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5. Environmental Pollution

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5.1 Introduction:

About 3.5 billion years ago life evolved on earth and it is the place in the universe where Human beings and other life forms evolved and started to survive depending on the environment of the earth. The word environment originated from the French word 'environment' meaning to encircle or to surround. Presently, pollution occurs in an unpreceded scale around the globe. Elements of the environment including water, land, and the ecosystem is hampered by man which results in pollution. Trends in two ominous directions, principally by burning fossil fuels, and the release of biocidal products and substances. Also, presently pollution is integrally webbed due to modern technology, population increase, lifestyle, and other factors taking a synoptic view, our atmosphere is polluted both globally and on a regional scale.

The ozone shield, the protective layer is thinning twice due to the build-up of greenhouse gases leading to global warming leading to a significant change in weathering patterns. Destruction of the ozone layer leads to catastrophic consequences including disturbance of the food chain, and rising sea levels that can lead to submersion of many islands. Due to the melting of glaciers, flooding is caused in many low-lying coastal areas leading to harvest loss. To address these pollution challenges and safeguard the ecosystem several technological translations must be implemented on a large scale. Cost-effective waste-intensive strategies must be implemented including shifting fossil fuels.

Managing pollution must be perceived with transboundary globally and progressing to stable world pollution. Also, the environmental problems can be ruled out by a multidisciplinary approach by scientific experts, and public awareness; sustainable solutions must be addressed by national and international organizations with reference to the threat of environmental pollution

Environmental pollution can be defined as “The phenomenon in which pollutants or contaminants are added to the natural environment that can cause undesirable change”. According to the United Nations pollution is defined as the “presence of substances and heat in environmental media (air, water, land) whose nature, location, or quantity produces undesirable environmental effects.”[1]

A Pollutant can be defined as “any substance when introduced to the natural environment can cause unwanted or adverse changes.” These pollutants or contaminants may belong to any phase (solid, liquid, or gas). They can either be of the anthropogenic origin or natural origin. Pollution can happen to any component of the environment like water, air, soil, etc.

The overuse of some energy sources like sound, radioactivity, light, and heat. Environmental pollution is one of the major causes of death worldwide causing one in six deaths worldwide and around 9 million death per year[2] Environmental pollution is usually classified as a point source and nonpoint source pollution.

5.1.1 Point Source Pollution:

Point source pollution is the type of pollution that has a single discrete source. The pollutants causing this type of pollution has a single source of emergence. The magnitude of point source pollution is usually less due to the single number of sources. For example, air pollution is caused by effluents from a single factory, sound pollution is caused by air jets.

5.1.2 Nonpoint Source Pollution:

Nonpoint source pollution is the type of pollution that has multiple sources. The contaminants emerge from different sources often combining so that it becomes difficult to identify these sources.

The magnitude of pollution is high since different types of pollutants come together from multiple different sources. Examples include water pollution due to agricultural runoff and pesticides and sound pollution in market areas. Environmental pollution can be mainly classified into the following types:

a. Air pollution
b. Water pollution
c. Soil pollution
d. Sound pollution
e. Light pollution
f. Thermal pollution
g. Radioactive pollution.

5.2 Air Pollution:

5.2.1 Definition:

According to the United Nations, organization air pollution can be defined as "the presence of contaminants or pollutant substances in the air that do not disperse properly and that interfere with human health or welfare or produce other harmful environmental effects[3][4]." The presence of unwanted substances in the air that can have undesirable effects on humans, animals, plants, and the planet as a whole is called air pollution.

5.2.2 Pollutants:

The pollutants that cause air pollution can be classified into gas particulate and biological molecules. The gases that cause air pollution include carbon dioxide, carbon monoxide, nitrous oxide, methane, sulphur oxide, chlorofluorocarbons (CFC)s, hydrofluorocarbons (HFC)s, ammonia ozone, etc.

Particulate matter (PM) includes smoke, soot, dirt, dust, and drops of liquids or solvents. Biological molecules include microbes like bacteria, viruses, house dust, animal dander, pollen, agricultural dust, etc.

5.2.3 Sources of Air Pollution:

The sources of air pollution include anthropogenic (human-made) and natural. The anthropogenic sources include the burning of fossil fuels like petrol and diesel. Burning of wood, agricultural waste, and dung.

Burning of plastics and other substances that contain hydrocarbons, emissions from factories and industries, emissions from automobiles, use of pesticides, insecticides in agriculture, fumes that arise from paint, aerosols, hair spray, and other solvents, use of fireworks, emissions from weapons testing, rocket launches, etc.

The natural sources include methane which is naturally produced by methanogenic bacteria, dust in the atmosphere, volcanic eruptions that release harmful and toxic gases, gases released during wildfires, etc.

5.2.4 Effects of Air Pollution:

Air pollution can cause difficulty in breathing, wheezing, coughing, asthma, chronic obstructive pulmonary disease(COPD), heart diseases, stroke, and lung cancer[5, 6] It can also worsen already existing heart and lung conditions like pneumonia.

