Scholarly Research Journal for Interdisciplinary Studies
Online ISSN 2278-8808, SJIF 2026 = 8.727
https://www.srjis.com/issues_data/304
Peer Reviewed & Refereed Journal, SEPT-OCT 2026, Vol- 15/97

BIOCHEMICAL STUDY OF WATER POLLUTION AND HUMAN LIFE : A COMPREHENSIVE REVIEW

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Paper Received On: 1 OCT 2026
Peer Reviewed On: 16 OCT 2026
Published On: 01 NOV 2026

Introduction

Water occupies about 71% of the earth's surface and yet it is one of the scarcest commodities especially in the developing countries of the world (Karikari and Ansa,2006). They also stated that water is one of the most demanded of all urban and rural amenities and it is indispensable for man's activities. Oketola, Adekolurejo and Osibanjo (2010) noted that water is abundant on the planet Earth as a whole, but fresh potable water is not always available at the right time or the right place for human or ecosystem use and water is undoubtedly the most precious natural resource vital to life. Furthermore, the yopined that water is distributed in nature as surface and ground water in different forms and sources which are oceans, seas, rivers, streams, lakes, ponds, wells, bore holes and springs. Rivers are among the oldest water bodies in the world (Higler, 2012). He also noted that in most urban-rural communities in the developing countries especially the Sub-Saharan Africa, surface waters (rivers, streams, and lakes) have been the most available sources of water used for domestic purposes. The water from these sources is contaminated with domestic, agricultural, and industrial wastes and is likely to cause water related diseases (Ojekunle, 2012; Ayeni, 2014).

Water is a resource that has many uses, including recreation, transportation, hydroelectric power and domestic, industrial and commercial uses (Kumar, 2007).He also asserted that water also supports all forms of life and affects our health, lifestyle, and economic well- being. Although more than three quarters of the Earth's surface is made up of water, only 2.8 percent of the Earth's water is available for human consumption (Iskandar, 2010). At present, approximately one-third of the world's people live in countries with moderate to high water stress and the worldwide freshwater consumption increases six fold between the years 1900 and 1995 more than twice the rate of population growth, thus, many parts of the world are facing water scarcity problem due to limitation of water resources coinciding with growing population (United Nations Environmental Programme, UNEP, 2002).

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India accounts for about 2.45 per cent of world's surface area, 4 per cent of the world's water resources and about 16 per cent of world's population. The total water available from precipitation in the country in a year is about 4,000 cubic km. The availability from surface water and replenishable groundwater is 1,869 cubic km. Out of this only 60 per cent can be put to beneficial uses. Thus, the total utilisable water resource in the country is only 1,122 cubic km.

Without water our planet Earth would be a gigantic dead desert. According to present knowledge the Earth is the only planet of our solar system with water in all three phases: solid, liquid and gas. The Earth's surface is clearly dominated by water: 70.8% of it (361.2 million km²) is covered by the oceans, about 3.16% (more than 16.1 million km²) by ice on land. Lakes cover approx. 2 million km² (0.39%). Including rivers and wetlands, with approx. 2.7 million km² (0.53%), the total water-covered surface of our planet is above 75% (Marcinek& Rosenkranz, 1996).

Chemical composition of water bodies

Water is a unique liquid; without it, life is not possible on earth. Water bodies have a complex composition which includes various gases, minerals and organic substances. Due to the presence of metal ions, dissolved gases and other organic substances different types of chemical reactions like oxidation-reduction, complexation etc. occur in water. The major chemical components which are found in all water bodies are dissolved gases and different ions and these are discussed below.

