UNIT 3 ENVIRONMENTAL POLLUTION

Structure

3.0 0BJECTIVES

After reading this Unit you will be able to:

- understand the concept of a pollutant and learn to distinguish them,
- develop an understanding about the sources of pollution and the way they reach into the environment, and
- Provide an orientation to the methods that are applied to control and prevent environmental pollution.

3.1 INTRODUCTION

Having read the first two units, you know the basics of environment and natural resources. In this Unit we begin by introducing the Environmental pollution and its types. Later on it shows how human activities and natural problems enhance the rate of pollution. We then move to the all important concept of measurement and examine it in detail.

3.2 ENVIRONMENTAL POLLUTION

Environmental pollution can be defined as any **undesirable change** in the physical, chemical or biological characteristics of any component of the environment (air, water, soil), which **can cause harmful effects** on various forms of life or property.
Many human activities pollute our environment, adversely affecting the water we drink, the air we breathe, and the soil in which we grow food.

Pollution always has a source and a recipient. The **source** is where the pollution comes from, that is, where the pollution is released into the environment. The **recipient** is where the pollution ends up, which may be a part of the environment or people or animals that become contaminated or damaged.

Pollutant: These are defined as **matter or energy** which leads to undesirable changes in the environment. 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. From an ecological perspective pollutants can be classified as follows:

1) **Degradable or non-persistent pollutants:** These can be rapidly broken down by natural processes. Eg: domestic sewage, discarded vegetables etc.
2) **Slowly degradable or persistent pollutants**: Pollutants that remain in the environment for many years in an unchanged condition and take decades or longer to degrade. Eg: DDT and most plastics.
3) **Non-degradable pollutants:** These cannot be degraded by natural processes. Once they are released into the environment they are difficult to eradicate and continue to accumulate. Eg: toxic elements like lead or mercury.

Classification of Pollution

Different types of pollution are classified based on the part of the environment which they affect or result caused by a particular pollution. Each type of pollution has its own distinctive cause and consequences.

The major types of pollution are as follows.

- Air pollution
- Water pollution
- Noise pollution
- Soil pollution

3.3 AIR POLLUTION

Air pollution occurs due to the **presence of certain substances** (including the normal constituent in excess) in **concentration** which can cause undesirable effects on human health, property and structure. These substance include gases, particulate matter, radioactive substances etc.

3.3.1 Classification of Air Pollutants:

(A) Based upon their origin air pollutant are classified into two type:

(I)Primary Pollutants:

Pollutants that are emitted **directly from identifiable sources** are produced both by **natura**l events (for example, dust storms and volcanic eruptions) and **human activities** (emission from vehicles, industries, etc.). There are **five primary pollutants** that together contribute about 90 percent of the global air pollution. These are carbon oxides (CO and CO_2), nitrogen oxides, sulfur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter.

Major primary pollutant:

1) **Particulate matter:** Particulates are **small pieces of solid material** (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.

Some important definition:

a) **Aerosol :** General term for particles **suspended** in air. Example: Sprays from pressurized cans
b) **Mist :** Aerosol consisting of **liquid droplets**. Example: Sulfuric acid mist
c) **Dust :** Aerosol consisting of **solid particles** (1-200 micron) that are blown into the air or are produced from larger particles by grinding them down. They can be metallic(Cu. Pb, Al, steel dust) or non metallic(Cotton dust, cement dust, asbestos dust etc.).
d) **Smoke:** Aerosol consisting of **solid particles**(0.01-1 micron) **or a mixture of solid and liquid particles** produced by chemical reaction such as fires.Example: Cigarette smoke, smoke from burning garbage.
e) **Fume :** It applies specifically to aerosols produced by **condensation of hot vapors of metals**. Example: Zinc/lead fumes
f) **Plume : Geometrical shape** or form of the smoke coming out of a chimney.
g) **Fog :** Aerosol consisting of **water droplets**.
h) **Smog :** Term used to describe a **mixture of smoke and fog**.

2) **Hydrocarbon:** Hydrocarbons are a group of compounds consisting of carbon and hydrogen atoms(methane, ethane, tolune, n-butane, acetylene) . They either **evaporate from fuel supplies** or

are **remnants of fuel** that did not burn completely. They act as precursor for the production of secondary pollutant.

3) **Nitrogen oxides:** 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. They are also important component of acid rain.
4) **Sulfur oxides:** are produced when sulfur containing fossil fuels are burnt. They are major source of increase acidity in the atmospheric rain, a phenomenon known as **acid rain**.
5) **Carbon monoxide:** is a **colorless, odorless 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. Carbon monoxide is however **not a persistent pollutant**. Natural processes can convert carbon monoxide to other compounds that are not harmful.
6) **Carbon dioxide:** It is a component of atmospheric system and currently make 0.038 per cent of the atmosphere. It is important for **maintaining the biotic system** as source of carbon. However during past decade its concentration is **increasing in atmosphere** due to burning of fossils fuel and land use changes. It shows property of green house gas, thereby results into a phenomenon known as **global warming**.

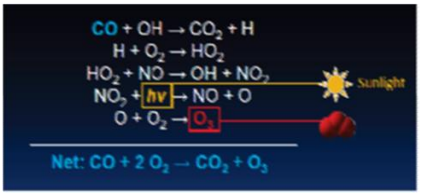
Beside these primary pollutant there are certain pollutant which are not a natural component of atmosphere, however it is introduced by human activities, such as CFC, MIC (methyl isocyanate).

(II) Secondary Pollutant:

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

Some more example of Secondary pollutant:

a) Tropospheric Ozone: The majority of tropospheric ozone formation occurs when nitrogen oxides (NO_x), carbon monoxide (CO) and volatile organic compounds (VOCs), such as xylene, react in the atmosphere in the presence of sunlight. NO_x, CO, and VOCs are called ozone precursors.



b) Peroxyacetyl nitrate (PAN): Acyl peroxy nitrates, or Peroxyacyl nitrates (also known as APNs, or PANs), are powerful respiratory and eye irritants present in photochemical smog.

Sources of Air Pollutants: It is mainly divided into two types:

a) **Natural sources:** The natural sources of air pollution are volcanic eruption, forest fire, sea salt sprays, biological decay, pollen grains of flowers, spore etc. Radioactive material present in earth crust are the sources of radioactivity in the atmosphere.
b) **Man-made (Anthropogenic sources):** it include thermal power plant, industrial units, vehicular emissions, fossil fuel burning, agricultural activities etc.

Human can be affected by both **indoor or outdoor** air pollution. The most important indoor air pollutant is **radon gas** (causing lung cancer) a radioactive atomic gas that results from the radioactive decay of radium, which may be found in rock formations beneath buildings or in

certain **building materials** (bricks, concrete, tiles etc) themselves. Beside radon **carbon monoxide, sulphur dioxide and hydrocarbon** released due to incomplete combustion of fossil fuel, wood for cooking purpose are other major air pollutant.

3.3.2 Effect of air pollution:

Air pollution has adverse effects on living organisms and materials.

1) Effects on human health:

- Air pollutants especially particulate matter(PM) is related to respiratory disease in human being. Particles come in a wide range of sizes. Those less than **10 micrometers in diameter (PM10)** are so small that they can get into the lungs, potentially causing serious health problems. Suspended particulates can cause damage to lung tissues and diseases like **asthma, chronic bronchitis and emphysema**(damage of air sacs leading to loss of lung elasticity and acute shortness of breath. Metal in form of PM like lead, Asbestos etc also cause cancer or affect vital organs like kidney, liver, spleen etc.
- Carbon monoxides combine with hemoglobin of blood to form **carboxyhaemoglobin**, due to which oxygen carrying capacity to various part of the body decrease which may results into suffocation, dizziness, unconsciousness and even death.
- **Hydrocarbon emission** from vehicle or industrial units (benzene, formaldehyde etc.) may results into mutation, reproductive problem or even cancer.

2) **Effects on Plant**: Air pollution affects plant by entering through stomata **(leaf pores through which gases diffuse),** destroy chlorophyll and affect photosynthesis. Gaseous pollutant like SO**2**, ozone etc can leads to necrosis(dead areas of leaf), chlorosis(yellowing of leaf due to reduction of chlorophyll), abscission (dropping of leaves).
3) **Effects on aquatic life:** Air pollutants (SOx and NOx) when mix up with rain can results into acid rain which **reduces the pH** of fresh water lakes especially in the higher latitude. This reduction in pH has adverse effect on aquatic biotic life.
4) **Effects on materials:** Metal parts of building, vehicle, bridges, wires and railway tracks are affected due to corrosion by particulate matter which further get accerlated in presence of SO_2 and moisture. Acid rain also affect the structure made up of marble and limestone. Example: Yellowing of Tajmahal in Agra. Ozone in the atmosphere can cause cracking of rubber tyres.

Beside these effect, air pollutants also leads to **stratospheric Ozone depletion** which results into increase UV-rays exposure on earth surface and **Global warming** due to green house gases are major environmental problem .

3.3.3 Control of Air Pollution

Air pollution can be controlled by applying various measures such as:

1) **Zonation in landuse pattern: Industries should be set up far away from the residential areas and** Industries should be located in places so as to minimize the effects of pollution after considering the topography and the wind directions.
2) **Dilution of emission:** It can be done by **increasing stack height**, beyond inversion layer. Wind current will disperse the pollutant.
3) Low Sulphur coal in industries to reduce emission of SOx from coal burning.
4) Installment of pollutant control equipment such as cyclones, bag house filters etc to reduce pollutant emission from industry.
5) Establish vehicular emission norm to reduce emission from vehicles, regular tuning of engines, installing catalytic converters, engine modification to have fuel efficient (lean) mixture to reduce CO and hydrocarbon emission, slow and cooler burning of fuels to reduce NOx emission(Honda Technology).
6) Using mass transport system, bicycles etc.

