

# ENVIRONMENTAL POLLUTION AND HAZARDS

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## 9.1 INTRODUCTION

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In the previous unit you have studied about biodiversity, the threats it focus and the need for conservation. In this unit we will discuss pollution, which is causing a serious problem to human health as well as agriculture. Pollution is caused by any undesirable physical, biological or chemical change in the components of the environment i.e., air, water and soil. In our daily usage pollution implies the adverse state of environment in which we live. In the preceding units you have studied about the concept of environment and earth's resources available for meeting the basic requirements and developmental needs of ever-growing human population. Unmindful use of resources and energy intensive technologies that generate lot of wastes have resulted in degradation of environment. The adverse effects are on living systems including humans, buildings and other materials.

In this Unit you will learn about the phenomenon of pollution in air, water and soil, their sources and their effects. Apart from gaseous emissions and liquid effluents, noise, radiations and thermal pollution also have adverse effects on living organism.

## Expected Learning Outcomes

After completing the study of this unit, you should be able to:

- ❖ define pollution and pollutants;
- ❖ identify and list major types of pollutants that contaminate our air, water and soil;
- ❖ explain the critical importance of a temperature range for the living organisms;
- ❖ understand and trace the pathways of major pollutants in the ecosystem;
- ❖ explain the reasons for high noise levels in the urban areas; and
- ❖ discuss the hazardous effects of radiations and the need for safeguards to prevent accidental release of radioactivity.

## 9.2 WHAT IS POLLUTION?

**Pollution** is defined as any undesirable change in the physical, chemical or biological characteristics of environmental components i.e., air, water and soil that adversely affect the life forms and life support systems of the biosphere. You can also say that pollution is unfavourable alteration of our environment mainly due to human activities. *The agent that contaminates the environmental component is called the pollutant.*

A normal constituent of the environment becomes pollutant if its concentration increases beyond the threshold, destroying its usefulness. A pollutant is also a new substance (biotic or abiotic) or energy (heat, sound, radioactivity etc.) that is added to or formed in any component of the environment and builds up to a level where usefulness of that component is damaged.

Pollutants can be grouped into two broad categories:

- i) **Non-Biodegradable Pollutants:** Pollutants that remain in an unchanged form in the environment for a very long time such as pesticides, heavy metals, rubber and nuclear wastes. Plastics also fall in the same category. Such substances are not broken down or decomposed by bacteria.
- ii) **Biodegradable Pollutants:** Generally pollutants such as paper, garden waste, domestic sewage, agro-based residues, and fertilizers breakdown into simple products by bacterial decomposition process. These simple products are raw materials of nature and are reutilized in the ecosystem. These biodegradable pollutants pose a threat when their input in the environment exceeds the decomposition capacity.

Pollutants can enter the environment either through point or non-point sources (Fig.9.1). **Point sources** are distinct and confined sources that discharge the pollutants/effluents through a chimney or through a discharge channel such as pipes or tunnels from industries or municipal areas. **Non-point sources** or area sources are diffused sources discharging pollutants over a large area. Some of the examples are run-offs from construction sites and agricultural fields.

Persistent organic pollutants (POPs) are nonbiodegradable chemical substances that accumulate through food chain in the humans and cause health problems. Nine organic chlorinated agro pesticides derived from chemicals like Aldrin, DDT, Chlordane, Dieldrin and three types of chlorinated industrial products derived from chemicals like Dioxin and Polychlorinated Biphenyls are listed as POPs.

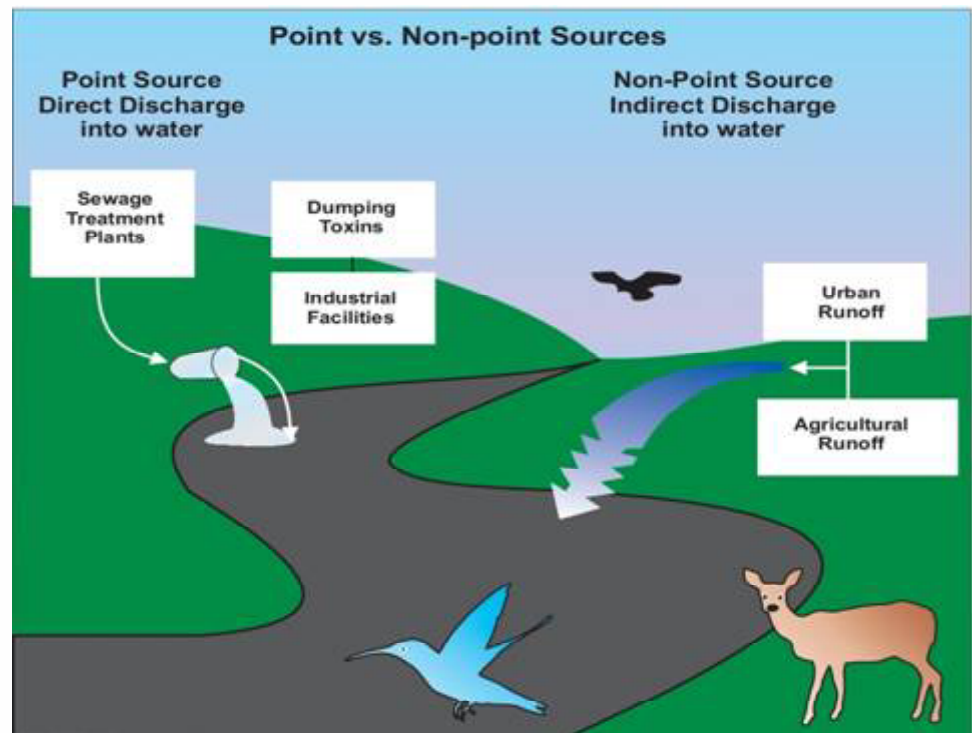


Fig. 9.1: Point and non-point sources of water pollution

### 9.3 CAUSES OF ENVIRONMENTAL POLLUTION

Industrial processes and pace of increase in human population led to the increase in the consumption of energy and natural resources. Growing use of the resources has ensured the steady rise in the emissions of gases, chemicals, wastes and other materials into air, water, soil and eventually in the biosphere. Resources and energy are required by humans for fulfilling their needs as well as greed for food, housing, transportation, entertainment and luxuries. With ever increasing human population, demand for resources and energy sources like wood, minerals, water, soil, coal, oil and gas increases. In Table 9.1 you can see how during more than last fifty years of 20<sup>th</sup> century there an increasing trend in the usage and build up of resources that affected the environment adversely.

