Water pollution: Its causes and effects

Suaad Hadi Hassan Al-Taai

University of Baghdad, College of Education Ibn Rushd for Humanities, Department of History.
Email: suaad.hadi@ircoedu.uobaghdad.edu.iq

Abstract

The topic of water contamination is one of the significant studies that, because of its great effect on the lives of humans, animals and plants alike, has attracted the attention of researchers and those interested in the environment. It is not less harmful than contamination of the air and soil, but more closely linked to them. The research centered on the study of the notion of pollution in general, then the notion of water pollution and its sources. In addition to groundwater contamination, there have been many pollution processes, the most important of which are biological, physical, and by dumping solid and liquid waste into waters of rivers, lakes and seas.

Key words: Seas, Environment, Germs; Factories, Air, water.

1. Introduction:

The study of water pollution is very important for most researchers and interested people. Its importance lies the fundamental changes that it makes in the lives of humans, animals, plants, soil, and the environment in general. The research addressed water pollution that occurs due to throwing solid objects and organic and liquid materials into water-streams and lakes that contain toxic chemicals such as metals, mercury, lead and others. Radioactive pollution is one of the most important types of pollutants that result from nuclear activity in which materials leak into the water and turned into a toxic and polluting substance. The research also sheds light on the most important sources of water pollution, which are industrial sources, especially tanning factories, lead, mercury and copper. The waste goes to water because most factories do not adhere to industrial drainage controls by using pesticides and fertilizers. Also, waste leaks from homes has a significant impact on water pollution. It also deals with sanitation sources, as the most important sources of water pollution, emphasizing the most important causes of groundwater pollution and the stages of its treatment and purification.

Pollution: It is the negative change that occurs to one of the components of the environmental, which results in whole or in part from the vital and industrial human activity, in comparison with the natural situation that prevailed before human intervention, and begins to occur in energy changes, different radiation levels and unwanted biological, physical and chemical changes, that occur in the biosphere that surrounds us, in which all other living creatures live, and these changes can affect directly or indirectly the ecological balance through food, air, water and various agricultural products, and in this sense the environment pollutants are many and varied sources and have different meanings and effects [1].

It is also defined as the quantitative and qualitative change - Accidental and intentional - that occurs to one or more elements of the environment and would harm the life of the organism and weaken the ability of ecosystems to continue its production [2].

Water is one of the most important natural resources available in any economic structure, as it is the means of life and development for any society, and it is not possible to imagine the existence of life on the surface of the earth without the presence of water, for the word water is the true synonym for the word life, for all living things, on top of which, people depend mainly on water as
a means of life and growth, water means agriculture, food, drink and energy, and it is sufficient to say that water represents no less than 75% of the composition of the human body and about 90% of the composition of plants, water is a necessary of the necessities of life, and when a person advances, his water needs increase. On the other hand, water has an important role in the rise and prosperity of human civilizations thousands of years ago. Historical evidence indicates that many civilizations arose and flourished around rivers. The importance of water does not stop at this point, because water resources are the only source of fish wealth, which is one of the important food sources in the world, as well as the role of water in connecting parts of the world with each other through various means of maritime transport [3].

2. Causes of water pollution:
Pollution is the negative change that occurs to one of the environmental components. In whole or in part, it results from vital and industrial human activity. It begins with changes in the energy, the levels of radiation, and unwanted biological, physical, and chemical changes in the biosphere, in which all other living creatures live. These changes can directly or indirectly affect the ecological balance through food, air, water and various agricultural products. The environmental pollutants are many and varied in sources, and have different meanings and effects [1]. It is also known as the quantitative and qualitative change that happens to one or more elements of the environment, which would harm the life of the organism and weaken the ecosystems ability to continue its production [2].

Water is one of the most important natural resources available in any economic structure. It is the means of life and the source of growth for any society. It is impossible to find life on the surface of the earth without water. The word “water” is the true equivalent of the word “life”. All living things, especially humans, depend mainly on the water as a means of life and growth. Water means agriculture, food, drink and energy. It represents more than 75% of the human body composition and about 90% of the plant composition. It is one of the necessities of life. On the other hand, water has an important role in the rise and prosperity of human civilizations for thousands of years. Many historical facts indicate that many civilizations arose and flourished around rivers. The importance of water does not stop at this point. Yet, water resources are the only source of fish wealth, which is one of the most important food sources in the world. Additionally, water links parts of the world with each other through various means of maritime transport [3].

