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The Environmental Impact of Pollutants and Heavy Materials on the Water Quality in the Tigris River

Mahmood S. Al-Saedi[1*], Sepanta Naimi[1], Zainab T. Al-Sharify[2,3]

[1] Department of Civil Engineering, Faculty of Engineering and Architecture, Altınbaş Üniversitesi, Bağcılar 34217, İstanbul, Türkiye
[2] Environmental Engineering Department, College of Engineering, Mustansiriyah University, Baghdad 14022, Iraq
[3] Chemical Engineering Department, College of Engineering and Physical Sciences, University of Birmingham, Edgbaston B15 2TT, Birmingham, United Kingdom

Corresponding Author Email: mahmoodluaibi@gmail.com

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ABSTRACT

This research aims to understand the characteristics of the Tigris River and the possibilities of human use in Baghdad. Samples for this study were collected for analysis from three separate districts in Baghdad, Iraq. Three sites in the upstream, middle, and lower downstream regions of the study area were used to collect river water samples (East Tigris Water Project, Al-Shuhada Bridge Project, and Al-Rasheed Project). To verify that the water is suitable for human needs including drinking water, agriculture, and industry, several tests have been carried out; The study data from the year (2005-2020) PH, Cl, NO_3, PO_4, SO_4, Na, Ec, Ca, K, Mg, TH and TDS are among these tests. And the results of the three projects in the water characteristics of the Baghdad River. The results showed that SO_4 was within the allowed in (East Tigris Water Project, and Al-Shuhada Bridge Project) and was higher than allowed in Al-Rasheed Project, while (PH, NO_3, PO_4, Ca, TH, and K) were all within the allowed range (Project East Tigris Water, Al-Shuhada Bridge Project). According to the World Health Organization, Ec had readings a few above the permissible levels and the TDS was above the permissible limit.

1. INTRODUCTION

The Tigris River is one of Iraq's twin rivers, which is one of the factors contributing to the rise of Mesopotamia's great civilizations. The Tigris River flows across Turkey, Syria, and Iraq after rising in the torso mountains in southeast Turkey. A few of the inlets of the Tigris are the Greater and Losser Zabs, the Al-Adhaim and Diyala Rivers, the Botmans, the Kessora, the Al-Khabour, and the Kessora [1]. At Shatt al-Arab, the Tigris River runs out. It is 1418 kilometers long overall in Iraq. The river picks up rubbish from Iraqi cities as it flows past several of them. With millions of residents, Baghdad is regarded as the most populous and industrialized metropolis in Iraq. The majority of its industrial and municipal pollutants are dumped untreated directly into the river. Despite this, there are no statistics on the level of Tigris River contamination in this region [2].

In nations with desert and semi-arid climates, like Iraq, water is the most valuable natural resource since it affects population demography and economic growth. Half of the world's population is anticipated to reside in water-stressed regions by the year 2025 [3]. As more urgent needs arise, irrigation water usage decreases due to source limitations [4]. More than 70% of all harvested water is used for agricultural purposes [5]. It is crucial to use cutting-edge water treatment technology to control existing water supplies and uncover potential sources since water for effective agriculture must meet specific quality criteria. [6]. Numerous physical, chemical, and biological elements define the quality of water. Water quality is controlled by the geological structure in addition to a wide range of chemical characteristics, and this includes organic pollutants (substances), salts, nutrients, heavy metals, sediments, and so forth. Reusing wastewater with better agricultural water has attracted attention on a global scale [7]. This type of reuse is a great way to manage water resources because of recurring droughts or lack of availability [8]. alternate water sources are readily available throughout the climate season for agricultural irrigation [9]. To safeguard the sustainable supply of natural water due to climate change, massive dams have been built and research has been done experimentally or through CFD modeling. There have been several attempts to apply sustainable approaches in a range of different aspects, not only for water resource management but also in everything else around the world and the resulting medical issues [10]. environmental problems. Additionally, it can remove oil and heavy metals from effluent. To purify wastewater and separate gases, they use polymers such as nanoparticles, nanotubes, fibers, and activated carbon. Polymer composites and nanocomposites are used in environmental research [11]. Extensive mechanical research on membranes for gas separation and wastewater treatment, particularly when using polymer nanocomposite adsorbents, which offer excellent hydraulic and mechanical properties. Other uses for it have been mentioned in the literature [12]. Numerous writers have looked at how high-power technologies are used today, and some have even designed an experimental radio frequency that can be used in wastewater treatment facilities [13-29]. Increasing agricultural productivity requires constant monitoring and analysis of irrigation water quality. Based on the results of their investigation, the World Health Organization (WHO) and the United States Environmental Protection Agency (US EPA) have suggested modifications to recommendations or water quality criteria for safe wastewater reuse [14].

