
UNIT 1 POLLUTANTS AND THEIR EFFECTS

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1.1 INTRODUCTION

The environment that is of immediate relevance, broadly consists of four components – atmosphere, hydrosphere, lithosphere and biosphere. Life on the earth is supported by this environment. This environment gets polluted by the contaminants that are generated during the life cycle of each living organism, and also by natural causes like, floods, earthquakes and volcanic eruptions. However, the assimilative capacity of the natural sources like land, water and air is such that ordinarily the pollutants get diffused, disposed and transformed and the quality of environment is maintained in the long run. If the quantity of contaminants is more than the natural assimilative capacity, the quality of environment gradually deteriorates, and environmental pollution begins assuming undesirable proportions.

During the last 4-5 decades, due to man's increased activities, environmental pollution has ever been increasing. The main factors responsible for present state of pollution are higher population growth rate, industrialization and urbanization.

Objectives

At the end of the study of this unit, you should be able to

- identify the pollutants and their effects,
- define pollution, origin of pollution, classification of pollutants, (solid, liquid, gaseous),
- understand the classification, such as, municipal waste, industrial waste, agricultural and urban runoff,
- understand the effects of pollutants on man and environment,
- get familiar with environment Acts and grasp their implications, and
- appreciate the effects of population on environment.

1.2 ENVIRONMENT

Normally environment means geographical and related conditions surrounding a given cluster of people. Thus, it includes land and land farms of the region, water, plants, animals and other living organisms, and the interfaces and situations arising due to their natural interactions.

Components of Environment

The environment, as mentioned already, has the following four components :

- (i) Atmosphere
- (ii) Hydrosphere
- (iii) Lithosphere
- (iv) Biosphere

These components have interactions amongst themselves, as well as with the man-made pollutants that are generated on this earth. Each component has its special role to play on this globe, especially with reference to sustaining all life forms in harmony with the rhythm of nature. This rhythm is fundamental to all sustainable development.

1.2.1 Atmosphere

Atmosphere is the gaseous cover surrounding the earth surface which includes air (and its components), as well as solar radiation and humidity. All life on earth is possible, as we know, due to the atmosphere, which may be assumed to exist upto a height of about 500 km from the surface of the earth.

1.2.2 Hydrosphere

Hydrosphere constitutes the total surface as well as sub-surface water. It, therefore, includes oceans, rivers, streams, lakes and underground sources of water. Water circulates in the hydrosphere through a maze of paths that make the hydrologic cycle.

About 97% of earth's total water lies in oceans, which to a large extent is not directly useful to man. Only about 1% water appears as rivers, lakes and aquifers – it is only this water that man uses for his domestic and industrial purposes.

1.2.3 Lithosphere

Lithosphere includes land surface along with its forms. The land, as we see it, has formed as a result of disintegration of rocks over the years due to natural forces like wind erosion and deposition. Main components of lithosphere are organic and inorganic substances. The microorganisms in the lithosphere decompose organic matter. Thus, lithosphere contains many organic components as well. Ground water is mainly contained in the aquifers that lie in the lithosphere.

1.2.4 Biosphere

Normally the shallow outer crust of the earth surface, which includes living organisms and their habitat as well as vegetation is termed as biosphere. However, the biosphere extends from the defrosted level of sea up to about 24 km in the atmosphere, where life is considered to be naturally possible. The natural resources required for sustaining life, as such, are available in the biosphere. Degradation of biosphere is the prime indicator of environmental deterioration. Effects of pollution are visibly felt in this vital part of environment.

1.3 POLLUTION

Our natural environment is being polluted by either natural causes like floods, volcanic eruptions, etc. and /or man's activities like building, dams across rivers, installing industries and urbanization of countryside and small towns. Moreover, an unplanned increase in population, especially over a large population, also leads to environmental pollution.

The word "pollution" is derived from the Latin word *pollutione*, that is to make dirty. Engineers and scientists have given different definitions for pollution according to the intended stress on a particular aspect. However, pollution may be defined as an

undesirable change in the environment causing harmful effects on man, animal, plant and/or natural assets and property.