Air Pollution control through pollution control equipment:

1) Particulate matter: Many devices are available for removal of particulate matter and choice of which depend upon characteristics of particulate matter, flow rate, collection efficiency, costs etc.

a) Cyclone: These are employed for large size particle. The gas with particle in it enters tangentially at the top of cylinder and spin forming a vortex. Due to centrifugal force, particle strike the wall of cylinder.

b) Bag house filter: It contain large number of filter bags made of fabric. Dirty gas is passed through the filter bags which leaves the bags through their pores. The dust particle get deposited on the inner surface of the bag filters and may form a cake which can be removed by shaking.

c) Wet scrubber: Dirty gas is passed through water in the chamber or water is sprayed on the gas. Particles are made wet and are removed from the gas stream which leaves from the top of scrubber.

d)**Electrostatic precipitator:** It can be plate type or cylinder type. Vertical wires are placed between the parallel plates or wires is hung along the axis of the cylinder. Higher negative voltage is applied to the wire. Dust particle while passing from the lower end get negatively charged and are collected on the positively charges surface. Electrostatic precipitators utilize electric energy and can efficiently remove even submicroscopic particles.

2) Gaseous pollutant: Gaseous pollutant can be reduced by physical absorption on porous solid materials like activated charcoal, silica gel etc. Effluent gases can be absorbed in liquid absorbent, example: SO_2 absorbed in ammonia solution.

Method	Absorbent/ Adsorbent	Byproducts
Wet type	NaOH or Na_2SO_3 solution	Na_2SO_3, $NaNO_3$, SO_2, gypsum
	NH3-water	$(NH_4)_2SO_4$, SO_2, gypsum, S
	Slaked lime or limestone slurry	gypsum
	$Mg(OH)_2$-slurry	SO_2, gypsum (blended with slaked lime slurry)
	Basic $Al_2(SO_4)_3$-solution	gypsum
	Dilute-H_2SO_4	gypsum
Dry type	Activated carbon	$(NH_4)_2SO_4$, gypsum, S, H_2SO_4

Legal aspects of air pollution control in India

The Air (Prevention and Control of Pollution) Act was legislated in 1981. The Act provided for prevention, control and abatement of air pollution. In areas notified under this Act no industrial pollution causing activity could come up without the permission of the concerned State Pollution Control Board.

To regulate vehicular pollution the Central Motor Vehicles Act of 1939 was amended in 1989. Following this amendment the exhaust emission rules for vehicle owners were notified in 1990 and the mass emission standards for vehicle manufacturers were enforced in 1991 for the first time. The mass emission norms have been further revised for 2000.

plan, knowing about the deviations of the critical variables and taking corrective action. The operating

Check Your Progress-1

1) What is environmental pollution ? How can we categorized pollutants?

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2) What do you understand by air pollution?

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3) Describe the air pollution control devices ?

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3.4 WATER POLLUTION

Water pollution can be defined as **alteration in physical, chemical or biological characteristics** of water making it unsuitable for the **designated use** in its natural state.

Source of water pollution: Water pollution can be divided into two broad categories depending upon source nature:

(A) **Point sources and Non-point sources**

1) **Point sources:** When a source of pollution can be readily identified because it has a definite source and place where it enters the water it is said to come from a **point source.** Eg. Municipal and Industrial Discharge Pipes.
2) **Non-point sources:** When a source of pollution cannot be readily identified, such as agricultural runoff, atmospheric deposition , etc, they are said to be **non-point sources** of pollution.

(B) Ground water and surface water

1) **Ground water Pollution:** While surface water pollution is highly visible and often gets a lot of media attention, a much greater threat to human life comes from our groundwater being polluted which is used for drinking and irrigation. Major source of ground water pollution are:
    a) Urban run-off of **untreated or poorly treated** waste water and garbage.
    b) Industrial **waste storage** located above or near aquifers.
    c) Agricultural practices such as the application of large amounts of **fertilizers and pesticides, animal feeding operations**, etc. in the rural sector.
    d) **Leakage from** underground storage tanks containing gasoline and other hazardous substances.
    e) Leachate from **landfills.**
    f) Poorly designed and inadequately maintained **septic tanks.**

Beside these sources of ground water pollution, **high metal concentration** in ground water in some part of country is also very serious environmental issue. The high **Arsenic concentration in ground water in West Bengal** is known today as the worst case of groundwater pollution.

The **arsenic poisoning was first noticed by K C Saha**, former professor of dermatology at the School of Tropical Medicine, Kolkata when he began to receive patients with skin lesions that resembled the symptoms of leprosy which was in reality not leprosy. Since all the patients were from the district of 24-Parganas, Saha along with others began to look for the cause and found it to be arsenic toxicity.

There are two theories that have been put forth to explain this unusually high content of arsenic in groundwater.

a) According to the first hypothesis, arsenic probably originates in the **Himalayan headwaters of the Ganga and the Brahmaputra** rivers and has been lying undisturbed beneath the surface of the region's deltas for thousands of years in the thick layers of fine alluvial mud across the banks of these rivers.

The mud in these areas is **thicker, wider and flatter** than almost anywhere else on earth. It can thus take hundreds or thousands of years for underground water to percolate through the mud before reaching the sea and thus it absorbs arsenic for a long period.

b) Other researchers feel that the excess amount of arsenic in groundwater can be contributed to by the **high rate of groundwater extraction.** Their hypothesis called the **pyrite oxidation thesis** describes how arsenic can get mobilized in the groundwater. In this hypothesis arsenic is assumed to be present in certain minerals (pyrites) that are deposited within the aquifer sediments. Due to the lowering of the water table below the deposits, arseno- pyrite which is oxidized in a zone of the aquifer called the Vadose zone releases arsenic as arsenic adsorbed on iron hydroxide. During the subsequent recharge period, iron hydroxide releases arsenic into groundwater.

Arsenicosis or arsenic toxicity develops after **two to five years** of exposure to arsenic contaminated drinking water depending on the amount of water consumption and the arsenic concentration in water. Initially the skin begins to darken (**called diffuse melanosis**) which later leads to spotted melanosis when darkened sports begin to appear on the chest, back and limbs. At a later stage **leucomelanosis** sets in and the body begins to show black and white spots.

Surface water pollution: The major source of surface water pollution is:

1) **Sewage:** Domestic waste mostly dumped into the nearby surface water bodies through drain and sewers are major source of pollution especially near the big cities.
2) **Industrial effluents:** waste emerging out of industrial units are major source of toxic chemicals, acids, alkalis, metallic salts, organic material to the surface water bodies.
3) **Synthetic detergents:** They are used in washing and cleaning processes in domestic and industrial unit and are major source of phosphate to surface water bodies.
4) **Agrochemicals:** Chemicals like fertilizers, pesticides and insecticides applied in the agricultural land or urban garden areas washed away with rainwater and surface runoff from these area are major pollution source.
5) **Oil:** Oil spillage into sea-water during drilling and shipment transport are major source of water pollution.

6) Waste heat: Thermal pollution occurs when industry returns the heated water to a water source. The warm water not only decreases the solubility of oxygen but changes the breeding cycles of various aquatic organisms.

3.4.1 The state of India's rivers

Urbanization, industrialization, excess withdrawal of water, agricultural run-off, improper agricultural practices and various religious and social practices all contribute to river pollution in India.

Waters from the **Ganga and the Yamuna** are drawn for irrigation through the network of canals as soon as these rivers reach the plains **reducing the amount of water that flows downstream.** What flows in the river is water from small nalas, and streams that carry with them sewage and industrial effluents.

Sewage and municipal effluents account for 75% of the pollution load in rivers while the remaining **25% is from industrial effluents** and non-point pollution sources.

In 1985, India launched the **Ganga Action plan (GAP)** the largest ever river clean-up operation in the country. The GAP Phase II in 1991 included cleaning operations for the **tributaries of the Ganga**, ie; the Yamuna, Gomti and the Damodar. Thus the Yamuna Action Plan (YAP), Gomti Action Plan and the Damodar Action plan were added.

In 1995 the **National River Conservation plan(NRCP)** was launched. Under this all the rivers in India were taken up for clean-up operations. In most of these plans, attempts have been made to tap drains, divert sewage to sewage treatment plants before letting out the sewage into the rivers.

NRCP is scheduled to be completed by March 2005. The approved cost for the plan is **Rs. 772.08 crores** covering 18 rivers in 10 states including 46 towns.

The cost is borne entirely by the Central Government and the Ministry of Environment and Forests is the nodal agency that co-ordinates and monitors the plan.

Under this plan the major activities include treating the pollution load from **sewer systems of towns and cities, setting up of Sewage treatment plants, electric crematoria, low cost sanitation facilities, riverfront development, afforestation and solid waste management.**

3.4.2 Classification of Water pollutants

Water pollutants are classified into different class depending upon their nature:

1) **Oxygen demanding waste:** 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.

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. If too much organic matter is added to the water all the available oxygen is used up. This causes fish and other forms of oxygen dependent aquatic life to die.

