



WATER POLLUTION

Water is essential for the existence of all life forms. In addition to household uses, water is vital for agriculture, industry, fishery and tourism etc. Increasing population, urbanisation and industrialisation has led to the decreased availability of water. The quality of water used is also being deteriorated as it is getting more and more polluted. You may be aware of at least some health hazards and harmful effects of water pollution. In this lesson a detailed account of various types, sources and effects of water pollutants is given. Some methods of water pollution control and legislatures involved have also been discussed.

Objectives

After reading this lesson, you will be able to:

- list earth's water resources;
- define water pollution and its different parameters;
- list the major types of water pollutants, their sources and effects;
- distinguish between natural and man-made pollutants;
- use the concept of biological oxygen demand (BOD) and account for the changes in a water body;
- state methods for the prevention of water pollution;
- compare primary, secondary and tertiary treatment of sewage and
- know necessary legislative measures for prevention of water pollution in the country.

34.1 Water Resources on Earth

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You may be aware that about three fourths of our planet earth's surface is covered by water. However, very little of it is available for consumption. Most (about 97%) of the water on earth is present in the seas and oceans. It is too salty to be of any use for



drinking, agriculture and industrial purposes. The remaining 3% is fresh water; 75% of which is locked up in the polar ice caps and in glaciers and quite deep under the earth's surface as underground water. The fresh water, which we can use, comes to us from two sources:

- i) Surface water
- ii) Ground water

Let us learn about these in detail.

(i) Surface Water: Rain and snow are good natural resources of fresh water. It is estimated that of all the precipitation (rain water and snow) that falls on the earth, about one-third is absorbed by the plants and another one-third seeps down into the soil and the remaining one third runs off the surface into streams and rivers. This part of precipitation, which runs off to form streams چھمکان, rivers and lakes, is called the **surface water**.

Precipitation (rain or snow) that runs-off into stream, rivers and lakes is called surface water.

The small fraction of usable surface water is continuously replenished by means of the hydrological cycle, Fig 33.1.

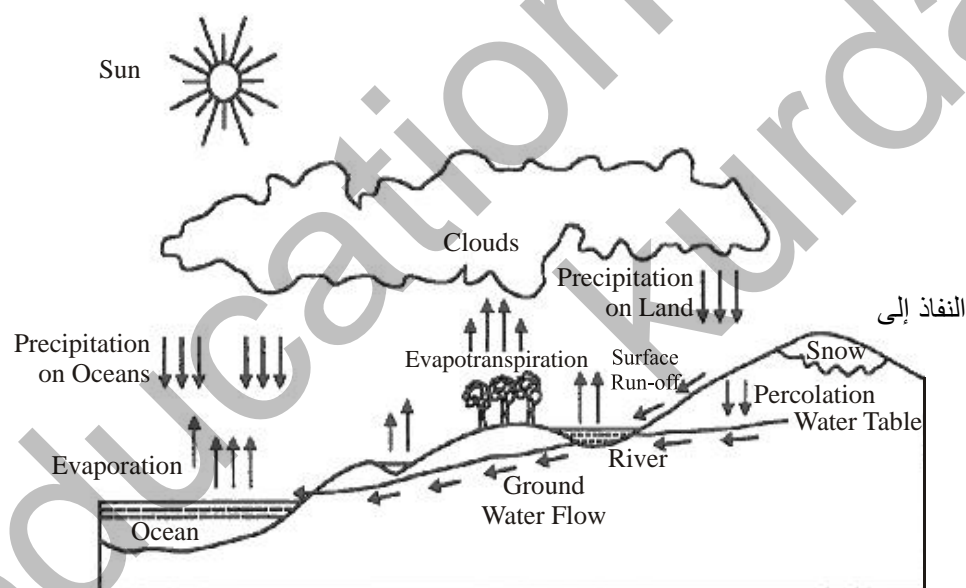


Fig. 34.1: A schematical representation of Hydrological cycle

The hydrological cycle involves evaporation of water from oceans, rivers and other sources to form clouds. The clouds on saturation with water vapours cause precipitation falling back on earth's surface. On surface, the water runs off to rivers and finally to oceans. The water again evaporates and the cycle continues.