1.3.1 Pollutant

Some harmful substances, brought about mainly as waste products, of industrial or other activity, are injected /emitted into the environment. Also, natural inputs like radiation, etc. do contribute to polluting the environment. These materials (or energy) which deteriorate the quality of environment are known as pollutants. The pollutant as defined in the Environmental Protection Act, (1986) is a harmful solid, liquid or gaseous substance present in such concentration in the environment which tends to be injurious for the living biota.

The pollutants can also be classified as conservative or non-conservative. Conservative pollutants are those substances which are not lost by decay, chemical reaction, or deposition. These pollutants when they hit the ground are not absorbed and reflected. The existing quality of ambient atmosphere, meteorological conditions and the type of pollutant determine whether the pollutant will be conservative or non-conservative.

1.3.2 Classification of Pollutants

The pollutants may broadly be divided into two groups, such as :

- (i) Characterised by type of energy it possesses, and
- (ii) Material substances.

The energy type includes heat, which is responsible for natural pollution, radiation, which cause radioactive or similar pollution; and sound which is responsible for noise pollution. Material substances may be organic or inorganic in nature; and both of them can exist in solid, liquid or gaseous forms.

1.3.3 Environmental Pollution

It is obvious that the presence of pollutants in our environment adversely affects the living and non-living components of the system; and this syndrome constitutes what we call environmental pollution.

With reference to the main targets that get affected, the environmental pollution may be classified as follows :

- (i) Air pollution
- (ii) Land pollution
- (iii) Water pollution

SAQ 1

- (a) Discuss in detail the various components of our environment.
- (b) Define pollution, and explain the action of various pollutants.
- (c) Distinguish between conservative and non-conservative pollutants. Give few examples.
- (d) Classify the commonly occurring pollutants. Discuss them in detail.

1.4 SOURCES OF POLLUTION

Pollution, as pointed out earlier, may take place either due to natural forces like floods, forest fires, volcanic eruptions and earthquakes; or due to man's activities that impact on nature. Impactful activities of man include excessive use of fossil emitting carbon dioxide, deforestation to increase land area, improper use of land areas, generation and disposal of wastage from domestic and industrial sectors, indiscriminate waste disposal in

natural water bodies, increased vehicular traffic emitting harmful gases, uncontrolled and unplanned industrial development, population explosion and urbanization, as well as wars for obvious effects. The ultimate result of pollution appears as contaminated life supports, namely, air, water, and food; and, also it impinges on the spiritual / psychological make up of man.

1.4.1 Municipal Waste

Cities and towns generate waste water as well as solid waste. About 80-90 per cent water supplied to the city dwellers turn out to be the waste water. The municipal organizations collect, treat and finally dispose off the waste water in such a way that it does not result in environmental degradation. If the treatment and ultimate disposal either in water bodies or on land is not done to comply with the standards prescribed for preventing environmental pollution, the waste water will create not only nuisance but will gradually result in poor quality of environment and even outbreak of epidemics. Normally the waste water constituents can be listed as follows :

- (1) Suspended solids, which can cause sludge deposits and anaerobic conditions in water bodies.
- (2) Biodegradable organic matter which consumes oxygen contained in the receiving water bodies, and ultimately resulting in poor water quality.
- (3) Pathogens, which can cause water borne diseases.
- (4) Nutrients like nitrogen and phosphorus, which can lead to eutrophication of relieving rivers and lakes.
- (5) Dissolved inorganic solids, which increase the level of total dissolved solids in water and may interfere with the reuse and recycling of process.

The municipal waste water may also contain *refractors organic*, (which resist biodegradation) and heavy metals if the industries are also allowed to dispose off their wastes in the same rivers.

The solid waste discharged by the cities and towns includes food wastes, rubbish, ashes, construction wastes, and street refuse, and other abandoned materials. The solid waste generated from the cities and towns is to be daily collected and disposed off properly by engineering systems so as to keep the city clean and protect the quality of the environment.

The vehicular traffic especially in big cities adds to overall pollution causing air and noise pollution.