**Table 9.1: Increasing trend in the resource usage, buildups and their effects on environment**

Items	Concentrations in 1950	Concentrations in 1995	Effect on Environment
Coal use	884 million tons oil equivalent.	2083 million tons of oil equivalent	Climate change
Oil production	518 million tons	2953 million tons	Climate change
Natural gas production	180 million ton soil equivalent	2128 million ton soil equivalent	Climate change
Fertilizer use	14 million tons	125 million tons	Water Pollution

Items	Concentrations in 1950	Concentrations in 1995	Effect on Environment
CFC production	42 thousand tons	300 thousand tons	Ozone layer depletion
Nuclear Arsenal	304	45100	Global security
Human population	2.55 billion	More than 5.6 billion	Changed land use and resource use patterns

**Source:** Vital Signs, 1995, World Watch Institute

The obvious reason for the presence of pollutants in our homes, offices and other indoor areas is that there are many potential indoor sources of pollution (Table 9.2).

**Table 9.2: Some examples of usage sources that lead to indoor and outdoor pollution**

SOURCES	POLLUTANTS
	<b><i>Predominantly Indoor</i></b>
<ul style="list-style-type: none"> <li>Particleboard, foam insulation, furnishing, ceiling tiles, tobacco smoke</li> <li>Building materials – concrete, stone, water and soil</li> <li>Fire proofing, thermal and electrical insulation, acoustics</li> <li>Adhesives, solvents, paints, varnishes, nicotine cooking, cosmetics, tobacco smoke</li> <li>Pesticides, paints, spills in laboratories, sprays</li> <li>Consumer products, domestic dust, debris, infected organisms</li> </ul>	<p>Formaldehyde</p> <p>Radon</p> <p>Asbestos, mineral wools, synthetic fibres</p> <p>Organic substances, aerosols, volatile organic materials</p> <p>Mercury, Cadmium</p> <p>Aerosols of varying animal composition, allergens, viable microorganisms</p>
	<b><i>Predominantly Outdoor</i></b>
<ul style="list-style-type: none"> <li>Coal and oil combustion, smelters, fires</li> <li>Photochemical reactions</li> <li>Automobiles, smelters</li> <li>Soil particulates, industrial emissions Cadmium</li> <li>Petrochemical solvents, vaporization of unburnt fuels</li> </ul>	<p>Sulphur oxides</p> <p>Ozone</p> <p>Lead, Manganese</p> <p>Calcium, Chlorine, Silicon,</p> <p>Organic substances</p>

	<i>Indoor and Outdoor</i>
<ul style="list-style-type: none"> <li>Fuel combustion</li> <li>Incomplete fuel combustion</li> <li>Fossil fuel combustion, metabolic activity</li> <li>Resuspension, condensation of vapours, combustion products</li> <li>Petroleum products, combustion, paint, metabolic action, pesticides,</li> <li>Cleaning products, agriculture, metabolic insecticides, fungicides products</li> </ul>	Nitrogen oxides Carbon monoxide Carbon dioxide Suspended particulate matter Organic substances, heavy metals Ammonia

In the following sections you will read about what causes pollution in various environmental components.

## SAQ 1

Fill in the blanks:

- The agent that contaminates the ..... component is called pollution.
- Plastics are ..... type of pollutants.
- Sulphur dioxide can be absorbed in small .....
- Of all animal species, ..... have inevitable spirits and capacity of adjusting to and manipulating the environment.
- Our ..... consumption strategies and living styles have compelled to live in polluted environment.

## 9.4 AIR POLLUTION

Have you ever felt that air is as much a resource as water or food? To stay alive the average adult human being exchanges about six times more amount of gases per day as compared to daily consumption of food and water. This is the reason why air quality is important to us. You might have read about the composition of normal air. For most of the living beings oxygen is the immediate requirement from the environment. We can live for days without food and water but only for few minutes without oxygen. Any significant change in the normal composition of air is harmful. Dry air contains almost 78% nitrogen, 21% oxygen, 0.04% carbon dioxide and small amounts of other gases. Air also contains variable amount of water vapour.

### 9.4.1 Types of Air Pollutants

Broadly air pollutants can be grouped into following categories.

- Natural Pollutants:** These pollutants are released from natural sources or as a result of natural activity. Some examples are: pollens and volatile organic compounds from plants; gases like sulphur dioxide and hydrogen sulphide from volcanic eruptions and decay of organic

More number of people are killed due to choking caused by smoke and fumes generated by fire as compared to that killed by being burnt.



materials; particles from wild fires and sea. In general natural emissions are low in concentrations and do not cause serious damage.

2. **Primary Pollutants:** These pollutants are emitted directly into the air as a result of natural or human activity (Fig. 9.2). Examples include sulphur dioxide, nitrogen oxides, carbon dioxide, carbon monoxide, hydrocarbons and particulates released from fuel burning.
3. **Secondary Pollutants:** Secondary pollutants are produced as a result of chemical reactions between primary pollutants and normal atmospheric compounds under the influence of electromagnetic radiations from the sun (Fig.9.2). For example, the primary pollutant sulphur dioxide ( $\text{SO}_2$ ) reacts with oxygen ( $\text{O}_2$ ) in the atmosphere to form sulphur trioxide ( $\text{SO}_3$ ), a secondary pollutant. Sulphur trioxide further reacts with water vapour to form another secondary pollutant sulphuric acid ( $\text{H}_2\text{SO}_4$ ), which is a component of acid rain. Another example is the formation of ozone on a bright sunny day over the urban areas. Nitrogen dioxide ( $\text{NO}_2$ ) absorbs ultra violet radiations that reach the earth's surface and splits into nitrogen oxide ( $\text{NO}$ ) and oxygen atoms ( $\text{O}$ ). These oxygen atoms combine with oxygen molecules to form ozone ( $\text{O}_3$ ).  $\text{NO}_2$  also contributes in the formation of other secondary pollutants, peroxy acetyl nitrate (PAN) and nitric acid ( $\text{HNO}_3$ ). **Smog**, a mixture of smoke and fog is formed by complex reactions between oxides of nitrogen and a wide range of hydrocarbons triggered by sunlight. It is formed mostly in urban areas especially in stagnant air. The main reason is vehicular overpopulation.

Ozone is both protector and a cause of problem for us. In the stratosphere ozone layer protects us from harmful UV-radiations. In the lower atmosphere it acts as powerful oxidizing agent and causes damage to crops, vegetation, fabrics etc. and harm to human beings. Some people are affected even at a low concentration of 0.001 ppm. The oxidizing agent is a chemical that takes away electrons from other chemicals.

