

STUDY MATERIAL

WATER POLLUTION: CAUSES, EFFECTS AND CONTROL MEASURES

Introduction:

Water is essential for life. Without water there would be no life. 71% of the earth's surface is covered by water only a tiny fraction of this water is available to us as fresh water. About 97% of the total water available on earth is found in oceans and is too salty for drinking or irrigation. The remaining 3% is fresh water. Of this 2.997% is locked in ice caps or glaciers. Thus only 0.003% of the earth's total volume of water is easily available to us as soil moisture, groundwater, water vapour and water in lakes, streams, rivers and wetlands.

Water that is found in streams, rivers, lakes, wetlands and artificial reservoirs is called surface water. Water that percolates into the ground and fills the pores in soil and rock is called groundwater. Porous water-saturated layers of sand, gravel or bedrock through which ground water flows are called aquifers. Most aquifers are replenished naturally by rainfall that percolates downward through the soil and rock. This process is called natural recharge. If the withdrawal rate of an aquifer exceeds its natural recharge rate, the water table is lowered. Any pollutant that is discharged onto the land above is also pulled into the aquifer and pollutes the groundwater resulting in polluted water in the nearby wells. **When the quality or composition of water changes directly or indirectly as a result of man's activities such that it becomes unfit for any purpose it is said to be polluted.** Any physical, biological or chemical change in water quality that adversely affects living organisms or makes water unsuitable for certain use is referred as water pollution

We usually take water as granted for its purity, but we must ensure the quality of water. Pollution of water originates from human activities. Through different paths, pollution reaches surface or ground water. **Easily identified source or place of pollution is called as point source.** e.g., municipal and industrial discharge pipes where pollutants enter the water-source. **Non point sources of pollution** are those where a source of pollution cannot be easily identified, e.g., agricultural run off (from farm, animals and crop-lands), acid rain, storm-water drainage (from streets, parking lots and lawns), etc.

Causes of water pollution

There are several classes of common water pollutants. These are **disease-causing agents** (pathogens) which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes causing different types of water born disease. Human excreta contain bacteria such as *Escherichia coli* and *Streptococcus faecalis* which cause gastrointestinal diseases

Another category of water pollutants is **oxygen depleting wastes**. The amount of oxygen that water can hold in the solution is limited. In cold water, dissolved oxygen (DO) can reach a concentration up to 10 ppm (parts per million), whereas oxygen in air is about 200,000 ppm. That is why even a moderate amount of organic matter when decomposes in water can deplete the water of its dissolved oxygen. The concentration of dissolved oxygen in water is very important for aquatic life . If the concentration of dissolved oxygen of water is below 6 ppm, the growth of fish gets inhibited. Oxygen reaches water either through atmosphere or from the process of photosynthesis carried out by many aquatic green plants during day light. If too much of organic matter is added to water, all the available oxygen is used up. The organic wastes that can be decomposed by aerobic (oxygen requiring) bacteria. Large populations of bacteria use up the oxygen present in water to degrade these wastes. In the process this degrades water quality. **The amount of oxygen required to break down a certain amount of organic matter is called the biological oxygen demand (BOD)**. The amount of BOD in the water is an indicator of the level of pollution. If too much organic matter is added to the water all the available oxygen is used up. This causes fish and other forms of oxygen dependent aquatic life to die. Thus anaerobic bacteria (those that do not require oxygen) begin to break down the wastes. Their anaerobic respiration produces chemicals that have a foul odour and an unpleasant taste that is harmful to human health.

A third class of pollutants are **inorganic plant nutrients**. These are **water soluble nitrates and phosphates** that cause excessive growth of algae and other aquatic plants. **The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication**. They may interfere with the use of the water by clogging water intake pipes, changing the taste and odour of water and cause a buildup of organic matter. As the organic matter decays, oxygen levels decrease and fish and other aquatic species die.

The quantity of fertilizers applied in a field is often many times more than is actually required by the plants. **The chemicals in fertilizers and pesticides pollute soil and water. While excess fertilizers cause eutrophication, pesticides cause bioaccumulation and biomagnification**. Pesticides which enter water bodies are introduced into the aquatic food chain. They are then absorbed by the phytoplanktons and aquatic plants. These plants are eaten by the herbivorous fish which are in turn eaten by the carnivorous fish which are in turn eaten by the water birds. At each link in the food chain these chemicals which do not pass out of the body are accumulated and increasingly concentrated resulting in biomagnification of these harmful substances. One of the effects of accumulation of high levels of pesticides such as DDT is that birds lay eggs with shells that are much thinner than normal. This results in the premature breaking of these eggs, killing the chicks inside. Birds of prey such as hawks, eagles and other fish eating birds are affected by such pollution. Although DDT has been banned in India for agricultural use and is to be used only for malaria eradication, it is still used in the fields as it is cheap.

A fourth class of water pollutants is **water soluble inorganic chemicals** which are acids, salts and compounds of toxic metals such as mercury and lead. High levels of these chemicals can make the water unfit to drink, harm fish and other aquatic life, reduce crop yields and accelerate corrosion of equipment that use this water.