1.4.2 Industrial Waste

After World War II, there has been a rapid proliferation and development of industries in the developing and underdeveloped countries. These industries mainly cover chemical, electronic and agricultural sectors. In most of the areas the technical know-how regarding these industries is imported from the developed countries. There are also instances where the technical collaboration is made amongst the developing or underdeveloped countries themselves because the existing technology may have been proved to be less efficient or more polluting; and the standards set in the developed country are very stringent, and may not be initially suitable for the interested country. Thus, in the former case, the pollution is transferred to the developing countries from the developed countries.

There are industries that generally depend on such manufacturing process and such raw materials that produce different pollutants which are responsible for air, water, and land pollution. The most polluting chemical industries are those that are involved in manufacturing fertilizers, pesticides, dyes and intermediates like H-Acid and Vinyl Sulfas. The tanneries, pulp and paper mills, dyeing and printing industries are also responsible for causing pollution especially water pollution. The chimneys of some of the industries emit air pollutants in the form of particulates, oxide of sulphur and nitrogen and hydrocarbons. Some of the industries also generate hazardous solid wastes, which if not properly disposed off can create land pollution and health problems.

1.4.3 Agricultural and Urban Runoff

The rainfall on the surface of earth partly reaches the water bodies like rivers and lakes, the rest seeping into the soil mass. This portion of precipitation is termed *runoff*. This

runoff also carries pollutants and impurities along with it, which ultimately pollute the water bodies. Therefore, the runoff is an agent carrying pollution with it.

The use of fertilizers and pesticides has considerably increased with a view to producing more and more agricultural products like food grains and vegetables. The runoff from the agricultural areas contains traces of fertilizers and pesticides, which are responsible for *eutrophication* of the water bodies, and are toxic to living organism. The urban runoff contains some of the soluble components of the solid waste generated in the city.

Although the solid waste of a city has to be regularly collected and appropriately disposed off; however, as per an estimate, about 50% solid waste remains uncollected in the developing and underdeveloped countries. The runoff also carries lot of silt load, which gets deposited in rivers and reservoirs. The silt deposits in the rivers are responsible for change in the river course and floods as well. The capacity of reservoirs gets reduced due to silt that is deposited in the reservoir area.

1.5 EFFECTS OF POLLUTION

The pollutants in solid, liquid or gaseous form emitted into the environment are, obviously, responsible for environmental degradation and the consequent poor quality of life. Pollutants have adverse impact on both the living and non-living entities. They cause imbalance in nature that takes a long time to correct. The whole world is subjected to harmful effects (e.g., holes created in ozone layer due to emission of chloro-fluro-carbons); but, the developing countries, having lack of wherewithal, are the worst sufferers. Perhaps, pollution is the price man has to pay for material progress.

1.5.1 Effects on Living Forms

The different chemicals that may be dissolved in drinking water can cause diseases, depending upon their concentration, toxicity and sensitivity of living organisms.

Methemoglobinemic in infants is caused by nitrates; and in appropriate concentration of fluoride may lead to mottled and discoloured teeth or flouresis. Some chemicals get accumulated in the tissues and prove to be fatal in the long run. Lead is found in water as a result of contact with lead pipes, and lead is a cumulative poison; continued consumption of such water results in lead poisoning. Pesticides spread like radio-active clouds, increasing the risk of all round contamination, is well known. Moreover, many communicable diseases are transmitted by pathogens present in water. These diseases include bacterial, viral and other infections.

The suspended particulate matter in the atmosphere when inhaled poses health hazards to humans especially those that are susceptible to respiratory illness. The lead particles affect the blood forming system, nervous system and the renal system. Carbon monoxide as an air pollutant reacts with the haemoglobin of the blood and reduces its oxygen carrying capacity. Sulfuric acid and sulfur dioxide irritate the respiratory system and are responsible for diseases like bronchitis and pulmonary emphysema (i.e., a disease that affects the lungs making breathing difficult). Photochemical oxidants can cause coughing, headache, irritation in eyes, nose and throat.