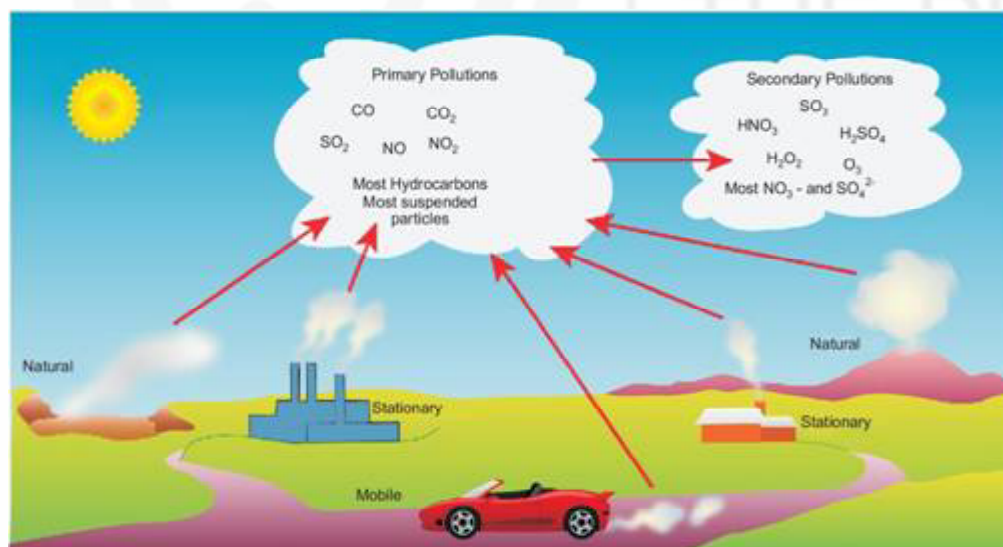


Fig. 9.2: Primary and secondary pollutants in the atmosphere result due to natural and human activities.

### 9.4.2 Major Air Pollutants

Let us now study Table 9.3 to know about major air pollutants, their sources, and an overview of their effects on humans and the environment.

**Table 9.3: Major air pollutants, their sources and effects on humans and environment.**

Pollutants	Sources	Effects
<ul style="list-style-type: none"> <li>● <b>Oxides of Carbon (<math>\text{CO}_x</math>)</b></li> <li>- Carbon dioxide (<math>\text{CO}_2</math>)</li> <li>- Carbon monoxide (<math>\text{CO}</math>)</li> </ul>	Combustion of coal, oil and other fuels for energy production, manufacturing and transport; biomass burning	$\text{CO}_2$ has a major role in green-house effect, produces weak carbonic acid adding to acid rains; $\text{CO}$ affects human health by binding to haemoglobin, which may result in asphyxia.
<ul style="list-style-type: none"> <li>● <b>Oxides of Sulphur (<math>\text{SO}_x</math>)</b></li> <li>- Sulphur dioxide (<math>\text{SO}_2</math>)</li> <li>- Sulphur trioxide (<math>\text{SO}_3</math>)</li> <li>- Sulphate (<math>\text{SO}_4</math>)</li> </ul>	Combustion of sulphur containing fuel e.g. coal, petroleum extraction and refining; paper manufacturing; municipal incineration; ore smelting for metal extraction	$\text{SO}_2$ can cause severe damage to human and other animal lungs and is important precursor to acid rain; adverse effects include corrosion of paints, metals and injury or death to animals and plants.
<ul style="list-style-type: none"> <li>● <b>Oxides of Nitrogen (<math>\text{NO}_x</math>)</b></li> <li>- Nitrogen oxide (<math>\text{NO}</math>)</li> <li>- Nitrogen dioxide (<math>\text{NO}_2</math>)</li> <li>- Nitrous oxide (<math>\text{N}_2\text{O}</math>)</li> <li>- Nitrate (<math>\text{NO}_3</math>)</li> </ul>	Burning of fuels; biomass burning; by-product in the manufacture of fertilizers	Form the secondary pollutants: peroxy acetyl nitrate (PAN) and nitric acid ( $\text{HNO}_3$ ); suppression of plant growth and tissue damage; cause irritation to eyes.
<ul style="list-style-type: none"> <li>● <b>Hydrocarbons (HCs) also called Volatile Organic Compounds (VOCs)</b></li> <li>- Methane (<math>\text{CH}_4</math>)</li> <li>- Butane (<math>\text{C}_4\text{H}_{10}</math>)</li> <li>- Ethylene (<math>\text{C}_2\text{H}_4</math>)</li> <li>- Benzene (<math>\text{C}_6\text{H}_6</math>)</li> <li>- Benzopyrine (<math>\text{C}_{20}\text{H}_{12}</math>)</li> <li>- Propane (<math>\text{C}_3\text{H}_8</math>)</li> </ul>	Evaporation from gasoline tanks, carburators; burning of fuels, biomass; municipal landfills; microbial activity of sewage; industrial process involving solvents	Can have carcinogenic effect on humans; higher concentrations are toxic to plants and animals; can convert into harmful compounds through complex chemical changes that occur in atmosphere; some are more reactive with sunlight and produce photochemical smog

Pollutants	Sources	Effects
<ul style="list-style-type: none"> <li>● <b>Other organic compounds]</b></li> <li>- Chlorofluorocarbons (CFCs),</li> <li>- Formaldehyde (<math>\text{CH}_2\text{O}</math>)</li> <li>- Methylene chloride (<math>\text{CH}_2\text{Cl}_2</math>)</li> <li>- Trichloro ethylene (<math>\text{C}_2\text{HCl}_3</math>)</li> <li>- Vinyl chloride (<math>\text{C}_2\text{H}_3\text{Cl}</math>)</li> <li>- Carbon tetrachloride (<math>\text{CCl}_4</math>)</li> <li>- Ethylene Oxide (<math>\text{C}_2\text{H}_4\text{O}</math>)</li> </ul>	<p>Aerosol sprays; foam and plastics for making disposable fast food containers; refrigeration</p>	<p>CFCs cause reduction in stratospheric ozone thus allowing greater penetration of ultraviolet light at earth's surface; intensified UV radiations cause skin cancer and can have lethal effects on various life forms</p>
<ul style="list-style-type: none"> <li>● <b>Metals and other inorganic compounds</b></li> <li>- Lead (Pb),Mercury (Hg)</li> <li>- Hydrogen sulphide(<math>\text{H}_2\text{S}</math>)</li> <li>- Hydrogen fluoride (HF)</li> </ul>	<p>Oil wells and refineries; transport vehicles; municipal landfills; fertilizer, ceramic, paper, chemical and paint industries; pesticides; fungicides; aluminium production; coal gasification</p>	<p>Cause respiratory problems, toxicity and even death to humans and other animals; damage to crops; prove to be carcinogenic</p>
<ul style="list-style-type: none"> <li>● <b>Liquid droplets</b></li> <li>- Sulphuric acid (<math>\text{H}_2\text{SO}_4</math>)</li> <li>- Nitric acid (<math>\text{HNO}_3</math>)</li> <li>- Oil</li> <li>- Pesticides e.g. DDT and malathion</li> </ul>	<p>Agricultural pesticides; fumigation; oil refineries; reactions of pollutants in the atmosphere</p>	<p>Contribute to acid rains; corrosion; damage to various life forms</p>
<ul style="list-style-type: none"> <li>● <b>Suspended particulate matter (SPM-solid particles)</b></li> <li>- Dust, soil, sulphate salts, heavy metal salts, fine particles of carbon (soot), silica, asbestos, liquid sprays, mist etc.</li> </ul>	<p>Fuel combustion; building constructions; mining; thermal power stations; stone crushing; industrial processes; forest fires; refuse incineration</p>	<p>Have chronic effects on respiratory system; deposition on the surface of green leaves thus interfering with absorption of <math>\text{CO}_2</math> and release of <math>\text{O}_2</math>; blocking of sunlight; particles size that range from 0.1 to 10 mm, cause lung damage</p>



