

Module 10 : Classification Of Water Pollutants And Effects On Environment

Lecture 12 : Classification Of Water Pollutants And Effects On Environment

The various types of water pollutants can be classified in to following major categories:

(1) Organic pollutants, (2) Pathogens, (3) Nutrients and agriculture runoff, (4) Suspended solids and sediments (organic and inorganic), (5) Inorganic pollutants (salts and metals), (6) Thermal Pollution, and (7) Radioactive pollutants.

10.1 ORGANIC POLLUTANTS

Organic pollutants can be further divided into following categories:

a) Oxygen Demanding wastes: The wastewaters such as, domestic and municipal sewage, wastewater from food processing industries, canning industries, slaughter houses, paper and pulp mills, tanneries, breweries, distilleries, etc. have considerable concentration of biodegradable organic compounds either in suspended, colloidal or dissolved form. These wastes undergo degradation and decomposition by bacterial activity.

The dissolved oxygen available in the water body will be consumed for aerobic oxidation of organic matter present in the wastewater. Hence, depletion of the DO will be a serious problem adversely affecting aquatic life, if the DO falls below 4.0 mg/L. This decrease of DO is an index of pollution.

b) Synthetic Organic Compounds

Synthetic organic compounds are also likely to enter the ecosystem through various manmade activities such as production of these compounds, spillage during transportation, and their uses in different applications. These include synthetic pesticides, synthetic detergents, food additives, pharmaceuticals, insecticides, paints, synthetic fibers, plastics, solvents and volatile organic compounds (VOCs). Most of these compounds are toxic and biorefractory organics i.e., they are resistant to microbial degradation.

Even concentration of some of these in traces may make water unfit for different uses. The detergents can form foams and volatile substances may cause explosion in sewers. Polychlorinated biphenyls (PCBs) are used in the industries since 1930s which are complex mixtures of chlorobiphenyls. Being a fat soluble they move readily through the environment and within the tissues or cells. Once introduced into environment, these compounds are exceedingly persistent and their stability to chemical reagents is also high.

c) Oil

Oil is a natural product which results from the plant remains fossilized over millions of years, under marine conditions. It is a complex mixture of hydrocarbons and degradable under bacterial action, the biodegradation rate is different for different oils, tars being one of the slowest. Oil enters in to water through oil spills, leak from oil pipes, and wastewater from production and refineries.

Being lighter than water it spreads over the surface of water, separating the contact of water with air, hence resulting in reduction of DO. This pollutant is also responsible for endangering water birds and coastal plants due to coating of oils and adversely affecting the normal activities. It also results in reduction of light transmission through surface waters, thereby reducing the photosynthetic activity of the aquatic plants. Oil includes polycyclic aromatic hydrocarbons (PAH), some of which are known to be carcinogenic.

10.2 PATHOGENS

The pathogenic microorganisms enter in to water body through sewage discharge as a major source or through the wastewater from industries like slaughterhouses. Viruses and bacteria can cause water borne diseases, such as cholera, typhoid, dysentery, polio and infectious hepatitis in human.

10.3 NUTRIENTS

The agriculture run-off, wastewater from fertilizer industry and sewage contains substantial concentration of nutrients like nitrogen and phosphorous. These waters supply nutrients to the plants and may stimulate the growth of algae and other aquatic weeds in receiving waters.

Thus, the value of the water body is degraded. In long run, water body reduces DO, leads to eutrophication and ends up as a dead pool of water. People swimming in eutrophic waters containing blue-green algae can have skin and eye irritation, gastroenteritis and vomiting. High nitrogen levels in the water supply, causes a potential risk, especially to infants under six months. This is when the methemoglobin results in a decrease in the oxygen carrying capacity of the blood (blue baby disease) as nitrate ions in the blood readily oxidize ferrous ions in the hemoglobin.

In freshwater systems, eutrophication is a process whereby water bodies receive excess inorganic nutrients, especially N and P, which stimulate excessive growth of plants and algae.

Eutrophication can happen naturally in the normal succession of some freshwater ecosystems. However, when the nutrient enrichment is due to the activities of humans, sometimes referred to as “cultural eutrophication”, the rate of this natural process is greatly intensified. Two major nutrients, nitrogen (N) and phosphorus (P), occur in streams in various forms as ions or dissolved in solution. Aquatic plants convert dissolved inorganic forms of nitrogen (nitrate, nitrite, and ammonium) and phosphorus (orthophosphate) into organic or particulate forms for use in higher trophic production. The main effects caused by eutrophication can be summarized as follows:

1. Species diversity decreases and the dominant biota changes
2. Plant and animal biomass increase
3. Turbidity increases
4. Rate of sedimentation increases, shortening the lifespan of the lake, and
5. Anoxic conditions may develop.