2) **Disease-causing agents:** It include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes. Human wastes contain concentrated populations of coliform bacteria such as Escherichia coli and Streptococcus faecalis. These bacteria are not harmful in low numbers. Large amounts of human waste in water, increases the number of these bacteria which cause gastrointestinal diseases.
3) **Inorganic plant nutrients:** These are water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication. While excess fertilizers cause **eutrophication**, pesticides cause **bioaccumulation and biomagnification**. At each link in the food chain these chemicals which do not pass out of the body are accumulated and increasingly concentrated resulting in biomagnification of these harmful substances.
4) **Water soluble inorganic chemicals:** It includes 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.
5) The disease called **Minamata disease** occurred due to consumption of methyl mercury contaminated fish caught from Minamata bay in Japan. The disease claimed 50 lives and permanently paralysed over 700 persons.
6) Pollution from heavy metal cadmium had caused the disease **Itai-Itai** in the people of Japan. This disease was caused by cadmium contaminated rice. In this disease bones, liver, kidney, lungs, pancreas and thyroid are affected.
7) **organic chemicals:** It include oil, gasoline, plastics, pesticides, cleaning solvents, detergent and many other chemicals. These are harmful to aquatic life and human health.
8) **Sediment of suspended matter:** These are insoluble particles of soil and other solids that become suspended in water. This occurs when soil is eroded from the land. High levels of soil particles suspended in water, interferes with the penetration of sunlight. This reduces the photosynthetic activity of aquatic plants and algae disrupting the ecological balance of the aquatic bodies.
9) **Water soluble radioactive isotopes:** These can be concentrated in various tissues and organs as they pass through food chains and food webs. Ionizing radiation emitted by such isotopes can cause birth defects, cancer and genetic damage.
10) **Hot water: Water is used for cooling purpose in Thermal power plant and other industries.** Thermal pollution occurs when industry returns the heated water to a water source. This heated water, which is at least 15^{o}C higher than the normal is discharged back into the water body. The warm water not only decreases the solubility of oxygen but changes the breeding cycles of various aquatic organisms.

3.4.3 **Control of water pollution:**

Non-point sources are difficult to control in respect to point sources, discharge from point sources can be controlled by using different treatment process.

Non-point pollution can be reduced by **reducing use** of chemical fertilizer, pesticides and insecticides applied to agricultural field. By reducing the amount of **surface runoff by lining the street** with percolating materials and prevent the mixing of storm water with the sewer water to avoid overflowing of sewer line.

Municipal waste water treatment Plant: The municipal waste water treatment plant are deigned to **reduced the BOD and suspended solid** load from the domestic sewage. Some of the treatment plant also use advanced treatment (tertiary) for removal of nutrients such as nitrogen and phosphate.

1. 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. This includes, stones, sticks, rags, and all such material that can clog pipes.

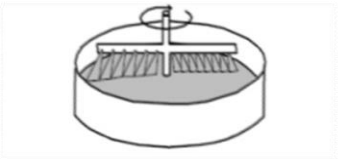
A **screen** consists of parallel bars spaced 2 to 7cms apart followed by a wire mesh with smaller openings. After screening the wastewater passes into a **grit chamber**. The detention time is chosen to be long enough to allow **lighter, organic material** to settle. From the grit chamber the sewage 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. Primary treatment normally removes about **35 percent of the BOD and 60 percent of the suspended solids.**

2. Secondary treatment:

There are three commonly used approaches: **trickling filters, activated sludge process and oxidation ponds**. Secondary treatment can remove at least **85 percent of the BOD**.

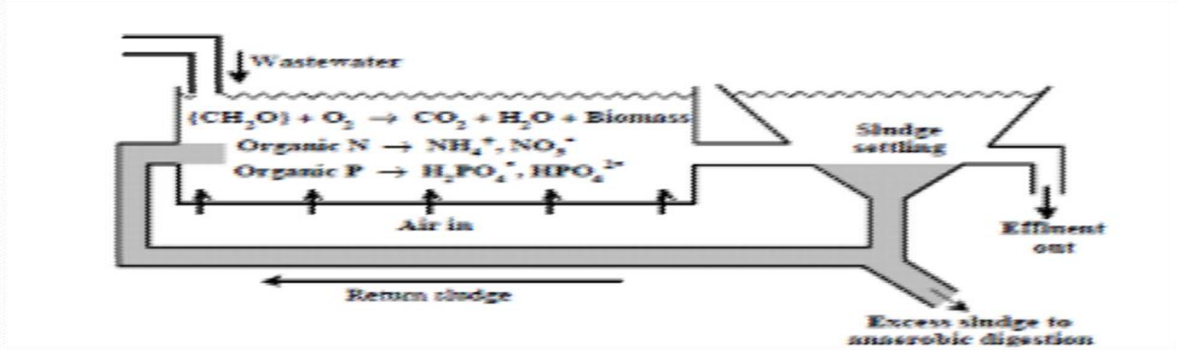
(a) Trickling filter:

It 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.



(b) 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. This sludge is then broken down in an anaerobic digester where methane-forming bacteria slowly convert the organic matter into carbon dioxide, methane and other stable end products.



(c) Oxidation ponds

These are large shallow ponds approximately 1 to 2 meters deep where raw or partially treated sewage is decomposed by microorganisms. They are easy to build and manage and accommodate large fluctuations in flow and can provide treatment at a much lower cost. They however require a large amount of land and hence can be used where land is not a limitation.

(d) Advanced sewage treatment:

This involves a **series of chemical and physical process** that removes specific pollutants left in the water after primary and secondary treatment. Sewage treatment plant effluents contain nitrates and phosphates in large amounts. These contribute to eutrophication. Thus **advanced treatment plants are designed to specifically remove these contaminants.** Chlorination of water is generally done to kill harmful bacteria and some viruses. Advanced treatment plants are very expensive to build and operate and hence are rarely used.

3.5 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. "Soil pollution" refers to the presence in the soil of a chemical or substance out of place and/or present at a higher than normal concentration that has adverse effects on any non-targeted organism. Soil pollution often cannot be directly assessed or visually perceived, making it a hidden danger.

3.5.1 Sources of soil pollution:

- Dumping of **domestic and industrial waste** on soil surface results into soil pollution. Domestic waste include garbage, rubbish material like glass, plastic, metallic can, paper, fibers etc.
- Industrial wastes are effluent discharged from industries and type of contaminant are dependent upon the **type of Industry present**. For example: paper and pulp industry mostly generate organic waste, Thermal power plant generate fly ash, or precipitate forms during treatment of pollutantgas produced due to combustion processes.
- Application of **fertilizers and Insecticides** into agricultural land are other important category of soil pollution. Persistent pesticides once applied are effective for a long time. However as they do not break down easily they tend to **accumulate in the soil and in the bodies** of animals in the food chain.

- Soil also receive **excreta from animals and humans.** The sewage sludge contain many pathogenic organism, bacteria, viruses and intestinal worm which cause pollution in the soil.
- The source of **radioactive substances in soil** are explosion of radioactive devices, radioactive waste discharged from industries and laboratories, aerial fall out etc. The main isotopes are radium, uranium, thorium, strontium etc.

3.5.2 Effects of soil pollution:

- Sewage and industrial effluents which pollute the soil ultimately affect human health. One example is **Itai-Itai disease** which occurs due to consumption of Cd containing rice. The chemical discharge on soil such as acid and alkali also affects the soil fertility.
- Some of the persistent toxic chemicals **target the non-target organisms**, soil flora and fauna and reduced soil fertility. These chemical accumulates in food chain and ultimately affect human health.
- Radioactive fallout on soil are source of radio-isotopes which enter the food chain. Some of these **replace essential elements in the body** and cause abnormalities. Example: strontium-90 instead of calcium gets deposited in the bones and tissue.
- Nitrogen and phosphorous from fertilizers in soil reach nearby water bodies with agricultural run-off and cause eutrophication.

3.5.3 Control of Soil Pollution:

1) Effluent should be **properly treated** before discharging them on the soil.
2) Solid waste should be **properly collected and disposed** off by appropriate method.
3) Biodegradable organic waste(cattle waste, human faeces) should be **used for generation of biogas.**
4) **Microbial degradation** of biodegradable substances is also employed for reducing soil pollution.

3.6 NOISE POLLUTION

Sound is a form of energy which is emitted by a vibrating body and on reaching the ear causes the sensation of hearing through nerves. Sounds produced by all vibrating bodies are not audible. The frequency limits of audibility are from 20 HZ to 20,000 HZ.

A type of sound may be pleasant to someone and at the same time unpleasant to others. The unpleasant and unwanted sound is called noise.

The discrimination and differentiation between sound and noise also depends upon the habit and interest of the person/species receiving it, the ambient conditions and impact of the sound generated during that particular duration of time. There could be instances that, excellently rendered musical concert for example, may be felt as noise and exceptional music as well during the course of the concert!

The intensity of sound is measured in sound pressure levels (SPL) and common unit of measurement is decibel, dB. The SPL is logarithmic ratio of the sound pressure to a reference pressure. If the sound levels are measured in terms of pressure, then, sound pressure level, L_P is given by,

$$L_P = 20 \text{ Log}_{10} (P/P_o) \text{ dB(A)}$$

The Lp is measured against a standard reference pressure, Po = 2×10^{-5} N/m^2 which is equivalent to **zero decibels.** The sound pressure is the pressure exerted at a point due to a sound producing source.

Addition of sound levels: The effective sound levels form two or more sources cannot be simply added algebraically.

3.6.1 Sources of noise

The sources of noise may be **domestic** (movement of utensils, cutting and peeling of fruits/vegetables etc.), **natural** (shores, birds/animal shouts, wind movement, sea tide movement, water falls etc.), **commercial** (vendor shouts, automobiles, aeroplanes, marriages, laboratory, machinery etc.) **industrial** (generator sets, boilers, plant operations, trolley movement, transport vehicles, pumps, motors etc.).

3.6.2 Effects of noise pollution on physical health

The most direct harmful effect of excessive noise is **physical damage to the ear** and the temporary or permanent hearing loss often called a temporary threshold shift (TTS). Permanent loss, usually called noise induced permanent threshold shift (NIPTS) represents a loss of hearing ability from which there is no recovery. Some of the adverse effects are summarized below:

(a) Annoyance: It creates annoyance to the receptors **due to sound level fluctuations.** The aperiodic sound due to its irregular occurrences causes displeasure to hearing and causes annoyance.

(b) Physiological effects: The physiological features like breathing amplitude, blood pressure, heart-beat rate, pulse rate, blood cholesterol are effected.