Water resources suffer from various forms of pollution. If water pollution continues to increase, this will lead to its depletion soon. There are 88 developing countries that cause 40% of the world's population. Water shortage is a serious hindrance due to its social and economic development. The number of people in the world and the multiplicity of their various activities, the amount of fresh water consumed for different purposes have increased progressively [2].

Water pollution results from the dumping of solids and oxygen-consuming organic materials that come mainly from untreated urban sewers and industrial drains, where the spread of trace pollutants (toxic chemicals and metals such as mercury, zinc, lead and cadmium) are exposed. One of the types of water pollution is thermal pollution, which results from pouring power stations, factories, and cooling water into the water streams, causing high temperature and imbalance in the water environment [4].

Surface water pollution and its suitability for use depend on several factors, including the following [2]:
1- The water velocity current in the water stream.
2- The amount of dissolved oxygen in the water.
3- The speed of bacteria in analyzing impurities and wastes.
4- The quality of impurities and wastes that are dumped into the sea. In fact, the most important qualities of water, that is suitable for use, are the following [3]:

1- It should be colorless, tasteless, and odorless.
2- It should be free of microorganisms such as bacteria, algae, and others.
3- It is free from all kinds of chemicals such as pesticides, chemical fertilizers and others.
4- It is free from any trace of acidity, and neutralization.

Water pollution leads to a change in its specifications since pollution reduces its ability to perform its natural role. So, it becomes inappropriate for human, agricultural or industrial uses allocated to it. There was a belief argues that rivers, seas, oceans and other watercourses are the most appropriate places for dumping production and consumption residues and wastes of human activity. Man did not think that these remnants and wastes that he throws into the waterways will return to him again through drinking or irrigating his agricultural crops or consuming his fish. This causes severe damage to him, either directly or indirectly [3].

3. Types of water pollutants:

3.1. 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 [5].

3.2. 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 materials, 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 [5].

3.3. 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 [6].

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 [6].
3- Nitrates and phosphates: These compounds cause the phenomenon of greening water, or what is known as blooming. They appear as a green layer of weeds on the surface of reservoirs, lakes, seashore, and stagnant waters. It covers the surface of the water, which prevents oxygen from entering the water and affects life. Green algae are made of carbon, nitrogen and phosphorous. It is worth noting that nitrates combine with hemoglobin and prevent oxygen from combining, causing suffocation [6].

4- Iron and Magnesium: Iron and magnesium change the color of water to rust-like color. It is widespread in surface water. It does not cause damage unless it is found in large quantities [6].

5- Organic compounds: Many organic compounds cause water pollution. The most famous types are the pollution of petroleum and its derivatives, pesticides, fungicides and other industrial chemicals [6].

6- Chlorine and fluorine are used to purify water from harmful microbes. Yet, They interact with hydrocarbons when it contains carcinogenic chlorocarbons [6].

3.4. Bio-pollution

Biological contamination includes vital pollutants such as pathogenic bacteria, viruses, and parasites. The sources of these pollutants are human and animal excreta. They are transferred to the water when it mixes with sewage or agricultural drainage water, causing human infection with many diseases such as cholera. Therefore, sterilizers such as chlorine must be used to eliminate these pollutants in drinking water [5].

3.5. Radioactive pollution

The risk of this type of pollution is increased by nuclear activity and the attempt to dispose of nuclear waste. Radioactive materials may leak into water bodies, where they are absorbed by living organisms and transferred to humans causing various effects on genetics [5].

Radium is the most important radiation, which causes bone cancer. Also, the presence of radioactive materials in water leads to a physiological change [6].

4. The main sources of water pollution:

The pollution of rivers, lakes, and other surface waters differ in their environmental importance or ease of control. It can be divided into two parts:

4.1. Specific sources of pollution: They include the sources that flow into water bodies through well-located outlets. It is easy to control these types of sources. Also, their quantities can be measured and their physical, chemical and biological properties can be determined. These pollutants include wastes from industry and sanitation [5].

4.2. Unspecific sources of pollution: Unspecified sources result from widespread sources that cannot be controlled directly. It includes wastes resulting from agricultural activities or those that are spewed by torrential waters and dumped into water bodies. Trucks and pipelines transport dangerous liquids to the leakage of various pollutants, and their access to water bodies is the best example of unspecified sources of pollution. Acid rain is also one of the unspecified sources of pollution [5].

5. The sources of pollution are the following:

1- Industrial sources: Factory water and their wastes contain 60% of the total pollutants of seas, lakes and rivers. Most pollutants are exported from factories such as tanning factories, lead, mercury, copper and nickel, paints, cement, glass, detergents, dairy sterilization plants, slaughterhouses, sugar refineries, hydrocarbon pollution resulting from oil pollution [2,7].

