

Water Pollution

Definition

Water pollution is the addition/presence of undesirable substances (organic, inorganic, biological, radiological, or heat) in water, degrading its quality and making it unfit for use.

Sources of Water Pollution

1. Natural Sources

- Soil erosion
- Leaching of minerals from rocks
- Decay of organic matter
- Acid rain increasing solubility of toxic elements

2. Point and Non-Point Sources

- **Point Source:** Pollutants discharged from a specific location (e.g., drain pipes carrying industrial effluents).
- **Non-Point Source:** Diffuse sources like agricultural runoff, grazing lands, construction sites, abandoned mines.

Major Causes of Water Pollution

Sewage Water

- Domestic & hospital waste contain pathogens.
- Contains excreta, detergents, food waste, and cleaning agents.
- Causes diseases: Cholera, Typhoid, Dysentery.

Dissolved Oxygen (DO)

- Essential for aquatic life.
- $DO < 8 \text{ mg/L} \rightarrow$ contaminated
- $DO < 4 \text{ mg/L} \rightarrow$ highly polluted
- Decreases due to decomposition of organic waste.

Factors affecting DO:

- Surface turbulence
- Photosynthesis
- Decomposition
- Respiration by organisms

Biological Oxygen Demand (BOD)

- Measures the oxygen required by bacteria to decompose organic waste.
- Expressed in mg/L.
- High BOD → Low DO → High pollution.
- Limited to biodegradable matter only.

Chemical Oxygen Demand (COD)

- Measures the oxygen required to oxidise both biodegradable and non-biodegradable substances.
- Better indicator than BOD for total pollution load.

Industrial Wastes

- Petroleum, paper, chemical, and metal industries discharge heavy metals.
- Heavy metals: Mercury, Cadmium, Lead, Arsenic, Copper (>5 g/cm³ density).
- Toxic and carcinogenic.

Agricultural Pollution

- Fertilizers (N, P, K) → Eutrophication
- Pesticides (DDT, Endosulfan, Organophosphates)
- Runoff from poultry farms and slaughterhouses
- Many pesticides are non-biodegradable → Biomagnification

Thermal Pollution

- Discharge of hot water from power plants.
- Raises the temperature by 10–15°C.
- Reduces DO levels.
- Sudden temperature rise kills aquatic organisms.

Radiation Pollution

Example: Fukushima Daiichi nuclear disaster

- Causes a DNA mutation.
- Radioactive iodine → Thyroid cancer.

Marine Pollution

Oceans act as ultimate sinks for pollutants.

Causes

- Oil spills
- Sewage dumping

- Offshore drilling
- Navigational discharge

Oil Spills



Effects

- Oil forms a thin layer blocking oxygen exchange.
- Fish & plankton die due to suffocation.
- Birds & mammals die due to poisoning.

Invasive Species

Water Hyacinth – “Terror of Bengal”



- Grows in eutrophic waters.
- Causes stagnation & ecological imbalance.

Groundwater Pollution

Common Pollutants

- Nitrates
- Fluoride
- Arsenic
- Uranium
- Heavy metals

Nitrates

- Cause Methemoglobinemia (Blue Baby Syndrome).
- React with haemoglobin forming non-functional methaemoglobin.
- Accelerates eutrophication.

Arsenic

- Major issue in the Ganga Delta (India & Bangladesh).
- Causes Black Foot Disease.
- Leads to lung & skin cancer.

Fluoride

- Causes Fluorosis.
- Skeletal deformities, knock-knee syndrome.

Effects of Water Pollution

On Human Health

- Mercury → Minamata disease
- Lead → Anaemia, neurological damage
- Cadmium → Itai-itai disease
- Arsenic → Skin cancer

On Environment

- Oxygen depletion kills fish.
- Biomagnification (DDT, Mercury).
- Eggshell thinning in birds due to DDT.

Eutrophication

Types

- Natural eutrophication
- Cultural eutrophication (human-induced)

Lake Classification

- Oligotrophic – Low nutrients
- Mesotrophic – Moderate
- Eutrophic – High nutrients

Mechanism of Algal Bloom



- Excess nitrates & phosphates → Rapid algal growth.
- Night respiration depletes oxygen.
- Fish die due to hypoxia.
- Anaerobic bacteria (e.g., Clostridium) release toxins.

Dead Zones

- Hypoxic marine regions.
- Caused by nutrient runoff.
- Example: Gulf of Mexico.

Mitigation Measures

- Wastewater treatment plants
- Riparian buffers (Wetlands, estuaries)
- Organic farming
- Nitrogen testing
- Reduce vehicular nitrogen emissions
- Cooling ponds for thermal discharge

International Conventions

London Convention (1972)

- Control the dumping of wastes at sea.
- The 1993 amendment banned radioactive waste dumping.

1996 Protocol

- Replaced the 1972 Convention.
- “Polluter Pays Principle”
- Prohibits incineration at sea.

United Nations Convention on the Law of the Sea (UNCLOS)

- Protects the marine environment.
- Establishes the International Seabed Authority.
- Holds states liable for marine pollution.