(c) Loss of hearing: Long exposure to high sound levels cause loss of hearing. This is mostly unnoticed, but has an adverse impact on hearing function.

(d) Human performance: The working performance of workers/human will be affected as they'll be losing their concentration.

(e) Nervous system: It causes pain, ringing in the ears, feeling of tiredness, thereby effecting the functioning of human system.

(f) Sleeplessness: It affects the sleeping there by inducing the people to become restless and loose concentration and presence of mind during their activities.

(g) Damage to material : The buildings and materials may get damaged by exposure to infrasonic / ultrasonic waves and even get collapsed.

The variations in the emission of noise levels in a particular environment can be assessed from the **statistical distribution of noise levels** in that environment. To draw a statistical distribution curve, terms like **L_{10}, L_{50} and L_{90}** play an important role. The Sound levels exceeding 10%, 50% and 90% of the total time intervals during a particular period are designated as L_{10}, L_{50} and L_{90} respectively.

The equivalent noise levels, **Leq** can also be calculated as

$$\mathbf{L_{eq} = L_{50} + (L_{10} - L_{90})^2 / 60}$$

3.7 THERMAL POLLUTION

It is defined as presence of **waste heat** in the water which can cause undesirable changes in the natural environment.

3.7.1 Causes of thermal pollution:
Heat producing industries i.e., thermal power plant, nuclear power plants, refineries, steel mills, etc are the major sources of thermal pollution. Power plants heat water to convert it into steam, to drive the turbines that generate electricity. For efficient functioning of the steam turbines, 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, which is at **least 15ºC higher than the normal** is discharged back into the water body.

3.7.2 Effect of Thermal Pollution:

1) The dissolved oxygen concentration (DO) of water is decreased as the solubility of oxygen in water is decreased at high temperature.
2) **Toxicity** of pesticides, detergents and chemicals in the effluent increases with increase in temperature.
3) The **composition of flora and fauna changes** because the species sensitive to increased temperature due to thermal shock will be replaced by temperature tolerant species.
4) Metabolic activities of **aquatic organisms increase** at high temperature and require more oxygen, whereas oxygen level falls under thermal pollution.
5) Discharge of heated water **near the shores can disturb spawning** and can even kill young fishes.
6) **Fish migration is affected** due to formation of various thermal zones.

3.7.2 Control of Thermal Pollution: Thermal pollution are control by using following majors:

1) **Cooling ponds:** Water from condenser is stored in ponds where natural evaporation cools the water which can then be recirculated or discharged in nearby water body.
2) **Spray Ponds**: The water from condenser is received in spray ponds. Here the water is **sprayed through nozzles** where fine droplets are formed. Heat from these fine droplet is dissipated to the atmosphere.
3) **Cooling towers:** It can be of two types:
    a. **Wet cooling tower:** Hot water is sprayed over baffles. Cool air entering from sides take away the heat and cools the water. This cool water can be recycled or discharged.
    b. **Dry cooling tower:** The heated water flow through pipes. Air is passed over these hot pipes with fans. It is costlier than wet cooling tower.

3.8 SOLID WASTE MANAGEMENT

Waste is defined as any unwanted or unusable substance that is discarded after primary use. Wastes are normally generated as a result of human and animal activities. Urbanization and rapid advancements in industrialization has led to an increase in the production and consumption processes resulting in the generation of wastes from various sectors that include agricultural, commercial, domestic, industrial, institutional, social and from community activities. Over time, these waste accumulate and can have real impacts on the health and the environment. Waste management is intended to reduce adverse effects of waste on health, the environment or aesthetics. So to carry out efficient management of wastes, knowledge about the source of wastes, its types and classification must be known. Hence, this module gives us an overview about wastes and its classification.

3.8.1 Classification of solid wastes
It is mandatory to classify solid wastes into groups that pose similar risks to the environment and human health for safe disposal. According to the modern systems of waste management, solid wastes are classified based on their source, type, properties and its effect on human health and environment.

(A) Source based classification
Wastes are produced from different sources and are categorized as follows

1. Municipal solid waste (MSW)

Municipal solid waste commonly referred to as trash, garbage or refuse comprises of street wastes, dead animals, market wastes, abandoned vehicles, household garbage, rubbish, construction and demolition debris, sanitation residue, packaging materials, trade refuges etc. They are collected from residential houses, markets, streets and other places mostly from urban areas and disposed of by municipal bodies. The proportion of different constituents of municipal wastes varies from place to place and season to season depending on the food habits, life style, standard of living and extent of commercial and industrial activities in the area. Municipal wastes their contents and source are illustrated in table given below. Municipal solid wastes are further categorized based on their physical, chemical and biological properties

2. Industrial wastes
Wastes generated during industrial activities such as manufacturing and processing involved in chemical plants, paint industry, cement factories, metallurgical plants, thermal power plants, petroleum, coal, gas, sanitary, textile, food processing and paper industry are referred to as industrial wastes. Some examples of industrial wastes are chemical solvents, paints, sandpaper, paper products, industrial by-products, metals, and radioactive wastes. Industrial solid wastes are further classified as hazardous and non-hazardous wastes.

3. Institutional/ Commercial wastes
Solid wastes originating from administrative, educational and public buildings such as offices, schools, colleges, hospitals, government centres, prisons and other commercial establishments like wholesale and retail stores, restaurants, hotels, markets, warehouses. Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes are the examples of industrial and commercial wastes

4. Agricultural wastes
Agriculture wastes include both natural (organic) and non-natural wastes generated through farming activities. These activities include but are not limited to dairy farming, horticulture, seed growing, livestock breeding, grazing land, market gardens, nursery plots, and even woodlands. Some of agricultural wastes include spoiled food grains, vegetables, animal and plant wastes, litter, pesticides, fertilizers etc. Other agricultural wastes are produced from agricultural products processing industries like sugarcane factories, tobacco processing units, slaughter houses, livestock, poultry etc. Agricultural wastes are mostly biodegradable but few wastes like pesticide and fertilizers are toxic. When discharged to the environment, agricultural wastes can be both beneficial and detrimental to living matter.

5. Biomedical wastes
Wastes produced from hospitals, medical centres and nursing homes are called biomedical wastes. Hospital wastes are generated during diagnosis, treatment or immunisation of human beings/animals or in research activities in these fields or in the production/testing of biologicals. These wastes are highly infectious and may pose severe threat if not managed properly. Biomedical wastes may be solid or liquid wastes that includes discarded blood, sharps, soiled wastes, disposables, anatomical wastes, cultures, discarded medicines, chemical wastes etc.

(B) Type based classification

1. Garbage
Garbage wastes mean and include animal and vegetable wastes generated from kitchen, cooking, serving of foods, slaughter houses, market refuse. These wastes contain putrescible organic matter which produces strong odour. They attract rats, vermins, flies and other insects and so they requires immediate attention in handling and disposal.

2. Rubbish
Solid wastes arising as a result of households, commercial and institutional activities excluding garbage and ashes is termed as rubbish. They are categorized into combustible and non-combustible wastes. Combustible wastes consists of all rubbish and refuse that can be incinerated to flames at 1400-1500◦F which includes leaves, plants, clothes, paper, leather, rubber, grasses. Non-combustible wastes are characterized as wastes that cannot be incinerated to flames at 1400-1500◦F and that includes glass, metals, plastic materials, stones, auto parts etc.

3. Bulk waste
Commercial bulky wastes include packaging and containers such as cardboard, wood boxes, fiber, plastic and steel drums, loose and bundled paper, bundles of textiles and plastics, wires, furniture and equipment etc. Industrial bulky waste includes crates, cartons; steel, fiber and plastic drums; bales and rolls of paper, plastics, and textiles; miscellaneous metal items etc.

4. Ashes
Ashes are defined as fine powdery residues, cinders and clinkers arising from the burning of wood, coal, charcoal, coke and other combustible materials during cooking and heating in houses, institutions and outer industrial establishments.

5. Street wastes

Wastes comprising of leaves, dirt, dust litter, paper, plastics and other vegetable matter collected from streets, walkways, alleys, parks, beaches and vacant lots are termed as street wastes.

6. Construction and demolition wastes

Construction and demolition wastes are the waste materials generated in large amounts during the construction, refurbishment, repair and demolition of houses, commercial buildings, roads and other structures. They consist of earth, stones, concrete, bricks, lumber, steel, roofing materials, plumbing materials, heating systems and electrical wires.

(C)Property based classification

1. Biodegradable / Organic wastes

Biodegradable wastes are those that can be decomposed by the natural processes such as composting, aerobic/ anaerobic digestion and converted into the elemental form like carbon dioxide, methane, water or simple organic molecules. Some of the biodegradable wastes include municipal solid wastes (greenwaste, food waste, paper waste, biodegradable plastics, human and animal wastes, sewage, sludge, slaughter house wastes etc).

2. Non-biodegradable /inorganic wastes

Non-biodegradable wastes are those that cannot be decomposed and remain as such in the environment indefinitely. They are persistent and threaten to overwhelm landfills and create disposal problems creating environmental concern. As non-biodegradable wastes cannot be decomposed, recycling is the ideal option for managing it. Example of non-biodegradable wastes includes plastics, nuclear wastes, glass, rubber tyres, styrofoam, fiberglass and metals.

3. Hazardous wastes

Hazardous waste is defined as chemical material that can no longer be used for its intended purpose and is known to be harmful or potentially harmful to plants, animals and human health or to the environment. Hazardous wastes may be in the form of solids, liquids, sludge's or gases. In some cases, although the active agents may be liquid or gaseous, they are classified as solid waste because they are confined in solid containers. They are generated primarily by chemical production, manufacturing and other industrial activities. The hazardous waste materials may be toxic, reactive, ignitable, explosive, corrosive, infectious or radioactive. If improperly handled, they can cause substantial harm to human health and to the environment. Henceforth, a good management practice should ensure that hazardous wastes are collected, stored, transported and disposed off separately, to render them innocuous. Some of the important hazardous wastes are lead, mercury, cadmium, chromium, many drugs, leather, pesticides, dye, rubber, solvents, paints and effluents from different industries.

