Pollution is **"an undesirable change in the characteristics of air, water and land that harmfully affect the life and also create health hazards for all living organisms on the globe"**.
According to **SOUTHWICK (1976),** Pollution can be defined as **"the unfavorable (or) alteration of environment caused by human activities and causing harm to human beings".**

TYPES OF POLLUTION:

Basically the Pollution is of two types viz.,

(1) Natural Pollution: This type of pollution is limited in its occurrence generally from natural hazards like volcanic eruptions, emissions of natural gas, soil erosion, ultraviolet rays, cosmic rays etc and
(2) Manmade Pollution: Most of the pollution is man made only. However, Pollution is usually categorized as Air Pollution; Water Pollution; Thermal Pollution; Noise Pollution; Land & soil Pollution; Radio Active Pollution and Marine Pollution

3.1.1 AIR POLLUTION

Air pollution may be described as "**the imbalance in quality of air so as to cause adverse effects on the living organisms existing on earth**". Pollution is due to the presence of undesirable substance of sufficient quantity which exists in environment.
The substance or energy which causes pollution is called pollutant.

Types of air pollutants:
Pollutants may be classified according to origin and state of matter.

a) According to Origin: Air pollutants are divided into two categories as primary & secondary.
1) Primary air pollutants are those which are emitted directly into the atmosphere.
Eg: C; CO; CO_2; SOx ; N; S; H; NOx; CFC's etc .
2) Secondary air pollutants are those which are produced in the air by the interaction Among the primary air pollutants or by reaction with atmospheric constituents.
Eg: **Ozone (O_3)**; **Smog; Para Acetyl Nitrate (PAN)**; **Acid Rain**; **Aerosols.**

b) According to State of Matter: Air pollutants include fine solids; liquids and gases. Dust, Smoke, Fumes etc are examples for solid particles whereas fog is an example for liquid particles.

PRIMARY POLLUTANTS

1. Carbon Monoxide: It is a colorless, odorless, poisonous gas that is produced by the incomplete burning of carbon based fuels (coal, petrol, diesel and wood) which comes from the automobile industries, exhaust devices, About 70% of CO emissions are from the transport sector.

When the air is polluted with CO, human blood is likely to be deprived of oxygen and leads to coma and death. In mild dosages, it leads to headache.

2. Oxides of Sulphur: SO_2 is a gas produced from burning of coal, mainly in thermal power plants. Some industries such as paper mills produce SO_2. It is injurious not only to men and plants, but it also attacks rapidly a few rocks such as limestone, marbles, electric contacts etc. It can even dissolve nylon.

Paper absorbs SO_2 causing the paper to become brittle and fragile. SO_2 polluted air leads to corrosion of metals such as Fe, Zn, Cu, steel etc… SO_2 is a major contributor to Smog and acid rain.

Sulphur trioxideis more irritant than SO_2 because it combines immediately with water to form sulphuric acid.

3. Oxides of Nitrogen: Combustion of coal, oil, natural gas and gasoline which produces upto 50 ppm of Nitrogen. NOx are also produced when fossil fuels are burned especially in power plants and motor vehicles. NO_2poisoning results SILOFILTER disease. High levels of NO_2 exposure causes cough and make the human beings feel short of breath. People who are exposed to NO_2 for a long time have a higher chance of getting respiratory infections.

NOx compounds contribute for the formation of Ozone. Similarly, when nitrogen oxide when combine with SOx to form acid rain.

4. Chloro Fluoro Carbons: CFC's (also known as Freon) are non- toxic. They contain Carbon, Fluorine and Chlorine atoms.The five main CFCs are the following:

- CFC – 11 (Trichloro Fluoro Methane $CFCl_3$)
- CFC – 12 (Dichloro Fluoro Methane CF_2Cl_2)

The major uses of CFCs are as coolants in refrigerators and in air conditioners; as solvents in cleaners particularly for electronic circuit boards etc.. CFCs are the main cause of ozone depletion. CFCs have a lifetime in the atmosphere of about 20 to 100 years, and as a result one free chlorine atom from a CFC molecule can do a lot of damage.