In developing countries, and even in developed one, most factories do not abide by industrial drainage controls, and throw their waste into the water. In the United States, toxic residues were found in rivers and seas surrounding factories. In Cairo, a study was conducted on twelve drinking
water treatment plants, and it was found that all of them suffer from a lack of discipline in the
disposal of industrial liquid waste. It should be noted that traditional methods of water purification
do not eliminate industrial pollutants (such as hydrocarbons), inorganic pollutants and pesticides. In
addition, using the water of rivers and lakes for cooling by factories and power stations is one of
the forms of industrial pollution. The increase in water temperature negatively affects biochemical
reactions and aquatic organisms [2].
2- Acid rain and its effect on water pollution: Acid rain are a result of the formation of sulfuric and
nitric acids and the interaction of sulfur and nitrogen oxides in raindrops. Its pH is usually less than
(5), and it may reach (4). Pure rainwater is acidic due to the dissolution of carbon dioxide in its
drops. It is not considered acid rain, since its pH is estimated to be about (5.6). Not all rainwater is
necessarily acidic. There are also base rains whose pH may reach more than (8.4). This type of rain
does not pose a risk in comparison with acid rain. The occurrence of acid rain is attributed to some
natural phenomena such as volcanoes. However, the main reason for their occurrence is due to
human activity, such as the various combustion processes of fuels resulting from the liberation of
huge amounts of sulfur and carbon oxides. Acid rain affects the environment by increasing the
acidity of soil and water bodies, and by eroding various structures [5].
3- The dumping of human waste, remnants such as sewage and untreated factory waste, dead
animals, and garbage into waterways cause toxic chemicals. Also, the dumping of the remains of
ships spread the seepage of petroleum and chemical materials into the seas and oceans. Similarly,
the spread of weeds and aquatic plants in the waterways impedes the movement of water. The
stagnation and growth of snails bring diseases such as schistosomiasis and others. In addition, it
causes the consumption of huge quantities of water, as in the spread of the Nile rose in Egyptian
waterways [3].
4 Sources of sanitation: it is consumed to meet the daily needs of people, such as domestic,
aricultural, industrial, and commercial use, as well as liquid medical wastes from hospitals.
Rainfall also contributes to wash away a large proportion of organic and inorganic impurities,
plankton and pollutants. Water loses most of its physical and chemical properties due to these
variables and pollutants. [9].
In addition, surface water runoff leads to sewage overflow and environmental pollution. To
overcome the problem, Sustainable Urban Drainage Systems (SUDS) have to be managed to
improve urban drainage without using tools and machines, and to store and treat water by natural
methods [9].
Sewage water is one of the most serious public health problems in most third world countries,
because most of these countries do not have an integrated sanitation network. The biggest problem
lies in receiving coastal cities wastewater from the seas without treatment, causing a serious health
problem. Also, the use of cesspits in areas, where there is no sanitation network, is harmful to the
public health. Especially, when it is left uncovered, or its waste is thrown in places near dwellings,
and mosquitoes and flies breed causing many diseases. In addition, the use of household pesticides
have very harmful effect on human health [2].
If wastewater is not treated well, it will cause serious diseases to humans. Particularly, when it
leaks into drinking water, it becomes a danger to the health of humanity. Sewage water contains
many microorganisms such as bacteria, viruses, and parasites and thus transmits many diseases. For
example, the spread of cholera epidemics in the seventeenth century in London is a result of the
pollution of the Thames water with sewage water. In New Delhi and California, salmonella and
hepatitis epidemics spread as a result of water pollution during the years 1955-1956 [6].
Sewage contains a large amount of organic matter and huge numbers of aerobic and anaerobic microorganisms [2,6].

The most important stages of wastewater purification are the following [8]:
1- Pre-treatment: At this stage, suspended materials such as tree stems, leaves and worn pieces are removed to prevent the subsequent treatment units from being destroyed.
2- Primary treatment: At this stage the liquid wastes are physically treated. It is represented by blocking large solid particles, separating grease, oils and sand, sediments and filtration to reduce and neutralize the acidic function (PH). Also, (5-10%) of decomposable organic matter and (2-20%) of suspended matter can be removed. This water cannot be reused for any activity.
3- Second treatment: It is the stage in which biological processes take place to remove organic materials through biochemical oxidation. At this stage, (35-50%) of degradable organic matter and (50-70%) of suspended matter can be removed.
4- Advanced tertiary treatment: At this stage, advanced treatment is carried out to remove particulate contaminants and prepare the water for reuse. A high degree of purification is achieved by removing phosphorous compounds, nitrogen, excess solid suspended matter and organic matter that is difficult to be broken down with primary and secondary treatment.