Radioactive radiation is more harmful and has long lasting effects even on future generations. They can cause cancer of lungs and adversely affect the nervous and reproductive systems. Vegetation too stands affected by it.

The noise pollution especially continuous exposure to noise can lead to nervous disorders and development of irritating nature. Students may lose concentration; and tiny tots may easily damage their ear-drums.

Animals and plants are also adversely affected by water and air pollution. The pollutants in animals and plants reach human by way of consumption of these food items; they later on get accumulated in human systems. The air pollutants arrest the plant growth and discolour the leaves. The heavy metals are also found in water, and are toxic to humans, animals and plants when the concentration is more than the permissible limits.

Green leafy vegetables are most often promoted as the best bet to good health. But pollution makes them very soon an unhealthy item of food. Pollution affects both the yield and the quality of many plants that are used as our food. In a study at Banaras Hindu University (*Science Reporter*, May 1999) it was found that the yield of wheat suffered a 49% reduction around a power plant. In metropolitan cities like, Delhi and Calcutta, vegetables are often cultivated near sewage canals, some of them close to

garbage dumps; and, this garbage often contains a high level of toxic metals like, lead, chromium, nickel, and cadmium. Some of their ions find their way into these vegetables.

1.5.2 Effects on Non-living Things

The water pollutants especially those that are acidic in nature ($\text{pH} < 6$), or highly alkaline ($\text{pH} > 10$) do have a corrosive effect on underground foundations if they enter the soil matrix. Similarly, dissolved solids picked up from city solid waste can enter the soil matrix in raining season, and may have corrosive effect on foundations of structures.

Further, our cultural assets and all exposed structures are adversely affected by air pollution. The particulate matter can damage materials, such as, soiling clothes and textiles, and eroding and dissolving building surfaces. Corrosion is also possible when the humidity is about 75 per cent. The derivatives of sulphuric acid attack the building materials especially those containing carbonates. Excess exposure to sulfur dioxide accelerates corrosion rates for many metals.

The adverse impact of environmental pollution on historically famous Taj-Mahal (due to pollution by the industries around Agra and Refinery at Mathura) is now well recognised.

The ozone is responsible for oxidizing plants, dyes and fibres.

SAQ 2

- (a) What are the common constituents of waste water? Discuss their respective sources.
- (b) Briefly outline the composition of industrial waste, and the source of each substance.
- (c) Explain the role of agricultural and urban runoff as pollutants.
- (d) Describe the impact of pollution on living and non-living with reference to a few real-life situations.

1.6 CONTROL OF POLLUTION

Human civilization and environment are linked with each other. Indiscriminate use of natural resources like, water, land, forest and fossil fuels has created environmental stress resulting from the consequent imbalance and pollution. If man understands his responsibility towards protecting the environment from being polluted, most of the problems concerning living a quality life can be solved. However, it needs arousing and sustaining public awareness.

The industry (the hall-mark of modern life) should accept the responsibility to protect the environment, and workers working in various situations. What is needed is to adopt such manufacturing processes and materials which are less polluting. The liquid and solid industrial wastes generated are to be treated, prior to disposal, as per the standards laid down by the regulatory government bodies like the State Pollution Control Board and Central Pollution Control Board.

However, it is observed that the wastes without proper treatment are discharged into environment and the natural resources are used without any consideration to sustainable development. As a result, the level of pollution of air, water and land is increasing at an alarming rate. Also, it is unfortunate that the facilities for health and housing, opportunities for jobs and education are gradually decreasing which indirectly hamper any effective control of pollution.

1.6.1 Environmental Legislation

It is basically the social awareness amongst the people that guarantees the quality of their environment. However, enactment of laws, also has a relevant role to play in order to check errant groups of people.

The Constitution of India, however, itself provides for environmental protection. As per the Constitution Amendment Act (42nd), 1976, Article 48A was inserted in Part IV of the constitution which reads as under :

“48A : Protection and improvement of environment and safeguarding of forests and wild life – The state shall endeavour to protect and improve the environment and to safeguard the forests and the wild life of the country.”