1. Dissolved Gases: The dissolved gases owe their presence in the water bodies to the fact that the atmosphere and the water bodies are in contact with each other and the exchange of gases occur between surface of water body and atmosphere. The major gases which are present in water bodies are oxygen and carbon dioxide while methane and hydrogen sulfide are present in minor amounts. The amount of these gases in water is measured in ppm or mg/L. Aquatic plants (algae) release O2 (oxygen) in water by photosynthesis. This oxygen gets dissolved in water and is called dissolved oxygen(DO).DO is consumed in the process of decomposition of organic waste (pollutant) present in water. Due to depletion of DO the survival of aquatic organisms becomes difficult. The concentration of dissolved oxygen depends on temperature of water also the partial pressure and salt content of water. As temperature of the water increases, solubility of oxygen decreases. In tropical oceans and lakes, the level of oxygen at surface water is lower than at the depth. However, surface water does not become deprived of O2 as the gas diffuses into water from the atmosphere. The second important gas present in water bodies is (carbon dioxide) CO2. The main sources ofCO2 in water are (i) from the decomposition of organic waste and (ii) by the presence of CO2 in air. Dissolved CO2 is present as loosely associated carbonic acid. When falling as rain, this slowlyerodes calcareous rocks and results in input of calcium slats to adjacent water bodies during drainage. The soluble atmospheric gases enter the water bodies during rain fall. Any atmospheric gases that are soluble in water will pass into water bodies during rainfall. Reducing conditions in sediments result in the production of (methane) CH4 and (hydrogen sulphide) H2S and these gases are also produced by volcanic process.

2. Metal Ions: Many chemical substances are soluble in water. The major sources of solutes are minerals and rocks with which water is in contact. Metal ions in water (Mn+) exist in many different forms(ions, hydrated metal ions, undissociated compounds and colloids). Some ions are present in large amount (Ca+2, Mg+2, Na+, K+, Cl-, SO4-2, HCO3-1, CO3-2) and are called

macro component which are present in amount exceeding mg/L. other elements like borate and fluoride are present in small amounts (μg/L) and are called micro component.

Water cycle

Most of the water of the world 97% is found in oceans but because of high salt content it cannot be used for municipal, agricultural or most industrial needs. Water serves as a pool for many dissolved and suspended materials. It is a vital component for all living cells and for various biochemical processes. In water cycle, water inter converts in all the three states i.e., liquid form, vapor and solid form. The water cycle is a key environmental dynamic for all types of processes physical, chemical and biological and had been in existence ever since oceans came into being ,i.e., more than two billion years ago. The movement of water on the earth's surface and through the atmosphere is known as hydrologic cycle. Figure 5 displays the water cycle and its various processes. The water cycle can be either a long cycle or various short cycles. Short Cycle: It involves only evaporation and immediate condensation and so on. The reservoir for short cycle could be any water body. Long Cycle: It involves various processes like evaporation, condensation, transpiration, infiltration and interception, run off, stream off and subsurface flow.

Causes of Water Pollution:

1. Agriculture and Nutrient Pollution: Around the world, agriculture is the leading cause of water degradation. Every time it rains, fertilizers, pesticides, and animal waste from farms and livestock operations wash nutrients and pathogens such bacteria and viruses into our waterways. Nutrient pollution, caused by excess nitrogen and phosphorus in water or air, is the number-one threat to water quality worldwide and can cause algal blooms, a toxic soup of blue-green algae that can be harmful to people and wildlife. Some waste water, fertilizers and sewage contain high levels of nutrients. If they end up in water bodies they encourage algae and weed growth in the water bodies, this will make the water undrinkable, and even clog filters. Too much algae will also use all the oxygen starvation

2. Sewage and Wastewater: The sewage and waste water that is produced by each household is chemically treated and released in to sea with fresh water. The sewage water carries harmful bacteria and chemicals that can cause serious health problems. Pathogens are known as a common water pollutant; The sewers of cities house several pathogens and thereby diseases. Microorganisms in water are known to be causes of some very deadly diseases and become the breeding grounds for other creatures that act like carriers. These carriers inflict these diseases via various forms of contact onto an individual. A very common example of this process would be Malaria.

3. Surface Water Pollution: Surface water includes natural water found on the earth's surface like rivers, lakes, lagoons and oceans. Hazardous substances coming into contact with this surface water, dissolving or mixing physically with the water can be called surface water pollution. For example, industries emptying oil spills and chemical waste into water bodies are also key contributors.