Pollutants	Sources	Effects
<ul style="list-style-type: none"> <li>● <b>Photochemical oxidants</b></li> <li>- Ozone (<math>O_3</math>), peroxyacyl nitrates (PANs),</li> <li>- Formaldehyde (<math>CH_2O</math>)</li> <li>- Acetaldehyde (<math>C_2H_4O</math>)</li> <li>- Hydrogen peroxide (<math>H_2O_2</math>)</li> <li>- Hydroxyl radical (HO)</li> </ul>	Photochemical reactions in the atmosphere that involve sunlight, oxides of nitrogen and hydrocarbons	Produce haze; irritation to eyes, nose and throat; respiratory problems; blocking of sunlight

### 9.4.3 Air Pollution and Atmospheric Problems

Apart from causing damage to materials, plant and animal communities and health problems in humans, air pollution affects the atmospheric processes. Acid rain, smog, global warming and ozone depletion are some of the effects of pollution in our atmosphere. Let us look into some examples of the problems of air pollution in our atmosphere.

1. **Suspended Particulate Matter (SPM)** : SPM in the ambient air is complex and variable mixture of different sized particles with many chemical components. Larger particles are trapped by nose hair (vibrissae) and breathing tubes. Particles smaller than 10  $\mu m$  in size, known as PM 10, are respirable suspended particulate matter (RSPM). Finer particles of size less than 2.5  $\mu m$  are known as PM 2.5. They can be inhaled deep in the lungs and cause a lot of trouble. Study of ambient air quality of some Indian cities conducted by Central Pollution Control Board (CPCB) in recent years indicate that many Indian cities such as Raipur, Kanpur, Delhi, Gwalior and Ludhiana have RSPM more than 200 microgram per cubic metre. Standard level of RSPM is 60 microgram per cubic metre.

There was a decreasing trend in the levels of  $SO_2$  and  $NO_2$  in the past decade. This could be due to low sulphur diesel introduced in Delhi and prohibition from plying of commercial vehicles more than 15 years old in Delhi. The use of unleaded petrol has drastically lowered the level of lead in the air in India.

2. **Acid Precipitation** : Acid rain or acid precipitation (Fig.9.3) includes wet acidic depositions like rain, snow, fog, mist or dew and deposition of dry acidic particulates from the air. Acid precipitation occurs in and around the areas where major emissions of sulphur dioxide ( $SO_2$ ) and nitrogen oxides ( $NO_x$ ) occur as a result of anthropogenic activities. Hydrochloric acid emitted from coal fired power plants also adds to acid rain problems. Acid depositions have disastrous effects on the life forms as well as the materials. Soil fertility is adversely affected because acidic water in soil releases immobile heavy metal ions which are highly injurious to plants and other soil biota. Apart from damaging forests and lakes, acid rain corrodes and harms building materials such as steel, paints, plastics, cement, limestone, sandstone and marble.

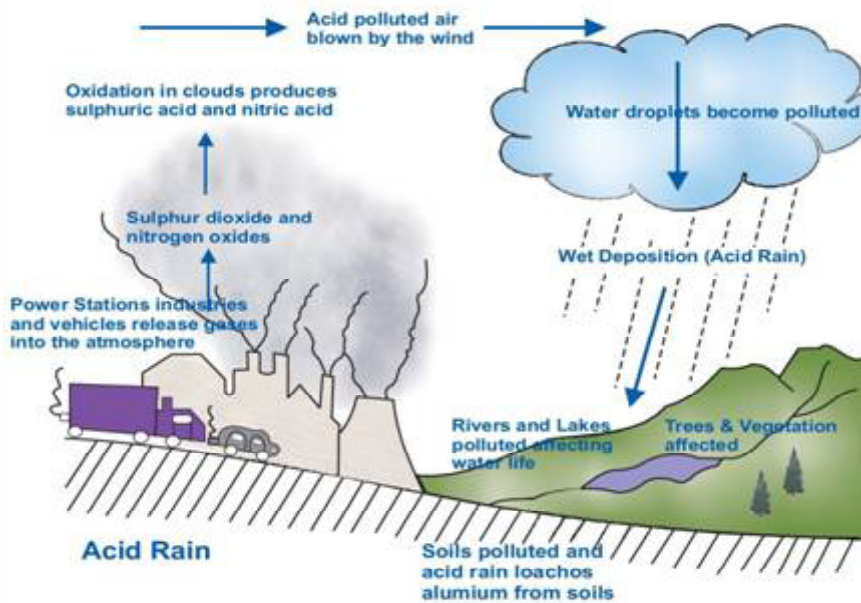


Fig. 9.3: Acid precipitation and its pathways.

**3. Atmospheric Inversion :** Atmospheric or temperature inversion (Fig.9.4) occurs when a stable layer of warmer air lays above the cooler air. The normal phenomenon of temperature decline along the increasing height reverses and thereby, convection air currents that normally disperse the pollutants are prevented. An inverted temperature gradient occurs, air circulations are restricted and pollutants are trapped in the lower atmosphere within the stagnant air mass. Such atmospheric inversion is responsible for dangerous levels of air pollution over polluted cities in India.