Surface water has a natural tendency to clean itself as it contains certain organisms that break down pollutants into harmless substances.

(ii) Ground Water: The part of precipitation that seeps into the ground as a result of gravity and fills the pores between soil particles and rocks under it is called **ground**



Chemistry

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water. The water bearing layers of soil and rocks are called **aquifers**. Ground water is very important for agricultural and industrial purposes. Ground water in the form of wells and springs is often the only source of water supply especially in villages and small towns.

In spite of a good number of water resources, we have shortage of usable water. This is due to increasing population, urbanisation شارنشینی and industrialisation. There is a need to optimise use of water and also conserve surface run off of water by means of rainwater harvesting حصاد، groundwater conservation حفظ، making use of recycling methods etc.

Water Pollution – Parameters

A large amount of water is discharged back after domestic and industrial usage. This is contaminated with domestic waste and industrial effluents. When this contamination reaches beyond certain allowed concentrations, it is called **pollution** and the contaminants are called the **pollutants**. **Water pollution** may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings. If the concentration of substances naturally present in water increases then also the water is said to be polluted.

Water pollution may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings. Industrialisation and population explosion are two important factors for water pollution.

Water may be called polluted when the following parameters stated below reach beyond a specified concentration in water.

i) **Physical parameters.** Colour, odour, turbidity, taste, temperature and electrical conductivity constitute the physical parameters and are good indicators of contamination.

For instance, colour and turbidity are visible evidences of polluted water while an offensive odour or a bitter and difference than normal taste also makes water unfit for drinking.

ii) **Chemical parameters:** These include the amount of carbonates, sulphates, chlorides, fluorides, nitrates, and metal ions. These chemicals form the total dissolved solids, present in water.

iii) **Biological parameters:** The biological parameters include matter like algae, fungi, viruses, protozoa and bacteria. The life forms present in water are affected to a good extent by the presence of pollutants. The pollutants in water may cause a reduction in the population of both lower and higher plant and animal lives. Thus, the biological parameters give an indirect indication of the amount of pollution in water.

Water Pollution – Sources

Water pollutants refer to the substances which are capable of making any physical, chemical or biological change in the water body. These have undesirable effect on living organisms. As mentioned earlier, the water used for domestic, agricultural and industrial purposes is discharged with some undesirable impurities in it. This contamination leads to the pollution

of water, which is generally called the **fresh water pollution**. Fresh water pollution may be classified into two types: **surface water pollution** and **ground water pollution**.

34.3.1 Surface Water Pollution

When pollutants enter a stream, river or lake these gives rise to surface water pollution. The surface water pollution has a number of sources. These can categorised as:

- Point and Non-point Sources
- Natural and Anthropological Sources

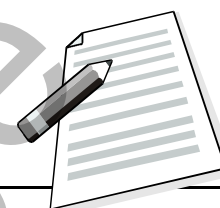
(i) Point and Non-point Sources

The well-defined sources that emits pollutants or effluents directly into different water bodies of fresh water are called **point sources**. Domestic and industrial waste are examples of this type. The point sources of pollution can be effectively checked. On the other hand, the **non-point sources** of water pollution are scattered or spread over large areas. This type of sources deliver pollutants indirectly through environmental changes and account for majority of the contaminants in streams and lakes. For example, the contaminated water that runs off from agriculture farms, construction sites, abandoned mines, enters streams and lakes. It is quite difficult to control non-point sources.

(ii) Natural and Anthropogenic Sources

As mentioned earlier, an increase in the concentration of naturally occurring substances is also termed pollution. The sources of such an increase are called **natural sources**. **Siltation** (which includes soil, sand and mineral particles) is one such natural source. It is a common natural phenomenon, which occurs in most water bodies. Indiscriminate deforestation makes soil loose and flood waters bring silt (طين) from mountains into streams, rivers and lakes.

On the other hand, the human activities that result into the pollution of water are called **anthropogenic** or man made sources of water pollution. For example, domestic (sewage and waste water), industrial and agricultural wastes that goes into the rivers, lakes, streams and seas are anthropogenic sources. Certain materials that are leached from the land by run-off water and enter the various water bodies also belong to this category.