4. Oxygen Depletion: Water bodies have microorganism. These include aerobic and anaerobic organisms, when too much biodegradable matter (things that easily decay) end up in water, it encourages more microorganisms growth, and they use up more oxygen in the water. If oxygen is depleted, aerobic organisms die, and anaerobic organisms grow more to produce harmful toxins such as ammonia, sulfides.

5. Ground Water Pollution: When humans apply pesticides and chemicals to soils, they are washed deep into the ground by rain water. This get to underground water, causing pollution underground. This means when we dig wells and bore holes to get water from underground, it needs to be treated before.

6. Oil Pollution by Oil Industries: Routine shipping, runoff and dumping of oils on the ocean surfaces happens every day. Oil spills cause major problems, and can be extremely harmful to local marine wildlife such as fish, birds and sea otters and other aquatic life. Because oil does not dissolve it stays on the water surface and suffocates fish. Oil also gets caught in the feathers of sea birds, making it difficult for them to fly. Some animals die as a result.



Figure : Causes of Water Pollution

Types of waters pollution and pollutants

1.Physical pollution

Physical pollution results from organic and inorganic materials suspended in water. This type of pollutants change the color, taste, and smell of water. One of the forms of physical pollution is the high temperature as a result of pouring the cool water of factories and nuclear reactors into water bodies. It leads to a decrease in the amount of dissolved oxygen and harms aquatic organisms (Ewaid and Abed2017).

2. Chemical pollution

This type of pollution results from the presence of excessive amounts of dissolved salts, acids, fluorides, metals, organic materials, fertilizers and pesticides. The metals are mostly soluble in water to some extent, including some toxic ones, such as barium, cadmium, lead, and mercury. Whereas, the non-toxic metals include calcium, magnesium, sodium, iron, and copper, whose increase causes some diseases. Excessive sodium concentration, for example, makes the water unpalatable and leads to health risks for heart and kidney disease, and poisoning plants. Likewise, most of the organic materials can be dissolved by water. They are either organic material, that can be dissolved by the bacteria present in the water, or they are not dissolvable, such as pesticides and detergents. Fertilizers include mainly nitrogen and phosphorous, and their presence in the water helps the aquatic plants to grow increasingly. This may result in the

phenomenon of premature aging of the lakes, which eventually turn into swamps or dry land (Ewaid and Abed2017).

Chemical pollution occurs in the following:

1- Acidic and alkaline compounds: Both acidic or alkaline compounds change the pH of water. If the water is contaminated with acids, this will cause corrosion of the pipes and their corrosion. This corrosion causes risks to human health according to the type of contaminated acid. Besides, alkali pollution forms salts such as carbonates, bicarbonate, hydroxides and chlorides. Carbon, calcium and magnesium bicarbonate causes hardness of water. Correspondingly, chloride compounds lead to the salinity of the earth Ewaidet al., (2019).

2- Heavy metals: The most common widespread heavy metals are lead, mercury, cadmium and arsenic. Mercury is a mineral that its compounds can be mixed with soil and water. Contamination with mercury compounds causes disturbances in the central nervous system, as well as insomnia, psychological depression, forgetfulness, and gingivitis and kidney inflammation. Cadmium is used in several industries such as the manufacture of plastics and batteries. Contamination of water with cadmium leads to kidney, lung, heart and bone diseases. Also, lead factories that produce batteries are among the most important sources of lead pollution Ewaid et al., (2019).

EFFECT OF POLLUTED WATER ON HUMANS

How does water pollution affect humans? Try drinking untreated water nowadays and your body will immediately react to it. You will get a stomach ache at the least. Water-borne diseases account for the deaths of 3,575,000 people a year! That's equivalent to a jumbo jetcrashing every hour, and the majority of these are children .Infectious diseases can be spread through contaminated water. Some of these water-borne diseases are Typhoid, Cholera, Paratyphoid Fever, Dysentery, Jaundice, Amoebiasis and Malaria.