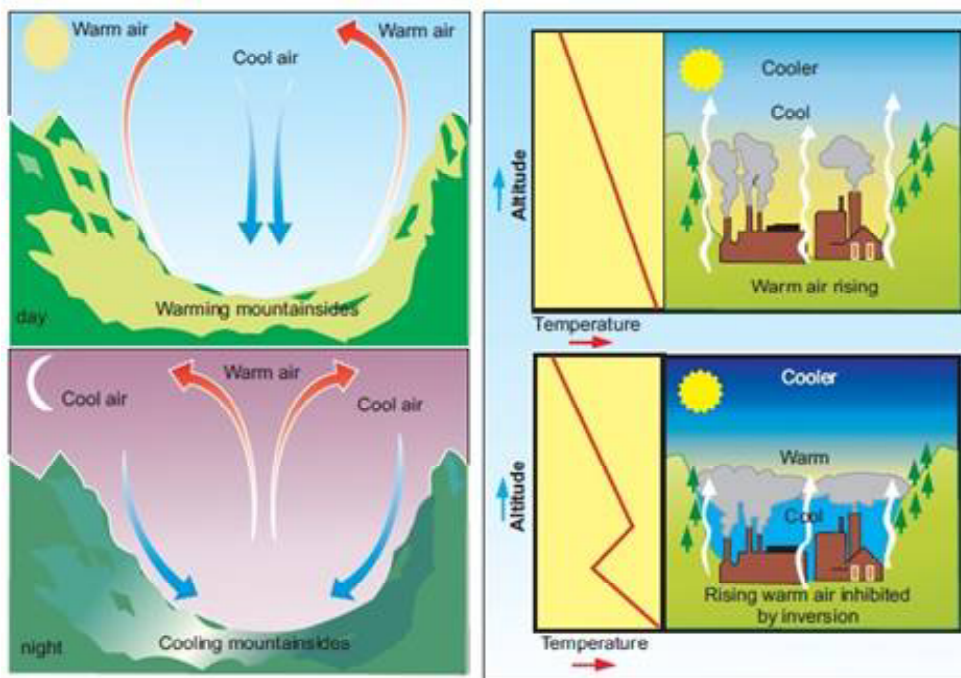


Fig. 9.4: Temperature inversion phenomenon. (a) Sun heats the ground during the day, warms the air near surface. Warm air rises up carrying dust and pollutant aloft. (b) At night the heat from the grounds devoid of greens as well as the paved streets quickly escapes into the sky

### 9.4.4 Case Study: Bhopal Gas Tragedy

In 1969, as part of its global empire, Union Carbide Corporation set up its pesticide formulation unit in the northern end of the city of Bhopal in central India. In December 1979, its Methyl Iso Cyanate (MIC) plant with an installed capacity of 5000 tonnes went into production (Fig. 9.5).



**Fig. 9.5: Methyl Iso Cyanate (MIC) plant.**

On the night of December 2, 1984 during routine maintenance operations in the plant, at about 9.30 p.m., a large quantity of water carrying catalytic material entered Methyl Iso Cyanate (MIC) storage tank no. 610. In the early hours of December 3 forty tons of toxic gases were released from the plant as a result of contamination of the storage tank and spread throughout the city. The result was a nightmare that still has not ended. No alarm ever sounded a warning and no evacuation plan was prepared. The gas leak lasted less than 1 hour, yet the accident killed about 2500 people. About 100,000 were seriously injured by the gas which causes burns on contact and severe irritation to eyes, nose, throat and lungs (Fig. 9.6). Only a few ppm of inhaled gas causes violent coughing, swelling of lungs, bleeding and death.



**Fig. 9.6: Disastrous effect of Methyl Iso Cyanate on human population during Bhopal gas tragedy.**



Some of the findings of ICMR on the health status of the persons who directly or indirectly suffered by the exposure are as follows:

- Fibrosis of the lungs, neurotic depression, anxiety and psychosis was reported in 22.6% of exposed people.
- Studies from 1987 to 89 show that gas exposed children (up to age 5 years at the time of disaster) suffered two to four times more from fever, breathlessness, vomiting and cough compared to children among similar unexposed populations.
- As late as in 1990, spontaneous abortion rates among the exposed women were more than three times that among unexposed women.

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## SAQ 2

Match column A with Column B:

Column A	Column B
a) Natural pollutants	i) Anthropogenic activities
b) Photochemical Oxidants	ii) A stable layer of warmer air lays above the cooler air
c) Acid Precipitation	iii) Methyl Iso Cyanate (MIC)
d) Atmospheric inversion	iv) Oxides of nitrogen and hydrocarbons
e) Bhopal Gas Tragedy	v) Volatile organic compounds from plants.

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## 9.5 WATER POLLUTION

Any physical, biological or chemical change that degrades the water quality results in water pollution. Water being a universal solvent can dissolve various types of substances in it. For this property, contamination of water becomes inevitable.



Fig. 9.7: Day to day human activities that cause water pollution.

Visible forms of pollution like formation of colour and foam in water discourages the use of water. Therefore, such visible pollutants sometimes tend to become more important issues than many more serious pollutants that solubilize in water and are not visible to the naked eyes.

Polluted water is a threat to our health and survival of aquatic life and other life forms. The pollution in non-flowing water bodies like ponds, lakes and underground water becomes localized and confined, making it more serious. The major human generated sources of water pollution are sewage, garbage and refuse, industrial and agricultural wastes like fertilizers and pesticides.

### 9.5.1 Types of Water Pollutants

Water pollutants are divided into following major categories. The types, sources and effects of water polluting agents shown in Table 9.4 are sometimes interrelated.

1. **Biological Agents** : Pathogenic organisms like viruses, bacteria and protozoans are serious water pollutants as far as human health is concerned. Cholera, bacterial and amoebic dysentery, gastroenteritis, typhoid, polio, flu, viral hepatitis and worm infections are important water borne diseases. Some insects that have aquatic larvae transmit malaria, dengue, yellow fever and filariasis. In our country generally onset of rainy season is accompanied by such epidemics. Overpopulated areas, unplanned industrial and human settlements, lack of proper civic amenities are some of the contributory factors. Water gets contaminated due to human wastes, animal wastes, domestic sewage and wastewater discharges from tanneries and slaughter houses.

2. **Chemical Agents** : Chemical pollutants can be **inorganic** in nature like nitrates, phosphates, acids, salts and toxic heavy metals. **Organic** chemical pollutants include oil, gasoline, pesticides, dyes, paints, plastics, cleaning solvents and detergents. **Radioactive substances** that make the third category of chemical pollutants are released into water bodies as a result of processing of uranium ore and wastes from research laboratories.

Organic wastes and inorganic nutrients like phosphates and nitrates enrich the water bodies and cause eutrophication due to excessive growth of certain plants. Inorganic salts ionise in water, enrich it and also render hardness to it. The effects in water bodies include colour changes of water (iron oxide gives red colour and iron sulphate gives yellow colour) and foaming by detergents. Such changes are harmful to the organisms dependent on these water bodies.

3. **Physical Agents** : Suspended solids, sedimentary solids and temperature are the physical factors that affect the quality of water. These pollutants adversely affect water bodies by silting, clogging waterways, filling the dams and making the water muddy. Aquatic animals face problems in breathing through gills in such waters. Suspended organic and mineral solids adsorb toxic substances like heavy metals and pass them in food chain. Thermal pollution occurs when heat-laden water from industries enters the water body.