SECONDARY POLLUTANTS:

1) Ozone (O_3) / Ozone layer Depletion: Ozone consists of oxygen molecules which contain three oxygen atoms. It is not emitted directly into the air but produced in the atmosphere when oxygen combines with oxygen radical (**O**$^{\cdot}$) in the presence of sunlight. Ozone protects us from ultra violet radiation and other harmful rays.

It is observed that over the last few years, many manmade processes release gases into atmosphere causing drastic depletion of ozone layer. The chlorine atoms cause depletion of ozone slowly and holes are formed in the ozone layer.

Ozone reacts with tissues and cause for breathing and decrease the working ability of the lungs, chest pains and coughing. It lowers the human body resistance power and leads to cold; pneumonia also.

Antarctic Ozone depletion: According to NIMBUS-7 satellite picture which was taken on 5th October, 1987 the protective ozone layer showed a hole over 50% of the area of the Antarctica continent covering 7 million sq km.
On Jan 1st 1989, the country Montreal (Canada) proposed redesigning refrigeration, air conditioning technology replacing the use of CFCs by ozone friendly substitutes.

2) Smog: Smog is a combination of smoke and fog or various gases when react in the presence of sunlight. The effects of smog on human health cause for respiratory, irritation to the eyes, diseases related to nose, throat, bronchitis, pneumonia, headache, nerves, liver, and kidneys.
The first smog related deaths were recorded in London in 1873, when it killed 500 people. In 1892, December, London had worst experiences causing 1000 deaths. In 1940's severe smog began covering the cities of Los Angeles in USA.

3) Acid rain: Acid rain has become one of the most important global environmental problems and poses significant adverse impact on soils, rivers, lakes, forests and monuments. The phenomenon occurs when SOx and NOx from the burning of fossil fuels such as Petrol, Diesel, Coat etc combine with water vapour in atmosphere and fall as rain or snow or fog.
Natural sources like volcanoes, forest fires, etc also contribute SOx and NOx. Increased urban and industrial activities cause air pollution resulting in the rise of concentration of SO_2 and NOx. Sulphur dioxide and NO_2 combines with water vapour in the atmosphere produce sulphuric acid and Nitric acid respectively and results acid rain. Some of the examples are:
Europe and parts of W Asia have experienced rain with water pH range of 4.5 to 5.0 (acidic) in 1958.

AIR POLLUTION EFFECTS, PREVENTION AND CONTROL MEASURES:
Human beings breathe 22000 times a day on the average, inhaling 16 kg of air. Atmosphere constitutes a protective cover of gases surrounding the earth which
sustains life and saves it from unfriendly environment.
The atmosphere consists of several layers viz. Troposphere, Stratosphere; Mesosphere; Thermosphere & Exosphere.
The lower atmosphere i.e., the troposphere contains 70% of gaseous components of major, minor and traces. Ultra violet radiation from the sun is absorbed by ozone in the stratosphere which is so called ozone layer located between 17 - 26 kms above sea level.

Effects of Air pollution: The effects of pollution may be direct and affect certain organisms. The effects of pollution may possess a hazard or nuisance. Long continued pollution even affects the evolution of a species and eliminates organisms that cannot tolerate certain pollutants and favor others who can eat.
Air pollution causes deaths, Impair health, reduce visibility and brings vast economic losses. It can also cause intangible losses to historic monuments such as Taj Mahal.
Finally, Air pollution can affect the environment on a global scale.

Prevention and control of Air Pollution:

- Inputs that do not contain the pollutants.
- Operating process to minimize generation of the pollutants.
- Replacing the process with one does not generate the pollutant.
- Removing the pollutants from the process.
- Substitution of raw materials.

Eg: The substitution of high sulphur coal with low sulphur coal in power plants.
Eg: Changing a fossil fuel with nuclear energy can eliminate sulphur emission.

- By involving the Process Modification:
  Eg: Chemical and petroleum industries have changed by implementing Automated operations, computerized process control by reducing the Oxidation of SO_2 to SO_3 by reducing excess air.
- By involving the control technologies: Control equipment viz., Wet Collector (scrubber), Gravity Settling chamber; Cyclone Collectors, Dry Scrubbers, filters, electrostatic precipitators etc. are to be used to minimize the air pollution.