4. Non-hazardous wastes

Non-hazardous wastes are defined as substances safe to use commercially, industrially, agriculturally or economically. Some of the non-hazardous wastes produced are from the food processing plants, cotton mills, paper mills, textile mills and sugarcane industries. Other non-hazardous wastes includes paint, oil, antifreeze, buffers, salts etc.

3.8.2 Management of solid waste: An integrated waste management strategy includes three main components. For waste management stress is on **three R'S'- Reduce, reuse and recycle** before destruction and safe disposal of solid waste.

1) **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. On an individual level we can reduce the use of unnecessary items while shopping, buy items with minimal packaging, avoid buying disposable items and also avoid asking for plastic carry bags.

2) **Recycling of materials:** is reusing some components of the waste that may have some economic value. **Metal, paper, glass and plastics** are recyclable. Mining of new aluminum is expensive and hence recycled aluminum has a strong market and plays a significant role in the aluminum industry. Paper recycling can also help preserve forests as it takes about **17 trees to make one ton of paper.** Crushed glass (cullet) reduces the energy required to manufacture **new glass by 50 percent.** The problems associated with recycling are either **technical or economical.**

3) Solid Waste Disposal Methods

The following methods are used generally for disposal of solid waste

a) Open burning of Wastes

Incineration of waste at lower temperature in an uncontrolled manner is said to open burning. Although it is a traditional method of waste management, practiced by major population of the country, is not proper method of waste management. It reduces the quantity of waste. Around 40% of the worldwide solid waste is eliminated by open burning. In developing countries, it is widely practiced because it is an easy, cheap and effective way to get rid of solid waste. Generally open burring is carried out near the dumping site as it reduces the cost of transportation. Burning of solid waste leads to air pollution which in turn helps in heating up of earth drastically. It has been scientifically proved that open burning releases harmful gases and causes soil and water pollution.

b) **Sanitary landfill:** is a depression in an **impermeable soil layer** that is lined with an impermeable membrane. The three key characteristics of a municipal sanitary landfill that distinguish it from an open dump are:

- Solid waste is placed in a **suitably selected and prepared landfill** site in a carefully prescribed manner.
- The waste material is **spread out and compacted** with appropriate heavy machinery.
- The waste is covered each day with a **layer of compacted soil.**

c) Incineration: It is the process of burning municipal solid waste in a properly designed furnace under suitable temperature and operating conditions. For complete oxidation the waste must be mixed with appropriate volumes of air at a temperature of about 815^{o} C for about one hour. Incineration can reduce the municipal solid waste by about 90 percent in volume and75percent in weight.

The risks of incineration however involve air quality problems and toxicity and disposal of the fly and bottom ash produced during the incineration process.

d)Vermicomposting: Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. It is a mesophilic process, utilizing microorganisms and earthworms that are active at 10– 32°C. The process is faster than composting; because the material passes through the earthworm gut, a significant transformation takes place, whereby the resulting earthworm castings (worm manure) are rich in microbial activity and plant growth regulators, and fortified with pest repellence attributes as well!

Check Your Progress-2

1) What do you understand by wastewater treatment?

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2) Mention the control process of thermal pollution.

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3) Describe the processes adopted for solid waste management.

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3.9 NUCLEAR HAZARDS

Radioactive substances undergo **natural radioactive decay** in which unstable isotopes spontaneously give out fast moving particles, high energy radiation or both, at fixed rate until a new stable isotope is formed. The isotopes release energy either in the form of gamma rays (high energy electromagnetic radiation), or ionization particles i.e. alpha particles and beta particles.

3.9.1 Sources of Radioactivity: It can be both natural or man made sources:

1) **Natural sources:** It includes cosmic rays from outer space, radioactive radon-222, soil, rocks, air, water and food, which contain one or more radioactive substances.
2) **Anthropogenic sources:** It includes nuclear power plants, nuclear accidents, nuclear weapon testing, X-rays, diagnostic kits, research laboratories etc.

3.9.2 Effect of Radiations: Ionization radiations can affect living organisms by causing harmful changes in body cells and also damage at genetic level.

1) **Genetic damage:** It includes mutation in the DNA, thereby affecting genes and chromosome. The damage can be transmitted up to several generations.
2) **Somatic damage:** it includes burns, miscarriage, eye cataract and cancer of bone, thyroid, lungs and skin. Example: Radioactive iodine (I^{131}) accumulates in thyroid gland and causes cancer. Strontium-90 accumulates in the bones and causes leukemia or cancer of bone marrow.

The damage cause by different type of radiation depends on the **penetration power**. The Alpha particles cannot penetrate the skin to reach internal organs whereas beta particles can damage the internal organs.
Greater threat is posed by radioisotopes with **intermediate half-lives** as they have long time to find entry inside the human body.
The radioactive material present in the earth crust or fall down as dry deposition from atmosphere enters the **crop grown there** and ultimately in Human beings. Radionuclide enters the water bodies such as ground water by coming in contact with the radionuclide bearing rocks.

3.9.3 Control of Nuclear Pollution:

1) Setting of nuclear power plants should be carefully done after studying long term and short term effects.
2) Proper disposal of wastes from research laboratory and hospital involving in the use of radioisotopes should be done.
3) Complete ban on Nuclear weapon testing should be imposed.

3.10 KEY WORDS

- **Environmental pollution**
- **Solid waste management practices**
- **Nuclear hazards**
- **Water treatment process**
- **Control equipments**

3.11 QUESTIONS FOR REVIEW

Q.1. Differentiate between
(a) Biodegradable and non biodegradable pollutants
(b) wet deposition and dry deposition
(c) smoke and fume

Q.2. Enlist various sources of air pollution and their effects.
Q.3. How fertilizers and pesticides both beneficial and harmful for land?
Q.4.Write a detailed note on solid waste management.
Q.5. Describe audible and non audible effects of noise pollution.
Q.7. Define thermal pollution and its control measures.
Q.8. What is the difference between point and non-point sources of water pollution and how it can be controlled?

UNIT 4 ENVIRONMENTAL AND SOCIAL ISSUES, MANAGEMENT AND LEGISLATIONS

Structure

4.0 0BJECTIVES

After reading this Unit you will be able to:

- Get knowledge about environmental issues
- understand the concept of Sustainable development,

4.1 INTRODUCTION

In order to live comfortably, conservation of resources or adequate use of resources is highly required as we know that all the environmental issues arise due to the human activities to fulfill their need or greed. This is the high time to adopt sustainable development as our environment and the resources are depleting at faster rate.

4.2 ENVIRONMENTAL ISSUES

4.2.1 Climate change:
Climate is average state of everyday's weather conditions of an area over long periods of time. It is measured by sorting the pattern of changes in temperature, humidity, atmospheric pressure, wind, precipitation and other meteorological factors of the particular area. When these weather conditions changes for few decades or for millions of years resulting in new climate pattern is known as climate change. The climate system consists of five components, the atmosphere, hydrosphere, cryosphere, biosphere and lithosphere, which receives about all of its energy from the Sun. Various Anthropogenic activities affects the climatic conditions which results in change of Earth's Climate.

4.2.2 Global Warming:
When the energy comes from the sun, earth receives the short wavelength solar radiation, some part of it absorbed and remaining reflects back in the form of large Wavelength solar radiation. Some atmospheric gases known as Greenhouse Gases trapped the long wave radiation and re-radiated as heat, back to the earth resulting in warming of Earth. This effect of Earth's warming is known as Greenhouse Effect. The most abundant greenhouse gases in earth's atmosphere are:

Natural Greenhouse Gases
1. Carbon Dioxide (CO_2)
2. Water Vapor (H_2O)

A. Anthropogenic Emissions Greenhouse Gases
1. Methane (CH_4)
2. Nitrous Oxide (N_2O)

3. Tropospheric Ozone (O_3)
4. Chlorofluorocarbons (CFCs)

The excessive increase in the amount of greenhouse gases over a long time period led to the huge rise in the temperature of Earth's climate, known as Global Warming.

Human activities are changing the natural greenhouse of earth. Over the last century the concentration of atmospheric carbon dioxide (CO_2) has increased by the burning of fossil fuels like coal and oil as coal or oil burning process combines carbon with oxygen in the air to make CO_2. The clearing of land for agriculture, industry, and other human activities has also increased concentrations of greenhouse gases.

Effects of Global warming:
1. Melting of Glaciers
2. Climate Change
3. Drought
4. Increase in Hurricanes Frequency
5. Rise in Sea levels
6. Decrease in Coral reefs
7. Loss of Agriculture
8. Heat waves
9. Frequent Wildfires
10. Severe Precipitation
11. Changes in food chains
12. Animal Extinction
13. Worsening of Air quality
14. Increase in severe diseases
15. Decreased population

4.2.3 Acid Rain:

Rain or any form of precipitation having pH less than 5.6 is known as Acid rain. The acidity of acid rain is because of three substances CO_2, NO_x, and SO_2 found in the troposphere which are emitted from the combustion of Coal in power plants and gasoline in vehicles.

Atmospheric reaction of Acid rain:

Most of the acidity of rain is accounted by Sulphuric acid (H_2SO_4).