Table 9.4: Major water pollutants, their sources and their effects.

Pollutants	Sources	Effects
<b>Biological agents</b> Bacteria, parasitic fungi, and protozoans	Human sewage; animal and plant wastes; decaying organic matter; industrial wastes (oil refineries, paper mill, food processing units); natural land and urban runoffs	Oxygen requiring bacteria feed on these biological wastes and deplete oxygen in the water body; life is destroyed in absence of oxygen; foul odours, poisoned live stock result.
<b>Chemical agents</b> <b>Inorganic chemicals and minerals</b> Acids, salts, metals like lead and mercury, crop nutrients like phosphates and nitrates.	Natural run off from land; industrial wastes; acid deposition; leaded gasoline; lead smelting; pesticides; agricultural runoffs; mining; oil fields; domestic sewage; food processing industries; detergents containing phosphates	Toxic to various life forms and humans through food chain, can cause genetic and birth defects; increased solubility of harmful minerals in water; make water unfit for domestic, agricultural and industrial uses; salinity build up in soil; upsets ecosystem of water bodies and cause eutrophication
<b>Organic chemicals</b> Pesticides, herbicides, detergents, chlorine compounds, oil, grease and plastics	Agriculture, forestry; pest control industries; home and industrial wastes; water disinfection processes; paper industry; bleaching process; machine and pipeline wastes; oil spills.	Toxic to aquatic life forms as well as organisms that depend on such water bodies; eutrophication of water bodies
<b>Radioactive substances</b>	Nuclear wastes from research laboratories and hospitals; processing of uranium ore; nuclear plants	Radionuclides enter the food chain and cause birth and genetic defects; causative agent for cancer
<b>Physical agents</b> Particulates and heat	Soil erosion, runoffs from the agriculture; mining, forestry and construction activities; power plants, industrial cooling	Filling of water ways, harbours and reservoirs; increase in temperature lowers the solubility of oxygen in water; reduction in biotic life in the water bodies.

### 9.5.2 Marine Pollution

Oceans are the ultimate sink of pollutants that are either directly dumped in the form of wastes or reach there as run-offs through streams, canals or rivers or accidental spills like oil spill. Major pollution of marine waters occurs near the coastlines where large cities, harbours and industrial centres are situated. The pollution of oceans, seas, estuaries, salt marshes and other similar water bodies is called as **marine** or **ocean pollution**. About 25% of the total Indian population lives in coastal areas and dependent on marine resources. The kind of pollutants encountered here are sewage, municipal discharge, agricultural run-offs, sludge, industrial effluents, waste heat generated from industries during cooling, processes, oil spills and discharge from marine vessels, oil and grease discharge from shipping industry and accidental discharge of oil from tankers. About 210 million gallons of petroleum enter the seas world over each year as a result of extraction, transportation, and consumption of oil and its products. About 180 million gallons of oil come into seas annually from natural seepage. After an oil spill, the aromatic hydrocarbons that are low boiling are the primary cause of immediate killing of number of aquatic organisms (Fig. 9.8). The floating oil can coat the feathers of marine birds, especially diving birds and few of marine mammals such as seals and others. This oil coating destroys the animals natural insulation and buoyancy, and most of them drown or die of exposure from loss of body heat. Marine pollution is also causing immense harm to coral reefs. Millions of tonnes of plastics reach the oceans. Researchers estimate as much as 2,45,000 tonnes of plastics floating on sea water, but there is also considerable down below. Plastics have also been found in the stomach of sea birds and fish.



Fig. 9.8: Oil spill in ocean killing animals.

### 9.5.3 Thermal Pollution

Thermal pollution occurs when the temperatures of a water body or air in the atmosphere are raised or lowered and subsequently deviate from normal levels. If the temperature of tropical oceans is lowered by even one degree,

the environment can become lethal to some corals and some reef species.

Raising the water temperature can have similar effects on sensitive organisms. Thermal pollution occurs when waste heat is released into a water body. Human causes of thermal pollution are altering of vegetation cover as well as discharging of heated water from steam generators. Metal smelters, processing mills, petroleum refineries, paper mills, food processing factories and chemical manufacturing plants use water for cooling purposes. Eventually this water gets heated and is released as effluent from the industrial units.

The solutions to the problem of chronic thermal pollution lies in retaining the heated water and effluents discharged by the power plants and other industrial unit in a holding unit and be cooled prior to their discharge into the water body.

### 9.5.4 Water Quality Parameters

There are several parameters applied to assess the quality of water. Water samples are tested for these parameters to ensure that water is fit for consumption. Dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), most probable number (MPN) and total dissolved solids (TDS) are some such parameters.

1. **Dissolved Oxygen:** It refers to the amount of oxygen gas ( $O_2$ ) that is dissolved into the water of any water source. Higher amounts of dissolved oxygen indicate that water quality is good. Low concentrations of oxygen content in the water indicate the presence of organic waste pollutant in water.
2. **Biological Oxygen Demand:** BOD is a measure of oxygen used by microorganism such as bacteria to decompose the organic matter like sewage, dead plant leaves, grass blades and food wastes. If the amount of organic wastes is high in the water source, more bacteria will be present to consume oxygen. Under such polluted conditions demand for oxygen will be high and so the BOD values will be high. With high levels of BOD, levels of DO in the water decrease.
3. **Chemical Oxygen Demand:** It is the amount of oxygen required to degrade or breakdown the organic chemical compounds of wastewater. A water body that receives effluents from chemical industries shows high values of COD.
4. **Most probable Number:** The water polluted with organic wastes such as sewage/sludge will have high population of bacteria like *E.coli* and coliforms. With the help of MPN test both *E.coli* and coliforms can be detected and enumerated. MPN method statistically predicts the number of these organisms present in the water body. Coliform is present in human intestines and isn't necessarily harmful to us. But its presence indicates the presence of human waste in the water. Polluted water will show high values of MPN.
5. **Total Dissolved Solids:** The amount of salts and solids dissolved in water is measured by testing the TDS and salinity contents. Some of the dissolved substances that make the water quality poor are calcium, phosphorus, iron sulphates, carbonates, nitrates, chlorides, and other

salts. Heavy metals also fall in this category. Excessive amounts of TDS degrade the quality of water.

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## SAQ 3

Fill in the blanks with the appropriate word given in the parentheses.