Freshwater quality degradation, particularly with regard to harmful organic compounds, salinity, and trace elements, is becoming more significant and necessitates expensive treatment. A major issue that contributes to water depletion is the discharge of untreated wastewater into fresh watercourses or lakes for applications of treated wastewater dilution. For the indirect re-use of wastewater as agricultural water, strong quality standards are also crucial [15]. Several ecologically viable agro-environmental irrigation technologies that can be employed in a dry climate with a fuel water well field have recently had their running costs identified and quantified. A soil and water model were created utilizing soil and climate data gathered in northeastern Qatar, using water from a PW gas field, for example, to simulate irrigation of sugar beet. To avoid soil and groundwater salinization and heating, a variety of irrigation techniques have been used, such as excessive irrigation and combining PW with treated wastewater. Japanese stock exchange. According to simulation outcomes, irrigation with a mixture of 2/3 PW and 1/3 treated wastewater (or desalinated PW) at a volume equivalent to 300% of total water needs may help preserve soil stability, crop output, and groundwater quality. Statistics showed that mixing PW with the same volume of TSE or four similar volumes of sweetened PW, both of which cost $0.26/m^3 and $0.46/m^3, respectively, was the most economical course of action. Due to PW's low cost and efficient usage in the oil and gas industries, where disposal rates range from $0.06 to $16.67 per cubic meter [16], irrigation is becoming increasingly interesting.

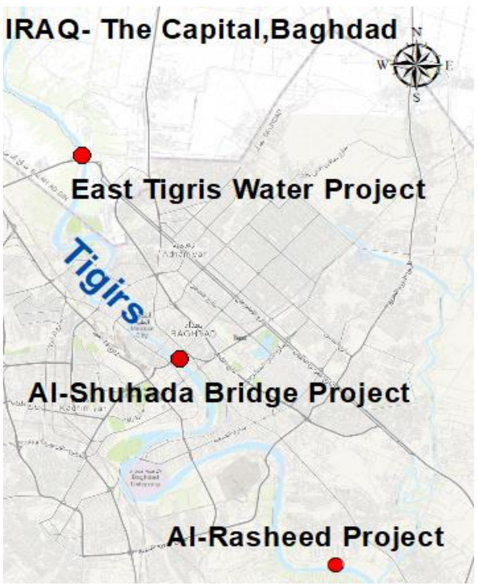

Figure 1. Map of Iraq River Tigris within Baghdad City [17]

According to Figure 1 of the Tigris River in the city of Baghdad, Iraq, where three water treatment plants were studied (East Tigris Water Project, Al-Shuhada Bridge Project, Al-Rasheed Project) as shown in Figure 1, and the study areas were chosen in the capital, Baghdad, because they contain the highest rate People were taken the first station in the city of Baghdad and a station in the center of the city and a station at the end of the city to find out the amount of water pollution due to the flow of the river in the center of the city to the highest population level, and that the city is hot and dry in the summer and cold and rains in the winter and moderate in the spring and autumn, the purpose of the research is to assess the quality of the river water Tigris in Baghdad and determining whether its water is suitable for human use as drinking water, industrial. MATERIALS, Cultivation, and Verification of the Degree of Using River Water for Sustainable Irrigation.

2. METHOD AND MATERIALS

2.1 Water samples: Gathering and analyzing data

The issue of water is considered one of the most important pillars of national security in any country such as Iraq, as it suffers from a shortage of water sources, a decline in lakes, and the drying up of some tributaries coming from neighboring countries, especially in arid and semi-arid regions that depend on limited water resources that are frequently imported from abroad. And the Iraqi borders have rivers and streams from the neighboring countries Turkey, Iran and Syria, and they flow into the Arab marshes in the Persian Gulf, as is the case with Iraq. Water samples were taken from the stations by the Iraqi Ministry of Environment and analyzed in the laboratory using (SPECTROIL M device) analysis (Ca, K, Na, Mg) and (MP-6 device) analysis (TDS, Ec, pH) and (DR 3900 device) Analysis (SO_4, PO_4, NO_3) and (burette) analysis (CL, TH).