- **Chemicals** in the water also have negative effects on our health.
- **Pesticides** – can damage the nervous system and cause cancer because of the carbonates and organophosphates that they contain. Chlorides can cause reproductive and endocrinal damage.
- **Nitrates** – are especially dangerous to babies that drink formula milk. It restricts the amount of oxygen in the brain and cause the "blue baby" syndrome.
- **Lead** – can accumulate in the body and damage the central nervous system.
- **Arsenic** – causes liver damage, skin cancer and vascular diseases
- **Flourides -** in excessive amounts can make your teeth yellow and cause damage to the spinal cord.
- **Petrochemicals** – even with very low exposure, can cause cancer

Effects of Water Pollution on Human Health:

There is a greater association between pollution and health problem. Disease causing microorganisms are known as pathogens and these pathogens are spreading disease directly among humans. Many water borne diseases are spreading man to man. Heavy rainfall and floods are related to extreme weather and creating different diseases for developed and developing countries. 10% of the population depends on food and vegetables that are grown in contaminated water. Many waterborne infectious diseases are linked with fecal pollution

of water sources and results in fecal-oral route of infection. Health risk associated with polluted water includes different diseases such as respiratory disease, cancer, diarrheal disease, neurological disorder and cardiovascular disease. Nitrogenous chemicals are responsible for cancer and blue baby syndrome. Mortality rate due to cancer is higher in rural areas than urban areas because urban inhabitants use treated water for drinking while rural people don't have facility of treated water and use unprocessed water. Poor people are at greater risk of disease due to improper sanitation, hygiene and water supply.

Poor quality water destroys the crop production and infects our food which is hazardous for aquatic life and human life. Pollutants disturb the food chain and heavy metals, especially iron affects the respiratory system of fishes. An iron clog in to fish gills and it is lethal to fishes, when these fishes are eaten by human leads to the major health issue. Metal contaminated water leads to hair loss, liver cirrhosis, renal failure and neural disorder.

Bacterial diseases :

Untreated drinking water and fecal contamination of water is the major cause of diarrhea. Disease cholera is caused by the contaminated water.

Viral diseases :

Hepatitis is a viral disease caused by contaminated water and infects the liver. Jaundice, loss of appetite, fatigue, discomfort and high fever are symptoms of hepatitis. If it persists for a long time it may be fatal and results in death. Gastroenteritis is caused by different viruses including rotaviruses, adenoviruses, calciviruses and Norwalk virus.

Parasitic diseases:

Cryptosporidiosis is a parasitic disease caused by the cryptosporidium parvum. It is worldwide disease and symptoms are diarrhea, loose or watery bowls, stomach cramps and upset stomach. Cryptosporidium is resistant to disinfection and affects immune system and it is the cause of diarrhoea and vomiting in humans.

Control measures of water pollution

Water pollution control is clearly one of the most critical challenges. Without urgent and properly directed action, world is facing mounting problems of diseases, environmental degradation and economic stagnation, as precious water resources become more and more contaminated. Sewage is one of the major causes of water borne diseases and therefore the treatment of sewage is one of the important tasks. For a long time treatment of municipal waste in the form of sewage involved mainly of the removal of suspended solids, oxygen demanding materials and harmful bacteria. Now the disposal of the solid residue from sewage has been improved by applying municipal treatment processes. The treatment of this waste water is carried out in the three stages - primary, secondary and tertiary. During primary treatment a large percentage of suspended solids and inorganic material is removed from sewage. The secondary stage reduces organic material by accelerating natural biological processes. Tertiary treatment is done when water is to be reused. Here 99% of solids are removed and various chemical processes are used to ensure that water is free from infecting materials. Now let's explain the three stages of treating sewage.

(a) Primary Treatment: When the waste water is to be dumped off into a river or flowing steam, the treatment is carried out by sedimentation, coagulation and filtration. This is known as primary treatment. If the water is required for drinking purposes, it has to undergo further

treatment called secondary and tertiary treatments. The following steps are performed to do primary treatment of water:

(i) Sedimentation: This step is carried out in large tanks specially built for this purpose. The polluted water is allowed to settle so that silt, clay and other matter settle to be bottom and water is slowly allowed to move out. Fine particles do not settle and are thus required to be removed in the next step.