Another cause of water pollution is a variety of **organic chemicals**, which include oil, gasoline, plastics, pesticides, cleaning solvents, detergent and many other chemicals. These are harmful to aquatic life and human health. They get into the water directly from industrial activity either from improper handling of the chemicals in industries and more often from improper and illegal disposal of chemical wastes. **Sediment of suspended matter** is another class of water pollutants. These are insoluble particles of soil and other solids that become suspended in water.

Water soluble radioactive isotopes are yet another source of water pollution. These can be concentrated in various tissues and organs as they pass through food chains and food webs. Ionizing radiation emitted by such isotopes can cause birth defects, cancer and genetic damage.

Hot water let out by power plants and industries that use large volumes of water to cool the plant result in rise in temperature of the local water bodies. This heated water, which is at least 15oC higher than the normal is discharged back into the water body. The warm water not only decreases the solubility of oxygen but changes the breeding cycles of various aquatic organisms.

Oil is washed into surface water in runoff from roads and parking lots which also pollutes groundwater. Leakage from underground tanks is another source of pollution. Accidental oil spills from large transport tankers at sea have been causing significant environmental damage.

Lists the major water pollutants and their sources

| Pollutant | Source |
|------------------------|---|
| Micro-organisms | Domestic sewage |
| Organic wastes | Domestic sewage, animal excreta and waste, decaying animals and plants, discharge from food processing factories. |
| Plant nutrients | Chemical fertilizers |
| Toxic heavy metals | Industries and chemical factories |
| Sediments | Erosion of soil by agriculture and strip mining |
| Pesticides | Chemicals used for killing insects, fungi and weeds |
| Radioactive substances | Mining of uranium containing minerals |
| Heat | Water used for cooling in industries |

Groundwater pollution: Ground water is polluted due to

- Urban run-off of untreated or poorly treated waste water and garbage
- Industrial waste storage located above or near aquifers
- Agricultural practices such as the application of large amounts of fertilizers and pesticides, animal feeding operations, etc. in the rural sector

- Leakage from underground storage tanks containing gasoline and other hazardous substances
- Leachate from landfills
- Poorly designed and inadequately maintained septic tanks
- Mining wastes
- Arsenic poisoning and other heavy metals contamination

International Standards for Drinking Water

Fluoride: For drinking purposes, water should be tested for fluoride ion concentration. Its deficiency in drinking water is harmful to man and causes diseases such as tooth decay etc. Soluble fluoride is often added to drinking water to bring its concentration upto 1 ppm or 1 mg dm⁻³. However, F⁻ ion concentration above 2 ppm causes brown mottling of teeth. At the same time, excess fluoride (over 10 ppm) causes harmful effect to bones and teeth.

Lead: Drinking water gets contaminated with lead when lead pipes are used for transportation of water. The prescribed upper limit concentration of lead in drinking water is about 50 ppb. Lead can damage kidney, liver, reproductive system etc.

Sulphate: Excessive sulphate (>500 ppm) in drinking water causes laxative effect, otherwise at moderate levels it is harmless.

Nitrate: The maximum limit of nitrate in drinking water is 50 ppm. Excess nitrate in drinking water can cause disease such as methemoglobinemia ('blue baby' syndrome).

Other metals: The maximum concentration of some common metals recommended in drinking water are

| Metal | Maximum concentration (ppm or mg dm ⁻³) |
|-------|---|
| Fe | 0.2 |
| Mn | 0.05 |
| Al | 0.2 |
| Cu | 3.0 |
| Zn | 5.0 |
| Cd | 0.005 |

Control measures for preventing water pollution:

1. Setting up effluent treatment plans to treat waste.
2. Recycling of water must be encouraged.
3. Industrial wastes must be treated before discharge.
4. Educate Public for preventing water pollution and the consequences of water pollution
5. Strict enforcement of water pollution control act.
6. Continuous monitoring of water pollution at different places.
7. Developing economical method of water treatment

CASE STUDY

One of the worst oil spill disasters that have occurred is that of the Exxon Valdez. On 24th march 1989 the Exxon Valdez, a tanker more than three football fields wide went off course in a 16 kilometer wide channel in Prince William Sound near Valdez in Alaska. It hit submerged rocks, creating an environmental disaster. The rapidly spreading oil slick coated more than 1600 kilometers of shoreline killing between 300,000 and 645,000 water birds and a large number of sea otters, harbor seals, whales and fishes. Exxon spent \$ 2.2. billion directly on the clean-up operations. However some results of the cleanup effort showed that where high pressure jets of hot water were used to clean beaches coastal plants and animals that had survived the spill were killed. Thus it did more harm than good. Exxon pleaded guilty in 1991 and agreed to pay the Federal Government and the state of Alaska \$ 1 billion in fines and civil damages. This \$8.5 billion accident might have been prevented if Exxon had spent only \$22.5 million to fit the tanker with a double hull-one inside the other. Such double hulled vessels would be less likely to rupture and spill their contents. The spill highlighted the need for marine pollution prevention.