Ground Water Pollution

When the polluted water seeps into the ground and enters an aquifer it results into **ground water pollution**. The most of our villages and many townships, ground water is the only source of drinking water. Therefore, pollution of groundwater is a matter of serious concern. Groundwater gets polluted in a number of ways. The dumping of raw sewage on soil, seepage pits چاله‌کافی and septic tanks دز مکر دن cause pollution of groundwater. The porous layers of soil hold back solid particles while the liquid is allowed to pass through. The soluble pollutants are able to mix with the groundwater. In addition to these, the excessive use of nitrogenous fertilizers and unchecked release of toxic wastes and even carcinogenic substances by industrial units many result in slow trickling down through the earth's surface and mixing with the groundwater. This problem is very serious especially in areas where water table is high (i.e., where water is available near surface of earth).

The ground water can move over large distances by virtue of فضیله of the large empty space available below the earth's surface. This way if some impurities seep into the ground water at one point, they may be observed at a different point far removed from the point of source. In such a case it is difficult to estimate the source of water pollution. However, suspended impurities and bacterial contaminants are removed in the process of seepage دز مکر دن by the soil acting as an absorbent and filter, and water acting as a solvent.

Since the movement of groundwater through the porous rock is very slow, pollutants which get mixed with the groundwater are not readily diluted. Furthermore, groundwater does not have access to air (in contrast to surface water) therefore, oxidation of pollutants into harmless products in groundwater does not occur.

Water Pollutants

You have read the various sources from where pollutants enter the water bodies. Let us now learn about the various types of pollutants arising out of these sources. These can be broadly put under the following types.

- (i) Sewage Pollutants (Domestic and Municipal Waste)
 - (ii) Industrial Pollutants
 - (iii) Agricultural Pollutants
 - (iv) Radioactive and Thermal Pollutants
- (i) **Domestic and Municipal Pollutants** : The sewage contains garbage خاشاک, soaps, detergents, waste food and human excreta بیسالی مرؤف and is the single largest sources of water pollution. Pathogenic (disease causing) microorganisms (bacteria, fungi, protozoa نیفلیجی مندالان, algae) enter the water system through sewage making it infected. Typhoid, cholera, gastroenteritis and dysentery هموکردنی گمده و ریخوله و نیسقان are commonly caused by drinking infected water. Water polluted by sewage may carry certain other bacteria and viruses cannot grow by themselves, but reproduce in the cells of host organisms. They cause a number of diseases, such as, polio, viral hepatitis هموکردنی جگهری and may be cancer which are resistant to like the organic matter are oxygen demanding substances. They are responsible for deoxygenation of water-bodies which is harmful for aquatic life.

Other ingredients which enter the various water bodies are the plant nutrients, i.e., nitrates and phosphates. They support growth of algae, commonly called **algal bloom** (blue-green species). This process is called **eutrophication** and is discussed in

details in the next section.

- (ii) **Industrial Pollutants** : Many industries are located near rivers or fresh water streams. These are responsible for discharging their untreated effluents into rivers like highly toxic heavy metals such as chromium, arsenic, lead, mercury, etc. along with hazardous organic and inorganic wastes (e.g., acids, alkalies, cyanides, chlorides, etc.). Most of these pollutants are resistant to breakdown by microorganisms (called nonbiodegradable), therefore damage the growth of crops and the polluted water is unsafe for drinking purposes.

Factories manufacturing plastic, caustic soda and some fungicides and pesticides release mercury (a heavy metal) along with other effluents in nearby water body. Mercury enters the food chain through bacteria, algae, fish and finally into the human body. Fish died due to mercury consumption and those who ate fish were affected by mercury poisoning and quite a few died. The milder symptoms of mercury poisoning are depression and irritability but acute toxic effects can cause paralysis, blindness, insanity, birth defects and even death. The high concentration of mercury in water and in fish tissues results from formation of soluble monomethylmercury ion, $(\text{CH}_3, \text{Hg}^+)$ and volatile dimethylmercury $[(\text{CH}_3)_2 \text{Hg}]$ by anaerobic bacteria in sediments.