3. RESULTS AND DISCUSSION

Planning to use contaminated river water for irrigation helps prevent various environmental pollution issues that can arise if this water is released into the environment carelessly as it can pollute soil and groundwater. The easiest way to get rid of it is to reduce the amount of pesticides for the lands along the river that need to be cleansed before utilizing this water, as well as municipal, industrial, and health water pollution of the river. The growing demand for timber places high importance on the usage of water for forests in emerging nations. Due to global warming, which increased temperatures in arid regions like Iraq and the Arabian Peninsula and the lack of water, the lack of agriculture in Iraq and the region, which led to a significant increase in dust storms in the region, its use to irrigate green belts around cities helps in controlling dust storms and at the same time improving the environment. Results of testing samples collected from various locations (East Tigris Water Project, Jisr Al-Shuhada Project, Al-Rasheed Project) The drawings of all the research's components revealed a disparity in the percentages of the examinations. Table 1 lists the results of the laboratory tests that were performed in terms of chemistry, physics, and biology to determine whether or not this water was suitable for consumption. For the preceding years, tests for PH, Cl, NO_3, PO_4, SO_4, Na, Ec, Ca, k, Mg, TH, and TDS were conducted.

Since it doesn't appear that river water may be used directly for drinking, industrial, or other treatments, it must first be treated. The proper use of river water for use after-treatment, however, must take into account the outcomes of the assessments made by the Ministry of Environment between 2005 and 2020 as well as environmental determinants.

Table 1. Iraqi Standards and World Health Organization [18-29]

Parameters	(Iraqi Standards, 1976)	WHO Guideline (WHO, 2011)
Ph	6.5-8.5	6.5-8
PO_4	0.4	250
NO_3	15	<50
SO_4	200 <	<250
CL	200 <	<250
TH	-	500
Ca	-	<1000
Mg	0.1	220 - 260
TDS	-	500
Ec	-	1000
k	-	50
Na	-	-

3.1 Results of pH values

The activity and activity of the hydrogen ion in water is expressed by the pH. Most natural waters have a pH value that ranges between (4-9), and the introduction of pollutants into the water leads to a decrease and increase in this value. The result of chemical analyzes revealed that the (pH) value is within the acceptable range for drinking and irrigation. When the degree of pH change was measured, its value in the three projects showed the highest rate of change (8.2) the high pH is due to the CO_2 emitted from factories and oil fields and climate change in the region, which causes an increase in gases in the air and is absorbed by water and rainwater. In the three projects, the lowest percentage (7.35) was observed (East Tigris Water Project, Al-Shuhada Bridge Project, Al-Rasheed Project) and this indicates that the value of the acid function is affected by the quantity and quality of pollutants emitted. to the river, as well as the temperature, which means that the function is either neutral or basic, and this is a good indicator because the pH values have negative effects on the river through the occurrence of reactions in an acidic medium more than in an alkaline medium, due to the evaporation process carried out by microorganisms, of which carbon dioxide is a metabolic byproduct. We also note the variation of the pH value at each site relative to the other region due to the difference in temperature and sample points, as well as the effect of the pH ratio through the photosynthesis of aquatic plants and phytoplankton as shown in Figure 2. The pH value, when compared with the permissible limits and environmental standards for the quality of river water according to the amended Iraqi Rivers Conservation System No. 25 of 1976 Determinants of the Iraqi Ministry of Environment for river water, falls within the permissible limits (6.5-8.5) and also within the permissible limits and environmental standards of river water from (6.5-8) according to WHO (2011).