It can also be associated with psychiatric disorders like depression, reduced intelligence quotient(IQ) and impaired cognition etc.[5].

Air pollution can also cause agricultural problems like decreased yield, toxicity to crop plants, etc. All of these effects lead to a huge amount of economic losses due to health expenses, agricultural losses, deaths, etc.

Air pollution causes around 7 million deaths worldwide annually and is considered a highly dangerous environmental risk [7]. Urban outdoor pollution causes around 1.3 million deaths annually worldwide [8] India and China are the countries with the highest death rate caused by air pollution [8] Air pollution is also estimated to cause about $5 trillion loss to the world economy per year.

5.2.5 Preventive Measures:

Using clean alternative energy instead of using fossil fuels can reduce air pollution. Increasing usage of wind energy, solar energy, hydropower, etc. can reduce air pollution significantly. The transition from petrol or diesel-powered vehicles to electric vehicles, and bicycles, and also promoting the use of public transport are some of the options.

Recycling and reusing plastics instead of burning them, Increasing Forest cover, planting more trees in urban areas, and treating effluents from factories and industries before releasing them into the atmosphere are some of the important preventive measures that can curb air pollution.

5.3 Water Pollution:

5.3.1 Definition:

Water pollution is the contamination of the water bodies like the ocean, seas, rivers, lakes, streams, etc. Anthropogenic activities pose a negative impact on the aquatic ecosystem and pollute unfit for any human use.

When contaminants are introduced into water bodies it makes water less useful and reduces it's ecosystem services it generally provides[9]. Water pollution can be classified as surface water pollution and groundwater pollution. Surface water pollution occurs when surface water bodies like rivers, lakes, streams, etc. get polluted while groundwater pollution occurs when groundwater sources like aquifers get polluted due to seepage of contaminants.

5.3.2 Pollutants:

Domestically used water and household water that is released into drainage systems often contain chemicals like detergents, vegetable waste, excretory waste, cosmetics, plastics, and other solid materials when this water is released to natural water bodies without treatment it causes pollution. Industrial effluents are usually released directly into nearby water bodies, they contain toxic compounds like heavy metals, no biodegradable hydrocarbons, inorganic compounds, etc. Pesticides and fertilizers used for agriculture make their way into the water bodies as agricultural runoff these contain nutrients like nitrogen, phosphorus, potassium, calcium, etc.

This promotes excessive growth of unwanted, toxin-producing, invasive algal species which are called algal blooms which utilize all the dissolved oxygen for their growth leading to the death of other aquatic species due to insufficient oxygen in the process known as eutrophication.

Groundwater is usually polluted due to seepage of agricultural waste like pesticides and insecticides into groundwater, effluents from wastewater treatment, leachates from landfills, and percolation of water through polluted soil. Marine water pollution occurs often due to the release of industrial effluents, oil spillages from cargo ships, deep-sea mining, polluted water from rivers, and entry of no biodegradable substances like plastics into oceans and seas. Polluted water also contains pathogens like bacteria, viruses, and parasites that spread rapidly causing large-scale deaths. These diseases are called water-borne diseases.

5.3.3 Sources:

Sewage is one of the main sources of water pollution. It usually contains 99.9% of water and around 0.1% of solids [11].

Sewage usually contains chemicals like cosmetics, surfactants, and sanitary products, hydrocarbons that includes fats and oils, pharmaceutical drugs, and other metabolites. Industrial wastewater is another major source that usually contains heavy metals like mercury, lead, arsenic, chromium, etc. Organic and inorganic waste, toxins, plastics, and solvents. Oil spillage from ships, boats, drilling rigs, wells, etc., and deep-sea mining is the major source of marine water pollution.

Agricultural runoff is another source that can cause both surface and groundwater pollution. Acid rain is another contributor which results in high acidity in water bodies. Mining activities can also result in the entry of inorganic elements into the water bodies. The disposal of radioactive waste produced from nuclear energy plants can also cause water contamination.

5.3.4 Effects of Water Pollution:

The main negative impact of water pollution is the disruption of the aquatic ecosystem. It has resulted in the death of millions of species of aquatic organisms and plants affecting their food chain and food web. Human consumption of polluted water results in the rapid spread of infectious diseases like typhoid, cholera, hepatitis, diarrhoea, and other parasitic infections, these diseases are therefore classified as waterborne diseases.

Inorganic contaminants in the water often cause several human disorders like colon cancer, digestive problems, urinary problems, skin disorder, etc. As mentioned previously eutrophication is another phenomenon that causes anoxia (decrease in oxygen levels) and affects aquatic life in rivers, ponds, lakes, etc.