6. Diseases result from water pollution:
Water-related diseases can be classified according to the following [6]:
1- Waterborne diseases: cholera, typhoid, dysentery bacillus, infectious hepatitis, and giardia.
2- Diseases that occur due to the lack of water use for hygiene, like scabies, skin rot and ulcers, leprosy, lice, trachoma, and others.
3- Water-based diseases like schistosomiasis, schistosomiasis, filariasis, and nematode worm.
4- Insects transmit the disease germs associated with water, which are yellow fever, dengue fever, filariasis, malaria and others.

The microorganisms play a prominent role in the transformations of methane, sulfur, phosphorous, and nitrates. Methane bacteria produce methane under aerobic and anaerobic conditions. However, the rot bacteria produce ammonia, which is oxidized into nitrate, and known as the greening of the water. They appear in the form of a green layer of weeds on the surface of water reservoirs, lakes and seashores. They are largely formed in stagnant water, blocking the infiltration of oxygen into the water. The increase of green grass causes blue eyes disease of children. Other microorganisms, such as Beggiato sp, can also oxidize hydrogen sulfide to sulfur [6].

Many countries have adopted “the exclusive marine economic zone and estuaries” to achieve the economic benefit of the country. It forms sites for a number of industries and a number of fish and shellfish species, and the random presence of tourist units. All these represent an important source in boosting the national economy. However, these areas have become important carriers of environmental pollutants. It receives household, agricultural and industrial wastes that contain cellulose, acids, alkalis and nitrogenous compounds. This negatively affects fish food organisms near downstream areas and hence humans as one of the consumers of their products [10].

7. The sources of groundwater pollution:
Water pollution is not limited to rivers, lakes, seas and oceans, but groundwater is also exposed to pollution. The most important sources of contamination are the following:
1- Agricultural operations: Excessive use of water, pesticides, fertilizers or poor disposal of livestock waste cause numerous problems. Operations increase the concentration of salts and minerals in the groundwater. Chemical fertilizers also rise the nitrates in the groundwater, making it unfit for drinking [5].
2- Injection wells: Injection wells are used to dispose of industrial, radioactive and other wastes in deep aquifers, such as those carrying saltwater. These processes may cause the contamination of the upper layers of producing drinking water due to the leakage of injected pollutants through the worn out casing tubes, or by their infiltration into the bearing layers through the cracking of impermeable layers [5].

3- Drainage pits: It refers to the ground pits with all their systems and forms that are used to dispose of wastewater in cities and villages that do not have sewage networks. Their use may lead to leach of the bacteria, germs and decompose organic compounds into the aquifer and pollute the drinking water [5].

4- The phenomenon of salty water intrusion: The excessive pumping of freshwater from water layers, near the seashore, leads to the intrusion of saltwater from the sea, and increases the salinity of its waters over time. Consequently, it becomes unfit for drinking and agricultural purposes [5].

5- The surface disposal of waste: In the United States, for example, about 390 million tons of solid waste are disposed of by burying them in designated places on the surface of the earth. About 10 trillion of liquid waste are deposited in surface storage ponds. About 10% of solid and liquid waste is a real danger to human health and the environment. Rainfall, the rise in the groundwater level, and the lack of tight isolation of storage ponds lead to the leakage of some of these hazardous materials into the freshwater-bearing layers. In some industrialized countries, chemical wastes are disposed of illegally by dumping them into water bodies causing the groundwater pollution. Its harmful health effects began to appear on the residents of the areas near the disposal sites, as in the famous "Love Canal" incident [5].

It is difficult to remove groundwater pollution, especially with chemical waste, and any treatment of the extracted water will be very expensive. The slow movement of that water increases the complexity and limitations of controlling groundwater pollution. The velocity of their transmission may not exceed several meters per day or even several meters per year. This means that decades, perhaps hundreds of years, will pass before pollution is discovered. It is the time required for pollutants to spread from the source of pollution until they reach the sites of drinking wells [5].

The tremendous progress that has occurred in the field of nanotechnology has prompted the United Nations to pay attention to it and to develop a plan to get benefit from its applications in various fields. Nanotechnology enables to increase energy efficiency, helps to regulate the environment, and solves many health problems. Nanotechnology is able to increase industrial production at very low costs. It is also expected to be advanced in many areas, such as: the medical field, industry, energy, agriculture, food, environment, and space, and the military field. Nanotechnology has been used to solve, or at least alleviate, problems of environmental pollution. Nanotechnology has been used to develop new methods to save and treat drinking water and detect air pollution. This, in turn, provided a great opportunity to develop some strategies to protect the environment from pollution, produce regulated energy sources, solve the problem of water and air pollution, and other environmental problems [11].