(ii) Coagulation: Fine particles and colloidal suspension are combined into large particles by a process called coagulation. This step is carried out by the addition of special chemicals called coagulants (flocculants) such as potash alum. The large particles either settle to the bottom or are moved in the next step.

(iii) Filtration: Suspended particles, flocculants, bacteria and other organisms are filtered by passing the water through a bed of sand or finely divided coal or through some fibrous materials. The total impurities collected in these steps are called sludge.

(b) Secondary or Biological Treatment: if the water is not fit for drinking purposes, that has to undergo further treatment. This is done through secondary or biological treatment. A commonly used method is to allow polluted water to spread over a large bed of stones and gravel so that the growth of different microorganisms needing nutrients and oxygen is encouraged. Over a period of time a fast moving food chain is set up. It involves the following processes:

(i) Softening: By this treatment undesirable cations of calcium and magnesium are removed from hard waters. Either water is treated with lime and soda ash to precipitate Ca2+ ions as carbonates or it is passed through cation exchangers. This makes water soft.

(ii) Aeration: In this process, soft water is exposed to air by forcing air through it to add oxygen to water. This encourages bacterial decomposition of organic matter into harmless products such as carbon dioxide and water. The addition of oxygen reduces carbon dioxide etc. The water is as yet not fit for drinking purposes. The pathogenic and other microorganisms need to be killed. This is done in the next treatment.

(c) Tertiary Treatment: The tertiary treatment is actually disinfecting water. Chlorine is the most commonly used disinfectant used for killing bacteria. However, chlorine also reacts with traces of organic matter present in water and forms undesirable chlorinated hydrocarbons (toxic and potentially carcinogenic). It is therefore desirable to reduce the organic matter in water before passing chlorine gas. Other methods of disinfection are as ultraviolet radiation, ozone gas treatment or reverse osmosis. The other different things that can tackle the water pollution problem includes,

(d) Management Practices: Effective control of urban runoff involves reducing the velocity and flow of storm water, as well as reducing pollutant discharges. Local governments use a variety of storm water management techniques to reduce the effects of urban runoff. These techniques, called best management practices, may focus on water quantity control, while others focus on improving water quality.

(e) Education or awareness: Making people aware of the problem is the first step to solving it. Greater public awareness can make a positive difference.

(f) International and National Laws: One of the biggest problems with water pollution is its trans boundary nature. Many rivers cross countries, while seas span whole continents.

Pollution discharged by factories in one country with poor environmental standards can cause problems in neighbouring nations, even when they have tougher laws and higher standards. Environmental laws can make it tougher for people to pollute, but to be really effective they have to operate across national and international borders.

(g) Economics: Most environmental experts agree that the best way to tackle pollution is through something called the polluter pays principle. This means that whoever causes pollution should have to pay to clean it up, one way or another. Polluter pays can operate in all kinds of ways. It could also mean that shoppers should have to pay for their plastic grocery bags, as is now common in Ireland, to encourage recycling and minimize waste. Ultimately, the polluter pays principle is designed to deter people from polluting by making it less expensive for them to behave in an environmentally responsible way. 1.5 Conclusion Water is essential for the existence of all life forms.

Conclusion

Water is a very significant source for all living organisms; all the living organisms need water so it is life itself. It keeps them alive but polluted water is a very harmful substance. When humans drink polluted water it has serious effects on their health. Water pollution is a global issue and world community is facing worst results of polluted water. Major sources of water pollution are discharge of domestic and agriculture wastes, population growth, excessive use of pesticides and fertilizers and urbanization. Bacterial, viral and parasitic diseases are spreading through polluted water and affecting human health. This study has reflected the fact that water contamination is posing serious threats to the human health. This might be due to the lack of awareness, time and resources. Moreover, it was concluded from this study that waterborne diseases were even found in those areas, where no microbial contamination was detected, so in future a detailed study should be carried out about this aspect. It is recommended that there should be proper waste disposal system and waste should be treated before entering in to river. Educational and awareness programs should be organized to control the pollution.

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