According to WHO around 2 billion people around the world consume water contaminated by faces [10]. Water pollution caused around 1.8 million deaths worldwide according to a lancet study in 2015[11]About 14 billion pounds of plastics are dumped into the water every year[12]Anthropogenic activities is also responsible for releasing 1.2 trillion gallons of no treated wastewater to various water bodies[13]. According to estimates, 47% of the world population may face a shortage of water pollution by the years 2050 if the same trend continues

5.3.5 Prevention:

Treating sewage water before releasing it into water bodies can reduce water pollution significantly. Establishing wastewater treatment plants with proper infrastructure can play an important role in this process.

Reduction in the use of chemical pesticides and fertilizers and replacing them with bio pesticides and organic manure. Industries and factories should treat effluents before releasing them into water bodies or can even reuse that water.

Proper disposal of waste and preventing entry of solid waste into water bodies. Reducing the use of detergents and other cleaning agents, and proper disposal of pharmaceutical drugs. Reducing recycling and reusing plastics are some options to prevent water pollution.

5.4 Soil Pollution:

5.4.1 Definition:

Soil pollution also called soil contamination or land contamination is a type of land degradation caused by the presence of undesirable chemical agents that cause an unwanted change in the natural soil environment.

The entry of human-made synthetic substances called xenobiotics usually affects the existing soil condition including changes in the soil composition, chemistry, and microbial population which can cause a decrease in soil fertility. Along with the decrease in soil fertility polluted soil may also become dangerous for plants growing in it and other organisms that depend on plants.

5.4.2 Pollutants:

Non-biodegradable plastics like polythene and polystyrene are one of the main soil polluting agents. Other chemicals involve include petroleum hydrocarbons, pesticides, heavy metals, chemical solvents, etc. pesticides and herbicides that are used in agriculture contain complex chemicals which can not only pollute soil but can also kill several beneficial microbes in the soil, they can also cause toxicity to humans and other organisms[14]. Insecticides like organochlorines, DDT, Dieldrin, Aldrin, organophosphates, etc. persist for a very long time in the soil causing toxicity in both plants and animals. Mining activities can also release heavy metals into soil layers due to metal leaching.

Fertilizers used in agriculture can also cause an increase in inorganic nutrients in soil like nitrogen, potassium, calcium, phosphorus, etc. which can cause toxicity in plants and eutrophication in lakes when agricultural runoff reaches lakes. The burning of coal releases coal ash into the soil which contains hazardous levels of lead and other hydrocarbons. Oil spills also pollute soil to significant levels.

5.4.3 Sources:

The major sources of soil pollutants come from agriculture procedures which make use of chemical fertilizers, pesticides, insecticides, etc. other important sources include mining, disposal of solid waste in the open grounds and landfills especially hazardous wastes and plastics. Oil spills because long-term land degradation other and the disposal of electronic waste, radioactive waste, and medical waste from hospitals are other minor sources.

The burning of fossil fuels can also cause the deposition of toxic compounds on the soil layer. Acid rain is another source that leads increases acidity in the soil. Various construction activities can also release dust which may deposit on soil causing pollution.

5.4.4 Effects of Soil Pollution:

Health consequences due to soil pollution depend on the type of pollutants. According to existing lines of evidence the pesticides and heavy metals that contaminate soil may have a negative impact on cardiovascular health, causing inflammation and alterations in the body's internal clock called the circadian rhythm. [14]

Long-term exposure to heavy metals like lead, chromium, petroleum hydrocarbons, pesticides, and herbicides may cause chronic health conditions, digestive problems, and congenital disorders. Insecticides like organophosphates and carbonates can cause neuromuscular disorders.

The contaminants like DDT usually undergo bio magnification and bioaccumulation in food chains causing various disorders in humans and higher trophic levels like peregrine falcon birds where they can interfere with calcium metabolism leading to the formation of fragile eggs which easily break causing the reduction in bird population[14] The pollutants in soil reduce soil fertility affecting plant growth and thereby affecting food chains in an ecosystem.

According to the UNO report at present, the degradation of land and soil is affecting at least 3.2 billion people which is 40% of the world population. [15, 16] According to the FAO report of 2018 Australia had more than 80k sites suffering from soil pollution.

In China, 16% of all soil including 19% of agricultural soil is polluted. There were more than 1300 polluted sites in Europe alone. [1] In India, there were more than 43 critically polluted zones in more than 16 states. Out of 43 sites, 21 sites alone exist in 4 states namely Gujarat, Uttar Pradesh, Maharashtra, and Tamil Nadu[17].

5.4.5 Prevention:

Limiting the use of plastics and recycling, and reusing it can reduce plastic soil pollution. Reducing the use of pesticides, herbicides, and insecticides and using biological pesticides instead can reduce the majority of soil pollution.

Other measures include reducing oil spills, taking care during mining to prevent the leaching of metals into soil layers, and reducing the use of fossil fuels. In the soil already affected by pollutants, bioremediation techniques like phytoremediation, mycoremediation and genetically engineered microbes like *Pseudomonas putida* can be used to remove pollutants and clean up the soil.

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