8. Conclusion:
The Article has attained a number of important results. They can be summarized as the following:
1- Water pollution is not less dangerous than air and soil pollution. All of them are negatively affect the lives of humans and animals alike.
2- Directly and indirectly, water is polluted with germs, solid, and liquid wastes. These pollutants change its color, taste and aroma and make it unfit for consumption.
3- There are many types of water pollutants. The most important are physical, chemical, biological, and radiological pollution. All these types are very dangerous, and causing several diseases to humans, animals and plants.

4- The vital pollutants are bacteria, viruses, and parasites. They come from humans and animals because their wastes are transferred to the water. Wastes are mixed with sewage or agricultural drainage water, causing many diseases, including cholera. Therefore, chlorine must be used to sterilize it.

5- Acid rain is an important cause of rivers and lakes pollution. Its acidic water contributes to the formation of sulfuric and nitric oxides from the reaction of sulfur oxides and nitrogen.

6- The use of fertilizers and chemical fertilizers to help agricultural crops grow rapidly and the use of pesticides are among the causes of water pollution.

7 - The spread of weeds and aquatic plants in waterways contributes to the obstruction of water movement. Also, the growth of snails, and their stagnation are important causes of disease transmission.

8- Groundwater is exposed to pollution due to several reasons; They includes the extensive use of chemical fertilizers and pesticides, the digging of lands to bury waste and industrial waste, the increase in its salinity percentage due to the intrusion of saltwater from the sea.

9. References:

[1] Rashid S 2017 The effects of the economic problems of environmental pollution in Iraq and ways to address them. Al-Mustansiriya Journal for Arab and International Studies. 14 p.103.

[2] Baya B 2008 Environmental Pollution and Development in Medea of Biskra, Master Thesis (Algeria :Ministry of Higher Education and Scientific Research Matnouri Kastania University Faculty of Humanities and Social Sciences).

[3] Fadlallah S 2001. Environmental pollution and its impact on agricultural economic development. Assiut Journal of Environmental Studies. 20 PP. 82-84..

[4] Badran A 1988 Environmental Pollution Its Sources and Its Types Journal of Science and Technology. 4 P.7.

[5] Ewaid, S.H., Abed, S.A., 2017. Water quality index for Al-Gharraf river, southern Iraq. Egypt. J. Aquatic Res. 43 (2), 117–122. http://dx.doi.org/10.1016/j. ejar.201703001.

[6] Ewaid, S.H.; Abed, S.A.; Al-Ansari, N. Crop Water Requirements and Irrigation Schedules for Some Major Crops in Southern Iraq. Water 2019, 11, 756.

[7] Ewaid, S.H.; Abed, S.A.; Al-Ansari, N. Water Footprint of Wheat in Iraq. Water 2019, 11, 535.

[8] Ewaid, S.H.; Abed, S.A.; Al-Ansari, N. Assessment of Main Cereal Crop Trade Impacts on Water and Land Security in Iraq. Agronomy 2020, 10, 98.

[9] Ewaid, S.H.; Abed, S.A.; Al-Ansari, N.; Salih, R.M. Development and Evaluation of a Water Quality Index for the Iraqi Rivers. Hydrology 2020, 7, 67.

[10] Al-Saati A 1988 Water Pollution. Journal of Science and Technology. 4 PP.13-14,16.

[11] Hashim N 2005 .The problem of water pollution in Iraq and its future prospects. Studies and research in the Arab world. 17 PP.174-176

[12] Adejumoke I, Babatunde A,Abimbola O, Tabitha A, Adewumi D. and Toyin O 2018 .Water Pollution: Effects, Prevention, and Climatic Impact( London ,UK: Intech Open).
[13] Mohammad N 2016 Determinants of Wastewater Pollution in Karbala Governorate for the Year 2016. Journal of the College of Basic Education. 25 PP.905-906.
[14] Nesaratnam S 2014 Water pollution control (United Kingdom: John Wiley & Sons Ltd).
[15] Saha A, Zaman S and Mitra A 2017 Assessment of Coastal Water Quality using Aquatic Health Index (AHI), Parana Journal of Science and Education (PJSE). Vol. 3, No. 6 pp35-37.
[16] Hamida M, Hamida N, Hamida A 2017. Introduction to Nanotechnology: Its Definition, Terminology, Presence and Applications in the Environment, Libyan International Medical University Journal. Volume 2, 1 p.18.