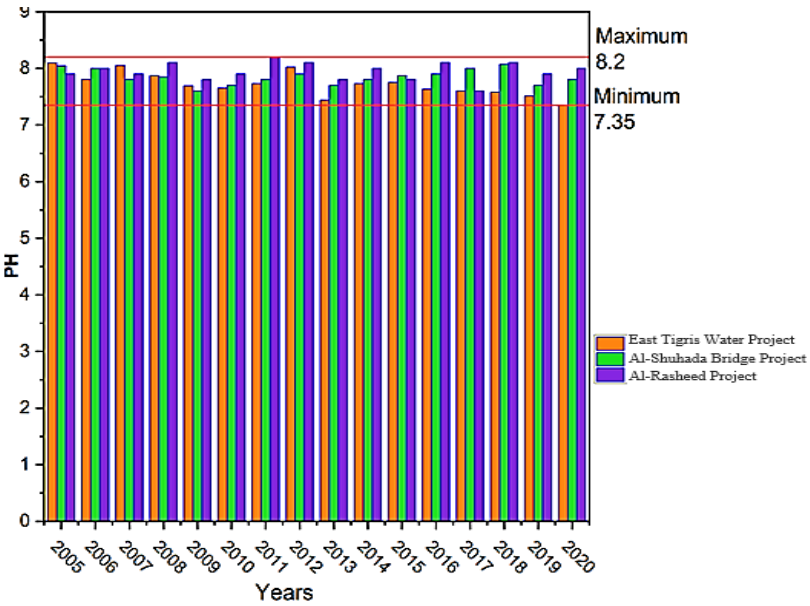

Figure 2. (pH) Values

3.2 Results of phosphate (PO_4) values

In liquid or residue form, phosphorous compounds are found in water sources and domestic and commercial wastewater discharged into rivers. The sediment at the bottom contains it. Waste excreted in water can be used to estimate its phosphate content. Makeup is also affected by the pH of the water. The three different types of phosphorous compounds that are soluble or suspended in water are phosphates, organophosphates, and polyphosphates. Phosphorous chemicals in water are mainly obtained from fertilizers and washing powders. Phosphates are mostly created by draining irrigation water or fertilizer waste that has been rinsed out by rain. While polyphosphates are created by disposing of waste from washing powders or household wastewater containing washing powders as they enter into polysulfate trisulfate, organophosphates are produced primarily through the vital activities of aquatic plants, where the phosphates are converted into phosphates, organic, triphosphate, salt [19]. However, the source of pollution is phosphorous itself, a vital nutrient for aquatic plants, a component of photosynthesis, a factor in the abnormal growth of lichens and algae in the water, and a factor in the amount of dissolved oxygen. in it. According to the Iraqi specifications, the concentration of phosphate in the East Tigris Water Project in 2010 and 2011 and the Shuhada Bridge Project in 2010, 2011, and 2012 exceeds the permissible limits and environmental standards. The use of cleaning materials such as soaps and powders of all kinds, where the ratio was between (0.18 mg/l - 0.49 mg/l) and the permissible limits were (0.4 mg/l) according to the amended Iraqi Rivers Maintenance System No. 25 of 1976 Determinants of the Iraqi Ministry of Environment for river water, in addition to the land of Iraq is gypsum land. This is evident from the results of chemical analyzes in Figure 3. For all projects (East Tigris Water Project, Jisr Al-Shuhada Project, Al-Rasheed Project), the value of phosphate falls within the environmental constraints and standards for irrigation water. According to the Iraqi Rivers Maintenance System No. 25 of 1976 Determinants of the Iraqi Ministry of Environment for river water, as amended.

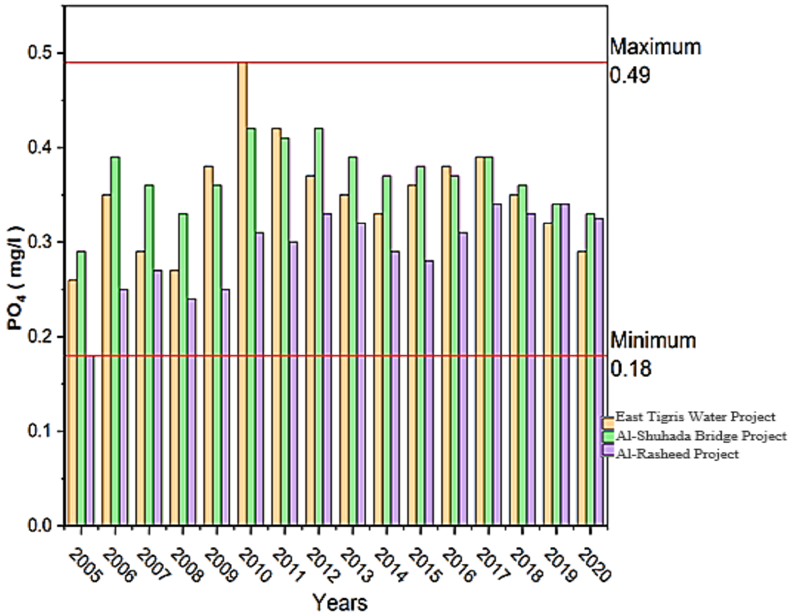

Figure 3. Phosphate (PO_4) values(mg/l)