It may be pointed out that many laws were enacted in India prior to independence. But, the following legislation (Acts) enforced in independent India are basic to protecting the environment :

- (1) The Prevention and Control of Pollution Act, 1974.
- (2) The Water (Prevention and Control of Pollution) Act, 1977.
- (3) The Forest (Conservation) Act, 1980.
- (4) The Air (Prevention and Control of Pollution) Act, 1981.
- (5) The Environment (Protection) Act, 1986.

As per these Acts the State Pollution Control Boards and Central Pollution Control Board have been established which monitor spreading and creation of pollution, and enforce the implementation of the provisions contained in these Acts to protect the environment. The defaulters are liable to be punished for violating the provisions of these Acts. The Forest Act refers to the preservation of forests and use of forest land for non-forest purposes.

1.7 POPULATION

Generation of pollution at a undesirable level is a phenomenon that is directly an outcome of industrialisation and enhanced human interference with nature.

Three main factors contributing to the environmental pollution are listed as under :

- (1) Population explosion,
- (2) Industrialization, and
- (3) Urbanization

The high rate of population growth which is termed as population explosion not only poses problems for the less developed countries (LDCs) but also for developed countries (DCs) as well.

Whatever benefits are made available due to any economic growth of the country, are all wiped out due to unbridled population growth i.e., these benefits, therefore, do not reach the people in adequate measure. The importance of population control has now been realized and the rate of population growth in the last 10 years has considerably decreased though much remains to be done yet. Table 1.1 gives the global population growth rate to emphasise the dimensions of the problem.

Table 1.1: Global Population Growth Rate

Sl. No.	Country	Annual	Population	Growth Rate
		1950-55	1960-65	1975-80
1.	World	1.77	1.99	1.81
2.	Developed Countries	1.28	1.19	0.67
3.	Less Developed Countries	2.00	2.35	2.21

The most important step for protecting environment and maintaining the quality of life is to arrest the population growth rate and reduce it to zero population growth status. If the population growth is not controlled in time, there will emerge a state of acute inadequacy of natural resources like water, fossil fuels and food.

Political will, and effective leadership qualities are basic to motivating the people for voluntary co-operation in the drive for population control.

SAQ 3

- (a) How pollution can be controlled? Discuss in detail.
- (b) What is the role of environmental Acts in pollution preservation?
- (c) "Population explosion is the main pollutant". Explain the statement.

1.8 SUMMARY

Environment is composed of four components, namely, atmosphere, hydrosphere, lithosphere, and biosphere. Environment supports all life. Any pollution reaching hazardous levels is harmful to life. Pollution can be caused by natural factors or man-made parameters.

Natural factors like floods, volcanic eruptions, urbanisation of countryside (to normal extent); and man-made factors, like population explosion, over industrialisation and over urbanisation, use of pesticides and fertilisers are the main culprits that harm our environment and impinge upon the quality of life. Pollutants may be classified into two groups – those characterised by the type of energy it possesses (heat, radiation, and sound); and material substances (organic or inorganic) in any state of matter.

Municipal and industrial wastes need to be treated appropriately before their disposal. Suspended solids, biodegradable matter, pathogens, nitrogen and phosphorous, etc. have to be dealt with to control the damage they may do to the environment; and, all objectionable chemicals in industrial effluents – solid, liquid, or gaseous – need special treatment either for their extraction or neutralisation. Bad effects of pollution on human, animal and vegetal health are too well known to need detailed reiteration. Poisonous gases emitted by vehicles, especially, in metropolitan cities pose a very serious challenge to the health of the people. These hazards assumes dangerous proportions in developing countries who have poor resources to tackle the problems of economic progress which they need to have at the earliest. Material things like, buildings (including monuments) and their foundations are also subjected to the bad effects of pollution.

Population explosion, and indiscriminate use of natural resources are also responsible for the menace of pollution. Public awareness, effective education and leadership are the fundamental bullworks against pollution. Legislation though necessary is not the basic and total answer to this problem.

1.9 ANSWERS TO SAQs

Refer to the appropriate Sections of this unit, and reference material.