3.1.2 WATER POLLUTION

Hydrosphere in the universe contains water in the form of oceans, rivers, lakes, tanks and many other water sources.
Water sources in the world are of two types.
They are (1) Marine water bodies and (2) Fresh Water bodies.
Water is a good solvent for many substances. Because of this property water cannot exist in its pure form at many parts of the world. Water pollution is mainly because of sewage, industrial disposals i.e., effluents.

PARAMETERS OF WATER POLLUTION:
Chemical examination of water (tests): pH; Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), etc are some of the chemical tests to find the stage of pollution of water.

1. pH: The value of pH gives the degree of acidity or alkalinity of polluted water. Determination of pH is important in calculating the coagulant (thick or thin) dose.

2. Biological Oxygen Demand (BOD): It is defined as the quantity of oxygen utilized by micro organisms at a temperature of 20^oC, generally measured for 5 days. When water is polluted by unwanted materials, naturally the O_2 content gets reduced and that water become not fit for consumption either by human beings or animals or plants.
Living organisms require water with some quantity of sustainable oxygen in it. That oxygen is necessary for living organisms is generally called BOD. If there is reduction in oxygen content of water, it becomes unfit for biological consumption because there is change in BOD.

COMMON TYPES OF WATER POLLUTANTS:
A) Based on sources **B) Based on natures**

A) Based on sources:
a) Disease causing agents: Bacteria, viruses, protozoan that enter water from domestic sewage and animal wastes.
b) Water soluble inorganic chemicals: Acids, salts and compounds of toxic metals such as Lead, Mercury can make water unfit to drink, harm fishes and other aquatic life. Also Nitrate, Phosphate compounds dissolve in water that can cause excessive growth of algae, which then die and decay, depleting dissolved O_2 in water and killing fish.

c) Water Soluble Organic chemicals: Oil, gasoline (a type of oil is obtained from petroleum), pesticides, detergents and many other water soluble chemicals that threaten human health and harm fish.

d) Heat: Large quantity of water is heated when it is used in the cooling towers of thermal power plants. When this hot water is discharged into the nearby water bodies, it causes an increase in its temperature.

e) Sewage: sewage is waste water from municipal area where there is human habitation. Sewage which comes from homes is called **domestic sewage**

B) Based on natures:

In nature water pollution is classified into three types by **Kimball** (1975). They are:

1. Domestic water pollution: Sewage is a part of domestic water pollution. Domestic sewage not only contains unwanted waste materials, but it is also infested with harmful bacteria, virus etc. These are responsible for causing diseases in animals and human beings, if they drink this polluted water and even plants may die if polluted water is provided. Domestic water pollution leads to Diarrhea, Cholera and Typhoid in human beings.

2. Agricultural Water Pollution: Water require for plants for its growth. Major irrigation, minor irrigation, sprinkler irrigation, drip irrigation, lift irrigation carry waste substances and causing water pollution in addition to the utilization of fertilizer and pesticides. Agricultural water pollution leads to Eutrophication & Water Bloom.

Ecological effects: The important troubling ecological impacts are:

1. Excessive nutrients in water bodies promote plant growth which leads to a drop in water quality;
2. Disruption of the natural ecosystem E.g. lack of oxygen for shelf marine life (causing a drop in their population).
3. Decrease in the recreational and aesthetic value of water bodies
4. Health problems when it occurs in drinking water reserves
5. Coral reef decline
6. Decreased biodiversity,
7. Changes in species composition and dominance, and
8. Toxicity effects.
9. Toxic phytoplankton species
10. Decreases in water transparency (increased turbidity)
11. Color, smell, and water treatment problems
12. Dissolved oxygen depletion
13. Increased incidences of fish kills
14. Loss of desirable fish species

3. Industrial water pollution: Many industries discharge waste materials containing harmful chemicals. Such Industrial wastes are called **effluents**. The river Godavari is polluted because of effluents released by the paper industry. It affects the entire water ecosystem causing enormous damage to fishes, prawns and fresh water animals.