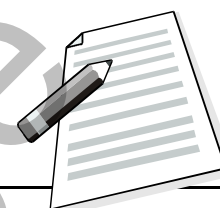
- (iii) **Agricultural Waste**: Manure, fertilizers, pesticides, wastes from farms, slaughterhouse, poultry farms, salts and silt are drained as run-off from agricultural lands. The water body receiving large quantities of fertilizers (phosphates and nitrates) or manures becomes rich in nutrients which leads to eutrophication and consequent depletion of dissolved oxygen. Consumption of water rich in nitrates is bad for human health especially for small children.

Pesticides (DDT, dieldrin, aldrin, malathion, carbaryl etc.) are used to kill insect and rodent pests. Toxic pesticide residues enter the human body through drinking water or through food chain (biomagnification). These compounds have low solubility in water but are highly soluble in fats. For example, the concentration of DDT in river water may be very low but some fish over a period of time accumulate so much of DDT that they become unfit for human consumption. The use of pesticides in our country is increasing very rapidly.

Some of these chemicals which are highly toxic become metabolised by animals that graze on fields. Therefore, these poisonous chemicals have been often observed in the human food chain. The presence of these chemicals in humans even in minute amounts can cause hormonal imbalance and may lead to cancer.

- (iv) **Physical Pollutants**: Physical pollutants can be of different types. Some of them are discussed below :

- (a) **Radioactive Wastes** : Radionuclides found in water are radium and potassium-40. These isotopes originate from natural sources due to leaching from minerals. Water bodies are also polluted by accidental leakage of waste material from uranium and thorium mines, nuclear power plants and industries, research laboratories and hospitals which use radioisotopes. Radioactive materials enter human body through water and food, and may be accumulated in blood and certain vital organs. They cause tumours and cancer.
- (b) **Thermal Sources**: Various industries, nuclear power plants and thermal plants require water for cooling and the resultant hot water is often discharged into rivers or lakes.





Notes

This results in thermal pollution and leads to the imbalance in the ecology of the water body. Higher temperature lowers the dissolved oxygen level (which is very essential for marine life) by decreasing the solubility of oxygen in water. Fish and other aquatic organism can get affected by a sudden change in water temperatures.

- (c) **Sediments** : Soil particles carried to streams, lakes or oceans form the sediments. The sediment become polluting due to their large amount. Soil erosion defined as the soil carried by flood water from crop land, is responsible for sedimentation. The sediments may damage the water body by introducing a large amount of nutrient matter.
- (v) **Petroleum Products**: Petroleum products are widely used for fuel, lubrication, plastics manufacturing, etc. and happen to be poisonous in nature. Crude oil and other related products generally get into water by accidental spillage from ships, tankers, pipelines etc. Besides these accidental spills الانسكابات, oil refineries, oil exploration sites and automobile service centres pollute different water bodies. Oil slick which floats on the water surface causes death of marine life and severely affects the ecosystem of the ocean.

A list of various types of water pollutants, their sources and effects have been summarised in Table 34.1.

Table 34.1: Types of water pollutants, their sources and effects

Pollutant	Sources of Pollutants	Effects and Significance
1 Pathogens	Sewage, human and animal wastes, natural and urban runoff from land, industrial waste	Depletion of dissolved oxygen in water (foul odour) health effects (outbreaks of water borne diseases)
2 Organic pollutants	Automobile and machine waste, tanker spills, offshore oil leakage	Disruption of marine life, aesthetic damage
• Oil and grease	Chemicals used for better yield from agriculture	Toxic effects (harmful for aquatic life), possible genetic defects and cancer; kills fish
• Pesticides and weedicides	Industrial and household waste	Eutrophication, aesthetics
• Plastics	Industrial and household waste	
• Detergents		
3 Inorganic pollutants	Agricultural runoff	Algal bloom and eutrophication, nitrates cause methemoglobinemia
Fertilizers (phosphates and nitrates)		
Acids and alkalies	Mine drainage, industrial wastes, natural and urban runoff	Kill fresh water organisms, unfit for drinking, irrigation and industrial use.
4 Radioactive materials	Natural sources, uranium mining and processing, hospitals and research laboratories using radioisotopes	Cancer and genetic defects
5 Heat	Cooling water for industrial, nuclear and thermal plants	Decreases solubility of oxygen in water, disrupts aquatic ecosystems
6 Sediments	Natural erosion, runoff from agricultural land and construction sites	Affects water quality, reduces fish population