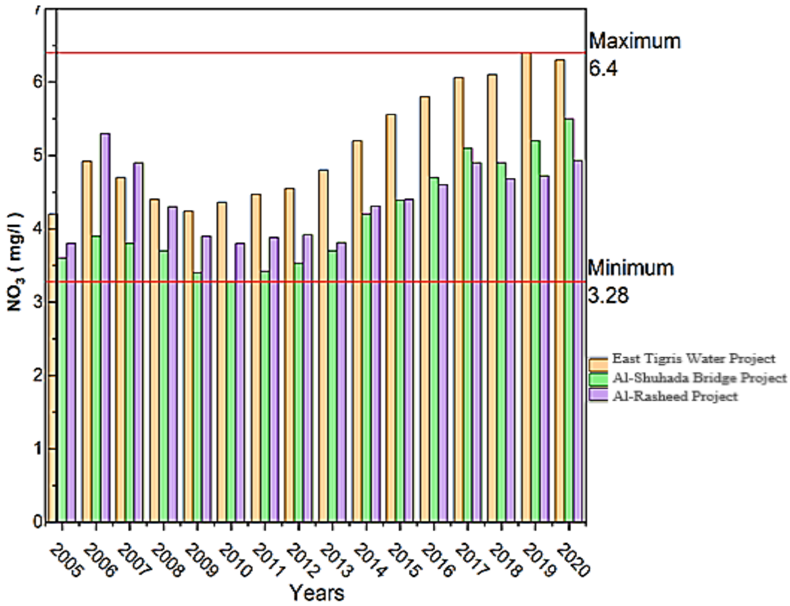

Figure 4. Nitrate (NO_3) values(mg/l)

3.3 Results of nitrate (NO_3) values

Since it is hydrophilic and has the potential to regenerate, nitrate is often used in agricultural fertilizers. Ammonia, sodium nitrate, potassium nitrate, and calcium nitrate are examples of primary nitrates. During the nitrification process, certain bacteria produce nitrates. The breakdown of protein in the soil results in ammonia particles, which are then oxidized by Nitrosomonas bacteria to nitrites, which are then oxidized by Nitrobacter bacteria to become nitrates. The bacteria act as a nitrogen-reducing agent in the absence of oxygen. These processes are used in wastewater treatment plants to eliminate nitrogenous pollutants, turning nitrates into nitrogen, this is done through the aeration basins (aerobic biological processes) in the wastewater treatment plant, which is bacterial, as nitrogen is the DNA of proteins, amino acids, some fats, and others. If eaten in moderation, nitrates may not be harmful to an individual's health but may be a problem for young children and those with abnormal gut microbiomes [20]. Figure 4 shows that the value of nitrate was within the permissible range of (3.28 mg/l -6.4 mg/l) according to the Iraqi Rivers Conservation System No. 25 of 1976 Determinants of the Iraqi Ministry of Environment for river water, the average rate of which is (15 mg/l) and the World Health Organization (Who) allowed less than (50 mg/l).

3.4 Results of sulfate (SO_4^{+2}) values

Oxidation of sulfides generated from natural rocks (pyrite), breakdown of sulfur organic matter, and reduction of sulfates by cracking of sulfur organic matter and anaerobic bacteria constitute the natural source of sulfur in the soil. As for its synthetic origins, it results from the spillage of industrial water and the dissolution of some chemical fertilizers used in agriculture. Sulfur, which consists of oxygen and the stable substance known as the negative sulfate ion, is present in natural waters with the highest degrees of oxidation. Gypsum salt, a natural sulfate ion, is soluble in water and has a concentration that is inversely related to the solubility of calcium sulfate (gypsum) in water. According to the results of the chemical study, the sulfate value in Figure 5 is within the permissible limits according to the amended Iraqi Rivers Conservation System No. 25 of 1976 Determinants of the Iraqi Ministry of Environment for river water, while in the East Tigris Project in 2005, 2006. And 2007 it was less than the permissible (200 mg/l) [21]. According to the World Health Organization (250 mg/l), sulfates are considered permanent hardening substances in water, especially when they are in the form of calcium and magnesium sulfate, and it is salinity-causing substance if it exceeds the permissible limits.