$SO_2\,(g) + O_2\,(g) \rightarrow SO_3\,(g)$

$SO_3\,(g) + H_2O \rightarrow H_2SO_4$

$H_2SO_4 \rightarrow HSO_4^- + H^+$

$HSO_4^- \rightarrow SO_4^{2-} + H^+$

About one fourth of the acidity of rain is accounted by Nitric acid (HNO_3)

$CO_2 + H_2O \rightarrow H_2CO_3$

$H_2CO_3 \rightarrow H^+ + HCO_3^-$

$NO\,(g) + ½\,O_2\,(g) \rightarrow NO_2\,(g)$
$N_2\,(g) + O_2\,(g) \rightarrow 2NO\,(g)$

$3NO_2\,(g) + H_2O \rightarrow 2HNO_3\,(aq.) + NO\,(g)$

Effects of Acid Rain:

- Acidification of many lakes, streams or ponds.
- Degradation of many soil minerals produces metal ions which are washed away in runoff causing several effects-

a. Al^{3+} increases in water supply
b. Deficiency of Ca^{2+} results in the killing of trees and damaging of crops.

- Damages the buildings and monuments made up of marble and limestone.
- Serious threat to human health.

4.2.4 Ozone Layer Depletion:

In the stratosphere of earth's atmosphere there is a ozone layer which protects us from the harmful ultraviolet radiations coming from the Sun. In last few decades, the ozone layer is continuously getting thinner because of depletion, when it becomes extremely thin over a particular area, it is known as Ozone hole. Ozone hole was firstly discovered in 1985 over Antarctica.
Some Compounds which are responsible for the depletion of ozone are known as ozone depleting substances like Chlorofluorocarbons, Methane, Nitrous Oxide, Methyl chloroform, Carbon tetrachloride and halon.
Ozone layer depletion results in increase in amount of UV radiations reaching to the earth's Surface which causes cataract and skin Cancer in human beings, damaged to developmental stages of aquatic fauna, decrease in reproductive capacity of organisms, inhibition of photosynthesis, mutation etc.

4.3 SUSTAINABLE DEVELOPMENT

In 1987, the United Nations Word Commission on Environment and Development released the report "our Common future" commonly known as Brundtland report. The concept of sustainable development is derived from this report only. The Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs is known as Sustainable development. For environmental management public awareness plays important role, individuals who do not have proper knowledge of environment causes the extreme damage to environment for fulfilling their basic needs like-

1. Cutting of trees - for timber and fuel wood
2. Clearing land – for agriculture
3. Throwing waste in water bottles
4. Using unscientific agricultural practices
5. Unplanned industrial processes
6. Overgrazing

The two key concepts of sustainable development are-
a. The concept of need, in particular the essential needs of world's poor to which overriding priority should be given.
b. The idea of limitations, imposed by state of technology and social organization on the environment's ability to meet the present and future needs.

4.4 RESETTLEMENT AND REHABILITATION

Natural and human made both disasters force people to move out of their land. Thus Strategies for rehabilitation of these displaced people by preventive action are in the first place. For example, construction of earthquake proof houses, arrangement timely evacuation by collecting advance information about cyclones, build appropriate bunds in flood prone areas, maintain bridges that take regular up and down passing of trains/ road transport vehicles on them in order to avoid likely disasters.

Secondly, advance preparation on the part of administration and local communities are made to face the consequences of sudden calamities. For both these remedial steps, the primary necessity is that of building awareness among the people in general and among administrative personnel in particular.

The scope for advance planning in the cases of natural and human made calamities is however quite limited and in comparison we can certainly plan better in the cases of development projects which are planned in advance.

4.5 ENVIRONMENTAL ETHICS

It is a branch of philosophy which deals with the ethical relationship between environment and human beings. According to environmental ethics humans and other living creatures are a part of a society, so it is necessary to every human being to respect and honor them and use morality when dealing with these creatures. Some common issues and their solutions regarding environmental ethics are-

1. **Disparity in resource utilization patterns** – Educated urban individuals consumes much larger quantity of resources and energy than the traditional rural individuals. The urban rural and other communities should share resources equally for sustainable development.

2. **Impact of industrialization** – It is everyone's responsibility to make up for the losses caused by industrialization.

3. **Equity - Disparity in Northern and Southern Countries** – The North nations are richer and more developed and uses more amounts of resources in comparison to south nations.

4. **Equity – Disparity among genders** – although our society is male dominated but most of the environmental movements are headed by women.

Consumerism and Waste products:

Consumerism is constant purchasing of new goods, without their true need, durability, product origin, or the environmental consequences of their manufacture and disposal. Consumerism interferes with the sustainable use of resources like in developed countries landfills are being filled with cheap discarded products that fail to work within short time and cannot be repaired.

Check Your Progress-1

1. Write a note on Acid rain, Global Warming and Climate Change

2. What are the reasons behind depletion of Ozone layer in the atmosphere? Explain its effects.

3. Describe environmental ethics.

4.6 DISASTER MANAGEMENT

The Indian subcontinent is very vulnerable to droughts, floods, cyclones, earthquakes, landslides, avalanches and forest fires. Among the 36 states and Union territories in the country, 22 are prone to disasters.

Among all the disasters that occur in the country, floods are the most frequently occurring natural disasters, due to the irregularities of the Indian monsoon. Approximately 40 million hectares of land in the country has been identified as being prone to floods. Major floods are mainly caused in the Ganga-Brahmaputra-Meghna basin which carries 60 percent of the total river flow of our country.

India has a long coastline of 5700 kms, which is exposed to tropical cyclones arising in the Bay of Bengal and the Arabian Sea. The Indian Ocean is one of the six major cyclone prone regions of the world. In India, cyclones occur usually between April and May and also between October and December.

Earthquakes are considered to be one of the most destructive natural hazards. About 50 to 60 percent of India is vulnerable to seismic activity of varying intensities. Most of the vulnerable areas are located in the Himalayan and sub- Himalayan regions.

Till very recently the approach towards dealing with natural disasters has been post disaster management involving problems such as evacuation, warnings, communications, search and rescue, fire-fighting, medical and psychiatric assistance, provision of relief, shelter, etc.

Natural occurrences such as floods, earthquakes, cyclones, etc. will always occur. They are a part of the environment that we live in. However destruction from natural hazards can be minimized by the presence of a well functioning warning system combined with preparedness on part of the community that will be affected.

Disaster management is a multidisciplinary area in which a wide range of issues that range from forecasting, warning, evacuation, search and rescue, relief, reconstruction and rehabilitation are included. It is also multi-sectoral as it involves administrators, scientists, planners, volunteers and communities. These roles and activities span the pre-disaster, during disaster and post disaster plans.

The early warning systems for a range of natural hazards are available at present however they are not enough to ensure communities are safe from disasters. This is where disaster mitigation can play an important role.

Mitigation means lessening the negative impact of the natural hazards. It is defined as sustained action taken to reduce long term vulnerability of human life and property to natural hazards.

The main elements of a mitigation strategy are as follows:

a) Risk assessment and Vulnerability analysis
b) Applied research and technology transfer
c) Public awareness and training
d) Institutional mechanisms
e) Incentives and resources for mitigation
f) Land use planning and regulations
g) Hazard resistant design and construction
h) Structural and constructional reinforcement of existing buildings

4.6.1 Floods and mitigation measures

Floods can be caused by natural, ecological or anthropogenic factors either individually or as a combined result. Anthropogenic activities such as deforestation and shifting cultivation can also contribute to floods. The mitigation measures for floods include both structural and non-structural measures.

The Structural measures include:

a) Reservoirs
b) Prevention of over-bank spilling
c) Improvement of flow conditions

The non-structural measures include:

1) Flood plain managements
2) Maintaining wetlands
3) Flood forecasting and warning services

4.6.2 Earthquakes and mitigation measures

Earthquakes occur due to sudden movements of earth's crust. The earth crust has several tectonic plates of solid rock which slowly moves along with their boundaries. Some time due to friction fracture formation take place along the boundaries or fault line within the plate.

Mitigation measures:

1) Ensure the incorporation of earthquake-resistant design features for the construction of new structures.
2) Facilitate selective strengthening and seismic retrofitting of existing priority and lifeline structures in earthquake-prone areas.
3) Improve the compliance regime through appropriate regulation and enforcement.
4) Improve the awareness and preparedness of all stakeholders.
5) Introduce appropriate capacity development interventions for effective earthquake management (including education training, R&D, and documentation).
6) Strengthen the emergency response capability in earthquake-prone areas.

4.6.3 Cyclones and mitigation measures

Tropical cyclones are the worst natural hazards in the tropics. They are large revolving vortices in the atmosphere extending horizontally from 150 to1000 km and vertically from the surface to 12 to 14 km. These are intense low- pressure areas. Strong winds spiraling anti clockwise in the Northern Hemisphere blow around the cyclone center at the lower level.

They generally move 300 to 5000 km per day over the ocean. While moving over the ocean they pick up energy from the warm water of the ocean and some of them grow into a devastating intensity. One of the requirements for formation of tropical cyclones is that the sea surface temperature (SST) should be above 26°C.

On an average about 5 to 6 tropical cyclones form in the Bay of Bengal and the Arabian Sea every year out of which 2 to 3 may be severe. More cyclones form in the Bay of Bengal than in the Arabian Sea.

The main dangers from cyclones are very strong winds, torrential rains and high storm tides. Most of the causalities are caused by coastal inundation by storm tides. This is often followed by heavy rainfall and floods. Storm surges cause the greatest destruction.

Mitigation measures:

a) Installation of early warning systems
b) Developing communication infrastructure
c) Developing shelter belts
d) Developing community cyclone shelters
e) Construction of permanent houses
f) Training and education
g) Land use control and settlement planning

Effects of Cyclones:

i. Tropical cyclones cause heavy rainfall and landslides.
ii. ii. They cause a lot of harm to towns and villages, causing severe
iii. Damage to kuccha houses.
iv. Coastal businesses like shipyards and oil wells are destroyed.
v. They harm the ecosystem of the surrounding region.
vi. Civic facilities are disturbed.
vii. Agricultural land is severely affected, especially in terms of water supply and soil erosion.
viii. It causes harm to human, plant and animal life.
ix. Communication systems are badly affected due to cyclones.