Eg: Minamata disease & Fluorosis.

Minamata disease is a neurological syndrome caused by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field

of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms.
Minamata disease was first discovered in Minamata city in Japan in 1956. It was caused by the release of methyl mercury from, the Chisso Corporation's chemical factory, which continued from 1932 to 1968. This highly toxic chemical bio- accumulated in shellfish and fish in Minamata
Bay which when eaten by the local people resulted in mercury poisoning. While cat, dog, pig, and human deaths continued over more than 30 years, the government and company did little to prevent the pollution.
Fluorosis: People suffer from a disease called fluorosis after consuming water containing fluorine for sufficiently a long time. Quantity of fluoride in water is only 1 ppm. Diseases caused by fluorosis are:

- Back pain and cannot easily bend.
- Joints get stiffened as so movement of joints is impaired.
- Teeth are the worst effected and a brown coating appears on the enamel of teeth giving bad appearance.
- Persons with fluorosis cannot erect freely.

CONTROL MEASURES OF WATER POLLUTION:

1. Drinking water should be boiled, cooled and then used.
2. Disinfection of drinking water should be done by using chemicals like bleaching powder.
3. Pesticides and insecticides should be prevented from nearby use of water lakes,ponds and pools.
4. Drainage water should not be allowed to mix with drinking water.
5. Drainage system should be maintained properly.
6. Chlorination process is to be adopted for drinking water. For 1 litre of water 30 - 40 mg of chlorine is to be added to get perfect disinfection. It kills bacteria, fungi, fungal spores and other microbes also.

3.1.3 SOIL POLLUTION

Definition:
Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, Radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health. Soil is the thin layer of organic and inorganic materials that covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark uppermost topsoil. The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to supply the world with sufficient food.

There are many different ways that soil can become polluted, such as:

- Seepage from a landfill
- Discharge of industrial waste into the soil
- Percolation of contaminated water into the soil
- Rupture of underground storage tanks
- Excess application of pesticides, herbicides or fertilizer
- Solid waste seepage

The most common chemicals involved in causing soil pollution are:

- Petroleum hydrocarbons
- Heavy metals
- Pesticides
- Solvents

Types of Soil Pollution

- Agricultural Soil Pollution and pollution due to urban activities
  - i) Pollution of surface soil
  - ii) Pollution of underground soil
- Soil pollution by industrial effluents and solid wastes
  - i) Pollution of surface soil
  - ii) Disturbances in soil profile

CAUSES OF SOIL POLLUTION:

Soil pollution is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage links, application of pesticides, and percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. This occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage.

A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the Soil or which disturbs the biological balance of the organisms in the soil. Pollution in soil has adverse effect on plant growth.

Pollution in soil is associated with

- Indiscriminate use of fertilizers
- Indiscriminate use of pesticides, insecticides and herbicides
- Dumping of large quantities of solid waste
- Deforestation and soil erosion

1. Indiscriminate use of fertilizers:

Soil nutrients are important for plant growth and development. Plants obtain carbon, hydrogen and oxygen from air and water. But other necessary nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and more must be obtained from the soil. Farmers generally use fertilizers to correct soil deficiencies. Fertilizers contaminate the soil with impurities, which come from the raw materials used for their manufacture. Mixed fertilizers often contain ammonium nitrate (NH_4NO_3), phosphorus as P_2O_5, and potassium as K_2O. For instance, arsenic, lead and cadmium present in traces in rock phosphate mineral get transferred to super phosphate fertilizer. Since the metals are not degradable, their accumulation in the soil above their toxic levels due to excessive use of phosphate fertilizers becomes an indestructible poison for crops.

The over use of NPK fertilizers reduce quantity of vegetables and crops grown on soil over the years. It also reduces the protein content of wheat, maize, grams, etc., grown on that soil. The carbohydrate quality of such crops also gets degraded. Excess potassium content in soil decreases Vitamin C and carotene content in vegetables and fruits. The vegetables and fruits grown on over fertilized soil are more prone to attacks by insects and disease.