- i) ..... (Water/Alcohol) being a universal solvent can dissolve various types of substances in it.
- ii) Polluted water is a threat to our health and survival of ..... (aquatic/terrestrial) life.
- iii) ..... (CPCB/MHRN) is monitoring the water quality of water resources at various locations in the country.
- iv) The productivity of an ecosystem reflects the rate at which its producers ..... (manufactures/photosynthesis).
- v) The oil coating destroys the ..... (animals/humans) natural insulations and buoyancy.
- vi) The release of heated water into a water body changes its temperature and concentrations of dissolved ..... (oxygen/chlorine) in the water body.
- vii) ..... (BOD/COD) is a measure of oxygen used by bacteria to decompose the organic matter.

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## 9.6 SOIL POLLUTION

All the terrestrial organisms including humans interact directly with the surface layer of land i.e., soil as it provides us the basic necessities of life, food, shelter and clothing. The vital source, soil, is only about 15 cm deep on the land surface throughout. Apart from natural causes we, the human population contribute to the degradation of our land surface mainly by three ways: by using it (agricultural and developmental activities); by taking things out of it (mining and deforestation); by putting things into it (waste disposal).

The major fallout of our over indulgence with our land areas are as follows:

1. **Loss of Biodiversity** : Natural flora and fauna are destroyed due to cutting of vast areas of forests as land is required to fulfill the agricultural and developmental needs, desires and greed of ever growing population of humans. According to International Union for Conservation of Nature (IUCN) it is estimated that by the year 2050 up to 50,000 plant species will become extinct or threatened. Presently about 4,500 animal species and 20,000 plant species are considered by the scientists to be threatened.
2. **Soil Erosion** : It is the process of loosening, detachment and removal of soil components especially the topsoil particles. Soil erosion is caused by wind blows and water flows. But these forces can damage only if the land surface becomes devoid of vegetation cover. Excessive loss of topsoil



reduces soil fertility and results in deposition of eroded soil in the riverbeds i.e., silting of water bodies.

3. **Acidity and Alkalinity** : Increase in the acidic or alkaline content of the soil reduces its fertility and is not good for certain types of crops. Minerals like calcium carbonate and alkaline compounds tend to get deposited in the soil if the climate is dry or rainfall is low. This increases the alkalinity of soil. Unmindful use of land and wrong agricultural practices are the main human generated reasons for such state of soil.

4. **Land Pollution by Waste Deposition** : We can call our land area as an ultimate garbage can as waste generated mainly by human activities is dumped in it as well as buried in it. The major types of wastes and their sources are listed in Table 9.5. As in other Asian countries, in India most of the solid waste is land filled. All types of waste is dumped in the landfills and when water seeps through them it gets contaminated and in turn pollutes the surrounding areas. This contamination of soil and ground water through landfills is known as leaching. The uncovered, untreated and unsegregated solid wastes are also left in open dumps. The rainwater run-off from such dumpsites contaminates nearby land and water bodies.

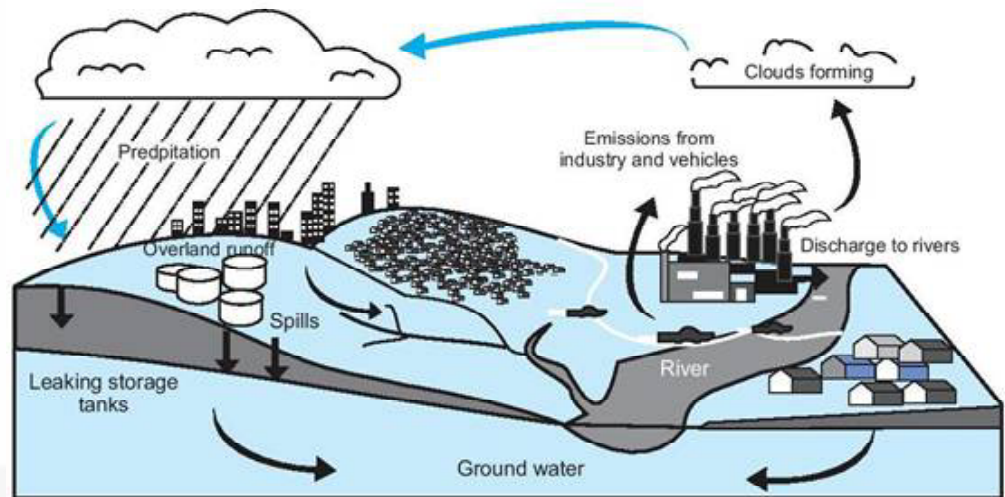
**Table 9.5: Major types of wastes generated from different sources that pollute our land areas**

Urban	Industrial waste	Domestic waste	Rural waste	Nuclear Plant waste
Municipal; sewage; industrial effluents; domestic effluents; hospital waste	Slag; lime sludge; brine mud, scraps of metals, glass, ferrous and non-ferrous metals, wool, thread and paper; fly ash; plastics; wastes from tanneries and other small scale industries, waste water effluents	Organic waste from kitchen, crockery, tin cans, plastics cans, bottles and bags; glass bottles, cloth rags, paper pieces; straw, board boxes; ash	Pesticides, herbicides; agricultural runoffs	Radioactive hazardous wastes

The pollutants once enter any component of the biosphere (ecosphere) can cycle through all the components i.e., air, water and soil and can enter the organisms (Fig. 9.9). Let us take the example of pesticides, the chemicals that are used to eliminate the pests. For use in the fields, pesticides are dusted or

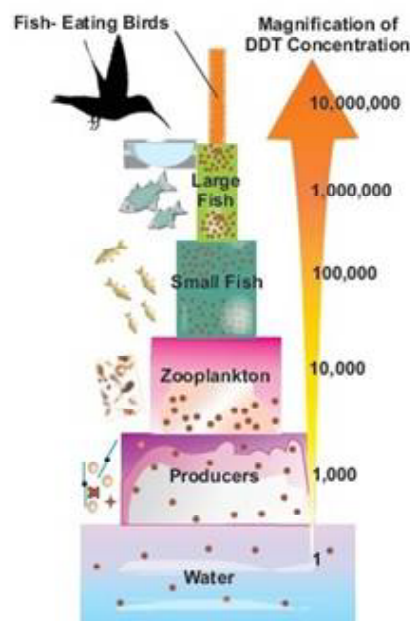


sprayed on plants or else mixed in the soil of the fields. Spraying and evaporation enable the entry of pesticides in the atmosphere. Rainfalls bring back these chemicals to land area and water bodies. Run-offs from agricultural lands bring the pesticides into the water bodies. Irrigation from such water bodies takes back pesticides in the field areas. Persistent chemicals and pollutants follow this pathway for much longer time and enter the food chain. If not biodegradable these pollutants can bioaccumulate and bio magnify in the higher levels of food chain (Fig.9.10).