10.4 SUSPENDED SOLIDS AND SEDIMENTS

These comprise of silt, sand and minerals eroded from land. These appear in the water through the surface runoff during rainy season and through municipal sewers. This can lead to the siltation, reduces storage capacities of reservoirs. Presence of suspended solids can block the sunlight penetration in the water, which is required for the photosynthesis by bottom vegetation. Deposition of the solids in the quiescent stretches of the stream or ocean bottom can impair the normal aquatic life and affect the diversity of the aquatic ecosystem. If the deposited solids are organic in nature, they will undergo decomposition leading to development of anaerobic conditions. Finer suspended solids such as silt and coal dust may injure the gills of fishes and cause asphyxiation.

10.5 INORGANIC POLLUTANTS

Apart from the organic matter discharged in the water body through sewage and industrial wastes, high concentration of heavy metals and other inorganic pollutants contaminate the water. These compounds are non-biodegradable and persist in the environment. These pollutants include mineral acids, inorganic salts, trace elements, metals, metals compounds, complexes of metals with organic compounds, cyanides, sulphates, etc.

- The accumulation of heavy metals may have adverse effect on aquatic flora and fauna and may constitute a public health problem where contaminated organisms are used for food.

- Algal growth due to nitrogen and phosphorous compounds can be observed.
- Metals in high concentration can be toxic to biota e.g. Hg, Cu, Cd, Pb, As, and Se. Copper greater than 0.1 mg/L is toxic to microbes.

10.6 THERMAL POLLUTION

Considerable thermal pollution results due to discharge of hot water from thermal power plants, nuclear power plants, and industries where water is used as coolant. As a result of hot water discharge, the temperature of water body increases. Rise in temperature reduces the DO content of the water, affecting adversely the aquatic life. This alters the spectrum of organisms, which can adopt to live at that temperature and DO level. When organic matter is also present, the bacterial action increases due to rise in temperature; hence, resulting in rapid decrease of DO. The discharge of hot water leads to the thermal stratification in the water body, where hot water will remain on the top.

10.7 RADIOACTIVE POLLUTANTS

Radioactive materials originate from the following:

- Mining and processing of ores,
- Use in research, agriculture, medical and industrial activities, such as I^{131} , P^{32} , Co^{60} , Ca^{45} , S^{35} , C^{14} , etc.
- Radioactive discharge from nuclear power plants and nuclear reactors, e.g., Sr^{90} , Cesium Cs^{137} , Plutonium Pu^{248} , Uranium-238, Uranium-235,
- Uses and testing of nuclear weapons.

These isotopes are toxic to the life forms; they accumulate in the bones, teeth and can cause serious disorders. The safe concentration for lifetime consumption is 1×10^{-7} microcuries per ml.

The summary of various pollutants and their adverse effect on the environment is presented in Table 10.1. The major impacts have been described, however there are additional adverse effects of release of these pollutants in the environment.

Table 10.1 Various pollutants and their adverse effect

Sr. No.	Pollutants	Impact
1.	Organic pollutants i) <i>Oxygen Demanding wastes:</i> ii) <i>Synthetic organic pollutants</i> iii) <i>oil</i>	Depletion of the DO will be a serious problem adversely affecting aquatic life, if the DO falls below 4.0 mg/L. Most of these compounds are toxic and biorefractory organics. It also make water unfit for different uses. This pollutant is also responsible for endangering water birds and coastal plants due to coating of oils and adversely affecting the normal activities which cause reduction of light transmission and photosynthesis.
2.	Pathogens	Number of diseases transmitted by pathogens available in wastewater
3.	Nutrients	When these are disposed in aquatic environment, it can lead to growth of undesirable aquatic life. When it discharged on land it causes groundwater pollution.
4.	Thermal pollutants	When organic matter is also present, the bacterial action increases due to rise in temperature; hence, resulting in rapid decrease of DO. It also results in thermal stratification which alters spectrum of organisms.
5.	Radioactive pollutants	These isotopes are toxic to the life forms; they accumulate in the bones, teeth and can cause serious disorders
6.	Suspended solids and sediments	Presence of suspended solids can block the sunlight penetration in the water, which is required for the photosynthesis by bottom vegetation. Finer suspended solids such as silt and coal dust may injure the gills of fishes and cause asphyxiation.
7.	Inorganic pollutants	These pollutants include mineral acids, inorganic salts, trace elements, metals, metals compounds, complexes of metals with organic compounds, cyanides, sulphates, etc. They have adverse effect on aquatic flora and fauna and may constitute a public health problem.

Questions

1. Explain different types of water pollutants.
2. What are the adverse effects on the receiving water body when these pollutants are discharged in water along with effluents?
3. Describe thermal pollution. How it is caused?