4.6.4 Landslides and mitigation measures

Landslides occur as a result of changes on a slope, sudden or gradual, either in its composition, structure, hydrology or vegetation. The changes can be due to geology, climate, weathering, land-use and earthquakes.

Landslides are recurring phenomena in the Himalayan region. In the recent years however intensive construction activity and the destabilizing forces of nature have aggravated the problem.

Landslide causes:

1) Geological: It can be due to presence of weak or sensitive materials, sheared, jointed, or fissured materials, contrast in permeability and/or stiffness of materials etc..
2) Morphological causes: It can be due to Tectonic or volcanic uplift, Fluvial, wave, or glacial erosion of slope toe or lateral margins, Vegetation removal (by fire, drought) etc.
3) Human causes: It is mainly due to Mining, Deforestation, Irrigation, Drawdown (of reservoirs) etc

Mitigation measures:

1) Preventing the exposure of population and facilities to landslides.

2) Developmental programs that involve modification of the topography, exploitation of natural resources and change in the balance load on the ground should not be permitted in the landslide prone region.
3) Some critical measures that could be undertaken to prevent further landslides are drainage measures, erosion control measures such a bamboo check dams, terracing, jute and coir netting.
4) Rock fall control measures such as grass plantation, vegetated dry masonry wall, retaining wall and most importantly preventing deforestation and improving afforestation.

4.7 ENVIRONMENTAL LEGISLATIONS

4.7.1 ENVIRONMENT (PROTECTION) ACT (1986)

The Environment (Protection) Act was enacted in the year 1986. It was enacted with the main objective to provide the protection and improvement of environment and for matters connected therewith. The Act is one of the most comprehensive legislations with pretext to protection and improvement of environment.

The Constitution of India also provides for the protection of the environment. Article 48A of the Constitution specifies that the State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country. Article 51 A further provides that every citizen shall protect the environment.

Objectives:

The main objective of the Act was to provide the protection and improvement of environment and for matters connected therewith. Other objectives of implementation of the EPA are:

- To implement the decisions made at the UN Conference on Human Environment held at Stockholm in June, 1972.
- To enact a general law on the areas of environmental protection which were left uncovered by existing laws? The existing laws were more specific in nature and concentrated on a more specific type of pollution and specific categories of hazardous substances rather than on general problems that chiefly caused major environmental hazards.
- To co-ordinate activities of the various regulatory agencies under the existing laws
- To provide for the creation of an authority or authorities for environmental protection
- To provide a deterrent punishment to those who endanger human environment, safety and health.

Definitions

Section 2 of The EPA deals with definitions. Some important definitions provided in the Section are:

Section 2 (a) "Environment" includes water, air, and land and the interrelationship that exists among and between water, air and land and human beings, other living creatures, plants, micro-organism and property. This definition is not exhaustive but an inclusive one.

Section 2 (b) "Environmental Pollutant" means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be injurious to environment.

Section 2 (c) "Environmental Pollution" means the presence in the environment of any environmental pollutant6 . This implies the imbalance in environment. The materials or substances when after mixing in air, water or land alters their properties in such manner, that the very use of all or any of the air water and land by man and any other living organism becomes lethal and dangerous for health.

Section 2 (e) "Hazardous Substance" means any substance or preparation which, by reasons of its chemical or physico-chemical properties or handling, is liable to cause harm to human beings, other living creatures, plants, micro-organism, property or environment.

Powers of Central Government to take measures to Protect and Improve Environment

According to the provisions of the Act, the Central Government shall have the power to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing controlling and abating environmental pollution. Such measures may include measures with respect to all or any of the following matters, namely: a) co-ordination of actions by the State Governments, officers and other authorities-

(a) Under this Act, or the rules made there under,

(b) Under any other law for the time being in force which is relatable to the objects of this Act;

1. planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution;
2. laying down standards for the quality of environment in its various aspects;
3. laying down standards for emission or discharge of environmental pollutants from various sources whatsoever: Provided that different standards for emission or discharge may be laid down under this clause from different sources having regard to the quality or composition of the emission or discharge of environmental pollutants from such sources;
4. restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards;
5. laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution and remedial measures for such accidents;
6. laying down procedures and safeguards for the handling of hazardous substances;
7. examination of such manufacturing processes, materials and substances as are likely to cause environmental pollution;
8. carrying out and sponsoring investigations and research relating to problems of environmental pollution;
9. inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and giving, by order, of such directions to such authorities, officers or persons as it may consider necessary to take steps for the prevention, control and abatement of environmental pollution;
10. establishment or recognition of environmental laboratories and institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act;
11. collection and dissemination of information in respect of matters relating to environmental pollution;
12. preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution;
13. Such other matters as the Central Government deems necessary or expedient for the purpose of securing the effective implementation of the provisions of this Act.

4.7.2 AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

Objectives:
1. Prevention, control and abatement of air pollution
2.Maintaining the quality of air
3. Establishing boards for prevention and control of air pollution

Important features:
1. Central board may lay down standards for quality of air
2. Central board coordinates and settles disputes between state boards in addition to providing technical assistance and guidance to state boards
3. State boards may lay down standards for emissions of air pollutants from industrial units, automobiles or other sources
4. State boards should collect and disseminate information related to air pollution and function as inspectorates of airpollution
5. State boards should examine manufacturing process and pollution control equipment to verify if they meet standardsprescribed.
6. State board can advise the state government to declare heavily polluted areas as pollution control areas and

advise avoidance of burning waste products that can increase air pollution.
7. The directions of central board are mandatory on state boards.
8. Operation of Industrial unit is prohibited in heavily polluted areas without the consent of the central board.
9. Violation of this law is punishable with imprisonment a term which may extend to three months or fine upto Rs. 10,000 or both.

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

Objectives:

1. to provide for the Prevention and Control of Water Pollution and the
2. maintenance or restoration of the wholesomeness of water for the establishment,
3. Establishment of Boards for the prevention and control of water pollution,

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.
2. 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 of 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 (perform such of the functions of any State Board as may be specified in an order made under sub section(2) of Section 18)
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 for a stream or well(Provided that different 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)
h) Plan and cause to be executed a nation-wide programme for the prevention, control or abatement of water pollution
i) Perform such other functions as may be prescribed

3. The Board may establish or recognise 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.

Functions of the State Boards:

1. Subject to the provisions of this Act, the functions of a State Board shall be:
a) To plan a comprehensive programme for the prevention, control or abatement of pollution of streams and wells in the State and to secure the execution there of
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 in 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) To evolve efficient methods of disposal of sewage and trade effluents on land, as are necessary on account of the predominant conditions of scant stream flows that do not provide for major part of the year the minimum degree of dilution
j) 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
k) 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 remedial measures as are necessary to prevent, control or abate water pollution

l) 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
m) 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
n) 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.

2) 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.

4.7.4 WILDLIFE PROTECTION ACT (1972)

Objective:
1. The sections in this schedule give absolute protection to certain species and these cannot be infringed on any account.
2. By this act government provide security to animals that are not in danger of becoming extinct.
3. This act also delineates animals that can be hunted like ducks and deer's. For this purpose the hunter has to apply for a license to the District Forest Officer who will allow a hunter to shoot during a specific season and restricted area. Any infringement can lead to cancellation of the hunting license.
4. It also concerns cultivation and plant life and gives teeth to setting up more protected animal parks.

4.7.5 FOREST CONSERVATION ACT, 1980

Forest Conservation Act launched 1980, which was amended in 1988. The Indian Forest Act of 1927consolidated all the previous laws regarding forests that were passed before the 1920s. The act gave the government and Forest Department the power to create Reserved Forest, and the right to use of resources by local people was controlled. It gives priority to maintaining environmental stability and ecological balance. It expressly states that the network of Protected Areas should be strengthened and extended.

Objectives:

1. Forest dwellers must have access to subsidized sources of fuel, fodder, building material etc so that they do not cut trees.
2. Modify working plans into environmentally sound action plans based on scientific research.

- Protection of standing Forests.
- Creation of new stock
- Building up of information base.

Penalties:
For offences in reserved forested: no person is allowed to make clearings or set fire to reserved forest. Cattle are not permitted to trespass into the reserved forest. Felling, collecting of timber, bark or leaves, quarrying, or collecting any forest product is punishable with imprisonment for a term of six months, or which may extend to Rs.500 or both.
Penalties for offences in protected forests: a person who commits any of the following offences like felling trees, stripping the bark or leaves of trees, setting fire to such forests, kindling a fire without taking precaution to prevent

its spreading, dragging timber, or permitting cattle to damage any tree, shall be punishable with imprisonment for a term which may extend to six months or with a fine which may exceed to Rs. 500, or both.

4.8 POPULATION GROWTH

Population explosion refers to the rapid and dramatic rise in world population that has occurred over the last few hundred years. Between 1959 and 2000, the world's population increased from 2.5 billion to 6.1 billion people. According to United Nations projections, the world population will be between 7.9 billion and 10.9 billion by 2050.

4.8.1 Causes of Rapid Population Growth:

The success in reducing death rates was attributable to several factors:

(1) increases in food production and distribution,

(2) Improvement in public health (water and sanitation), and

(3) Medical technology (vaccines and antibiotics), along with gains in education and standards of living within many developing nations.

4.8.2 Environmental Effects of Overpopulation

The relationship between overpopulation and environmental impacts are often interrelated and complex. Below are some of the key sustainability challenges associated with overpopulation. For the sake of simplicity they are listed separately, but understand the connections between them are complicated, which makes them more challenging to manage.

1) Farming impacts

As the global population increases, more food is needed. Such measures may be met through more intensive farming, or through deforestation to create new farm lands, which in turn can have negative outcomes. Agriculture is responsible for about 80 percent of deforestation, worldwide.