**Fig. 9.9: Movement of chemicals through the components of the environment.**

Bioaccumulation refers to the entry of a pollutant in a food chain. It is the increase in the concentration of a pollutant from the environment to the first organism in the food chain. Biomagnification is the phenomenon of increase in the concentration of a pollutant from one link in a food chain to another.



### **Biomagnification (Bioconcentration):**

Toxic substances become increasingly concentrated within living organisms as they move up each step of the food chain

**Fig. 9.10: Bioaccumulation and biomagnification of pollutants in the food chain.**

## 9.7 NOISE POLLUTION

Sound is the medium for communication. It is almost impossible to lead our day-to-day life without sound. However, sound is annoying and harmful if it becomes noise. **Noise is any unwanted or exceedingly high levels of sound that can annoy, cause stress or impair the hearing ability.** The main sources of noise are industrial operations, machines, vehicles, railways, aircrafts, military arms and ammunition, construction work and recreational appliances. Loudness or the intensity of the sound is measured by measuring on a scale called decibel (db). A tenfold increase in the sound intensity is represented as 10 db on scale. The instrument is called decibel meter. Apart from pressure sound has pitch also. High pitched sound is more annoying than low pitched sound of same intensity. The unit that measures both pressure and pitch of the sound is called decibel–A (dbA). Noise can affect by interfering with communication, causing health and behaviour disorders and diminishing the hearing. Increased adrenalin levels, hypertension, migraine, high cholesterol levels, gastric ulcers, easy irritability, insomnia, increased aggressive behaviour and other psychological disorders and permanent damage to hearing ability may be caused in humans by high sound levels.

Noise pollution control measures include: (i) reduction of noise at source, (ii) interruptions in the path of transmission and (iii) protection of the receiver. Comparatively little attention has been paid to control noise pollution in our country. Awareness, motivation, legislations and their effective implementations are required to control the menace of noise pollution.

Monitoring of ambient noise levels by CPCB on Deepawali day at certain locations in Delhi and Mumbai showed that noise levels were much higher than the prescribed limits of 45 dbA during night time applicable to residential area. Aware generated by mass media and initiative of school children against the use of cracker for Deepawali celebrations can contribute in the control of noise and air pollution.

### SAQ 4

Read the following statements and write True (T) or False (F):

- i) Natural flora and fauna are destroyed due to cutting of vast areas of forest. [    ]
- ii) Excess loss of top soil increases soil fertility and results into deposition of eroded soil in the riverbeds. [    ]
- iii) Bioaccumulation refers to the entry of pollution in a food chain. [    ]
- iv) Fat-insoluble pollutants may be retained for a long time and biomagnify. [    ]
- v) Noise is a wanted and exceedingly high levels of sound. [    ]
- vi) Awareness, motivation, legislation and their effective implementations are required to control the menace of noise pollutions. [    ]

## 9.8 SUMMARY

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In this unit you have read about the concept of pollution and pollutants of air, water and soil resulting from human activities. Environmental degradation also occurs due to noise and radioactive pollution.

- Pollutants are the agents that cause undesirable changes in the quality of air, water and soil. Anthropogenic activities are primarily responsible for pollution and environmental degradation. The natures of pollutants largely depend on factors like our life style, occupation, habits, traditions and awareness etc.
- Unmindful use of resources, by-products of industrial processes, waste generation, lack of will on the part of people to treat and manage the effluents and wastes are the contributory factors in polluting the environments. Biodegradable pollutants breakdown easily but nondegradable pollutants when introduced in any component of the ecosystem can cycle through all the environmental components i.e. air, water and soil.
- In the ecosystem pollutants affect the humans and other life forms directly or indirectly by causing damage to materials and crops. Persistent pollutants such as heavy metals and persistent organic compound enter the food chain, get biomagnified at the higher levels of food chain and eventually reach the human beings, causing a variety of health problems. Public awareness of the causes and problems caused by pollution, and active involvement of individuals and communities, apart from strict environment law and their strict implementations are essential to control environmental pollution. Use of ecofriendly technologies are highly effective in combating the problem of pollution caused by industry..

## 9.9 TERMINAL QUESTIONS

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1. Define pollution and discuss various sources of air pollution.
2. Describe Bhopal Gas Tragedy and its after effects.
3. What is water pollution? Explain various parametres applied to assess the quality of water?
4. What is soil pollution? Describe the phenomenon of biomagnification by giving example.
5. Discuss noise pollution and its effects on humans.

## 9.10 ANSWERS

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### Self-Assessment Questions

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1. i) Environmental ii) Non-degradable iii) Particulates iv) Humans v) Resource.
2. a) v b) iv c) i d) ii e) iii.
3. i) Water ii) Aquatic iii) CPCB iv) Photosynthesis v) Animals vi) Oxygen vii) BOD.
4. i) T ii) F iii) T iv) F v) F vi) T.

## Terminal Questions

1. Refer to Section 9.2 and sub-sections 9.4.1 & 9.4.2
2. Refer to Sub. Section 9.4.4.
3. Refer to 9.5 and Sub-section 9.5.4
4. Refer to Section 9.6.
5. Refer to Section 9.7.

## 9.11 FURTHER READING

1. Bharucha, E. (2005) *Textbook of Environmental Studies for Undergraduate Courses*, Hyderabad: Universities Press (India) Private Limited.
2. Botkin, D. B. & Keler, E. A. 8<sup>th</sup> Ed, (2011) *Environmental Science, Earth as a Living Planet*, New Delhi: Wiley India Pvt. Ltd.
3. Kaushik, A. 2<sup>nd</sup> Ed. (2004) *Environmental Studies*, New Delhi: New Age International (P) Limited.
4. Rajagopalan, R. 3<sup>rd</sup> Ed. (2015) *Environmental Studies*, New Delhi: Oxford University Press.
5. Wright, R. T. (2008) *Environmental Science: Towards a Sustainable Future* New Delhi: PHL Learning Private Ltd.

### Acknowledgement

1. Fig. 9.5: Methyl Iso Cyanate (MIC) plant.  
(Source:[http://www.aristatek.com/Newsletter/NOV09/Images/ts\\_files/image002.jpg](http://www.aristatek.com/Newsletter/NOV09/Images/ts_files/image002.jpg))
2. Fig. 9.7: Day to day human activities that cause water pollution.  
(Source:[https://commons.wikimedia.org/wiki/File:Water\\_pollution\\_due\\_to\\_domestic\\_garbage\\_at\\_RK\\_Beach\\_02.jpg](https://commons.wikimedia.org/wiki/File:Water_pollution_due_to_domestic_garbage_at_RK_Beach_02.jpg))
3. Fig. 9.8: Oil spill in ocean killing animals.  
Source:<https://pixnio.com/science/biology-pictures/oil-spill-duck-kill>