2) Deforestation

Human population increase is related to all of these deforestation pressures. More people mean we need more food, more residential and industrial area, and more firewood.

3) Eutrophication

Agricultural runoff is one of the main causes of eutrophication, the presence of excessive nutrients (nitrogen & phosphorus) in bodies of water, causes the dense growth of plant life that consumes oxygen, resulting in the death of aquatic animals. Other major sources of eutrophication are industry and sewage disposal--both related to population growth. Although it is a natural and slow process but due to use of pesticides and fertilizers to increase the yield lead to eutrophication fastly.

4) Loss of Fresh Water

While there is plenty of water on the planet, it is very much a scarce resource. Only 2.5 percent of water resources are fresh water, and just a small fraction of that is available as unpolluted drinking water. One of the byproducts of population growth has been stress on freshwater supplies. "Water stressed" is defined as a case of demand exceeding the supply of suitable water available.

5) Global Warming

Human population growth and climate change have grown hand in hand as the use of fossil fuels has exploded to support industrialized societies. "More people means more demand for oil, gas, coal and other fuels mined or drilled from below the Earth's surface that, when burned, spew enough carbon dioxide (CO_2) into the atmosphere to trap warm air inside like a greenhouse," notes Scientific American. Most fossil fuel consumption comes from developed

countries. It is a sobering thought that most developing nations aspire to similar industrial economies as they experience economic growth, which further escalates CO_2 emissions into the atmosphere.

Deforestation is another important component of greenhouse gas emissions. Globally, forests store more than twice the amount of carbon dioxide than is found in the atmosphere. As forests are cleared and burned, that CO_2 is released into the atmosphere, accounting for an estimated 25 percent of total greenhouse gas production.

4.8.3 Population Control

Family planning is the planning of married couples to decide and plan the number and the time of having children by using birth control methods and other techniques to implement such plans. According to WHO, family planning is a way of thinking and living that is adopted voluntarily, upon the basis of knowledge, attitude and responsible decisions.

In India, the family planning association was formed in 1949 and family planning programme was launched in 1952. In 1977, the family planning department was renamed to Family Welfare Programme (FWP).

4.8.4 Importance of Family Planning in India

- Improvement of family's economic condition
- Health and nutrition of the mother and child
- Importance of spacing births, atleast 2 years apart from one another.

NATIONAL FAMILY WELFARE PROGRAMME

India launched the National Family Welfare Programme in 1951 with the objective of "reducing the birth rate to the extent necessary to stabilize the population at a level consistent with the requirement of the National economy.
The Family Welfare Programme in India is recognized as a priority area, and is being implemented as a 100% centrally sponsored programme.

To impart new dynamism to the Family Welfare Programme, several new initiatives were introduced and ongoing schemes were revamped in the Eighth Plan (1992-97). Realizing that Government efforts alone in propagating and motivating the people for adaptation of small family norm would not be sufficient, greater stress has been laid on the involvement of NGOs to supplement and complement the Government efforts.
Reduction in the population growth rate has been recognized as one of the priority objectives during the Ninth & Tenth Plan period. The strategies are:

i) To assess the needs for reproductive and child health at PHC level and undertake area specific micro planning.
ii) To provide need-based, demand-driven, high quality, integrated reproductive and child health care reducing the infant and maternal morbidity and mortality resulting in a reduction in the desired level of fertility.

4.9 ENVIRONMENT AND HUMAN HEALTH

A clean environment is essential for human health and well-being. However, the interactions between the environment and human health are highly complex and difficult to assess. This makes the use of the precautionary principle particularly useful. Many factors influence the health of a population, including diet, sanitation, socio-economic status, literacy, and lifestyle. These factors have changed significantly during the economic transitions that have shaped present society

1) **Unsafe water** - poor sanitation and hygiene kill an estimated 1.7 million people annually, particularly as a result of diarrhoeal disease
2) **Malaria** - kills over 1.2 million people annually, mostly African children under the age of five. Poorly designed irrigation and water systems, inadequate housing, poor waste disposal and water storage, deforestation and loss of biodiversity, all may be contributing factors to the most common vector-borne diseases including malaria, dengue and leishmaniasis.
3) **Indoor smoke** - from solid fuels kills an estimated 1.6 million people annually due to respiratory diseases.
4) **Urban air pollution** - generated by vehicles, industries and energy production kills approximately 800 000 people annually.

5) **Road traffic injuries** - are responsible for 1.2 million deaths annually; low- and middle-income countries bear 90% of the death and injury toll. Degradation of the built urban and rural environment, particularly for pedestrians and cyclists, has been cited as a key risk factor.
6) **Lead exposure** - kills more than 230 000 people per year and causes cognitive effects in one third of all children globally; more than 97% of those affected live in the developing world.
7) **Climate change -** impacts including more extreme weather events, changed patterns of disease and effects on agricultural production are estimated to cause over 150 000 deaths annually.
8) **Unintentional poisonings** - kill 355 000 people globally each year. In developing countries, where two-thirds of these deaths occur, such poisonings are associated strongly with excessive exposure to, and inappropriate use of, toxic chemicals and pesticides present in occupational and/or domestic environments.

4.9.1 Human Rights

Human rights are the rights that a human being must enjoy on this Earth. There are several environmental issues which are closely linked to human rights.

a) Equity: It means that there should be a minimum level of environmental quality. Everyone should have equal access to resources and opportunities, all individual should ensure to judicious use of resources keeping in view the future requirements.

b) Nurition, Health and Human rights: Nutrition defines of health of all people. It affects not only growth and physical development of a child but also his social development. Proper nutrition and health are fundamental human rights.

c) Intellectual property rights & community biodiversity registers: it a tool employed by certain communities which helps to –
Establish and inventory of local products and their use
Allow monitoring of crop diversity
Safeguard indigenous knowledge of local crops & livestock resources
Maintain a balance between development and conservation

4.9.2 Value Education

Despite a worldwide rise in awareness about environment then also we are facing continued degradation of our environment. It shows that knowledge of environmental problems does not necessarily lead to action to dissolve them. The values of environment cannot be taught to individuals rather should be inculcate in their nature and behavior so that they appreciate the nature, use resources judiciously and develop a harmonious relationship with environment.

Environmental values:

Value based education has a significant role in providing direction to the young generation to inculcate a positive attitude in them and aware them about right and wrong activities. It is important to

- Develop respect for and appreciation of all forms of nature
- Understand the relationship between habitat and human
- Appreciate the beauty provide by nature
- Develop a respect for all living creatures

Environmental values are integral part of human nature that brings about sensitivity for preserving nature. It aware us about the need to take action for its conservation instead of degradation.

4.9.3 HIV/AIDS

Acquired immunodeficiency syndrome (AIDS) is a chronic, potentially life-threatening condition caused by the human immunodeficiency virus (HIV). By damaging your immune system, HIV interferes with your body's ability to fight the organisms that cause disease.

HIV is a sexually transmitted infection (STI). It can also be spread by contact with infected blood or from mother to child during pregnancy, childbirth or breast-feeding. Without medication, it may take years before HIV weakens your immune system to the point that you have AIDS.

There's no cure for HIV/AIDS, but there are medications that can dramatically slow the progression of the disease. These drugs have reduced AIDS deaths in many developed nations.

Progression to AIDS

When AIDS occurs, your immune system has been severely damaged. You'll be more likely to develop opportunistic infections or opportunistic cancers — diseases that wouldn't usually trouble a person with a healthy immune system.

The signs and symptoms of some of these infections may include:

- Soaking night sweats
- Recurring fever
- Chronic diarrhea
- Persistent white spots or unusual lesions on your tongue or in your mouth
- Persistent, unexplained fatigue
- Weight loss
- Skin rashes or bumps

HIV become AIDS

HIV destroys CD4 T cells — white blood cells that play a large role in helping your body fight disease. The fewer CD4 T cells you have, the weaker your immune system becomes.

You can have an HIV infection for years before it turns into AIDS. AIDS is diagnosed when the CD4 T cell count falls below 200 or you have an AIDS-defining complication.

HIV transmission

To become infected with HIV, infected blood, semen or vaginal secretions must enter your body. This can happen in several ways:

- **By having sex.** You may become infected if you have vaginal, anal or oral sex with an infected partner whose blood, semen or vaginal secretions enter your body. The virus can enter your body through mouth sores or small tears that sometimes develop in the rectum or vagina during sexual activity.
- **From blood transfusions.** In some cases, the virus may be transmitted through blood transfusions. American hospitals and blood banks now screen the blood supply for HIV antibodies, so this risk is very small.
- **By sharing needles.** Sharing contaminated intravenous drug paraphernalia (needles and syringes) puts you at high risk of HIV and other infectious diseases, such as hepatitis.
- **During pregnancy or delivery or through breast-feeding.** Infected mothers can pass the virus on to their babies. HIV-positive mothers who get treatment for the infection during pregnancy can significantly lower the risk to their babies.

HIV doesn't transmits

You can't become infected with HIV through ordinary contact. That means you can't catch HIV or AIDS by hugging, kissing, dancing or shaking hands with someone who has the infection. HIV isn't spread through the air, water or insect bites.

4.10 QUESTIONS FOR REVIEW

Q.1 Discuss the reasons of high population growth in India

Q.2 Explain sustainable development

Q.3 Define disaster .

Q.4 What functions are performed by Central and state boards for conservation?

Q.5 Describe Earthquake mitigation measures.

Q.6 What are environmental values? Why they are important in present scenario?

Q.7 Write a note on family planning, HIV and human rights.

Q.8 Describe the objectives of EPA and Water (Prevention & control of pollution) Act

Q.9 What is consumerism? What are the ill effects of consumerism on environment?

Q.10 What are the consequences of overpopulation on environment and human health?