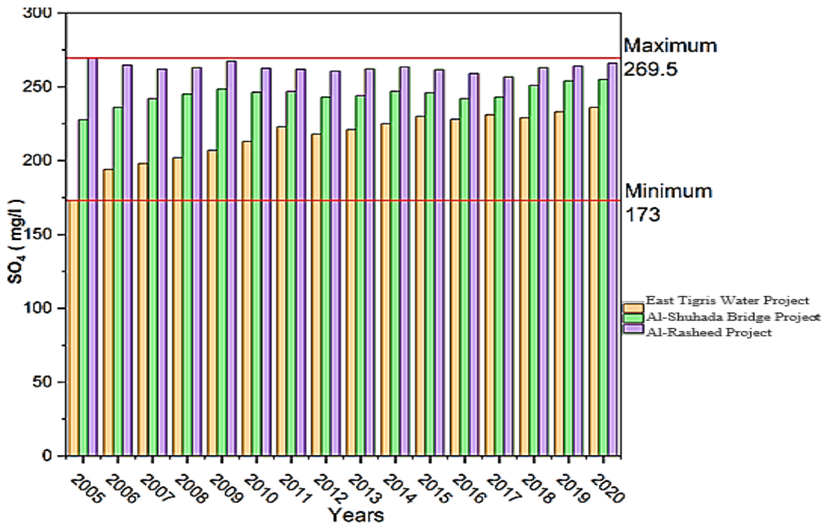

Figure 5. Sulfate (SO_4) values(mg/l)

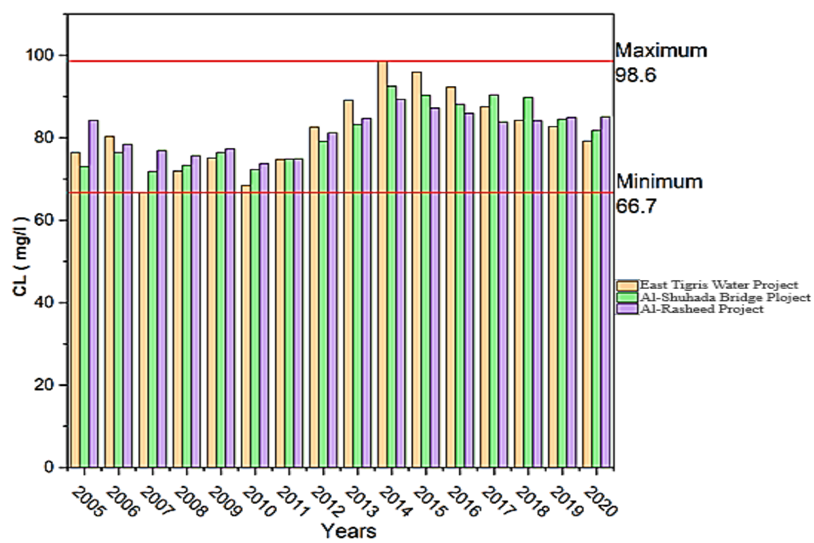

Figure 6. Chlorides (CL) values(mg/l)

3.5 Results of chlorides (CL) values

A prominent inorganic component in wastewater is chloride. Although most of them are found in the oceans, they are found throughout nature in the form of sodium, potassium, and calcium salts, making up 0.05 percent of the Earth. It occurs naturally in salt deposits, chemical waste, and oil well operations. The concentration of chloride ions in water, among other chemical elements, determines the salinity of the bait in the water [22]. Where the concentration of chloride is 250 mg/liter according to the World Health Organization and 200 mg/liter according to the amended Iraqi Rivers Maintenance

System No. 25 of 1976 Determinants of the Iraqi Ministry of Environment for river water. The information in Figure 6 was within the permissible limits, as it ranged between (66.7 mg/l -98.6 mg/l).

3.6 Results of total hardness (TH) values

The average total hardness of the Tigris River in the Baghdad region was (253.6 mg/l -394 mg/l) total water hardness in Baghdad is within the permitted range of the World Health Organization (500 mg/l). Moreover, the detection strategy based on the slightly discussed self-calibration technique improves the detection accuracy significantly [20]. However, hardness is not the appropriate criterion for irrigation water as calcium and magnesium are useful ions in the soil. The information is given in Figure 7.

3.7 Results of calcium (Ca) values

One of the main inorganic cations, or cations, in both freshwater and saltwater, is calcium, which exists as the Ca^{2+} ion. It can develop when salts like calcium chloride or calcium sulfate dissolve in water. The majority of the calcium in surface waters is produced by currents passing through calcium-containing rocks and minerals such as limestone, $CaCO_3$, gypsum, and $CaSO_4$ $2H_2O$. Calcium carbonate dissolves more readily in water that has a substantial amount of dissolved carbon dioxide than it does in water that is relatively insoluble in calcium carbonate. The range of calcium ions (Ca^{2+}) in freshwater is 0 to 100 mg/L, and this is often the region where this cation is most abundant [21]. The acceptable limit for drinking water is 50 mg/L. Elevated amounts are not thought to pose a health risk, although levels above 50 mg/L may be troublesome owing to the buildup of too much calcium carbonate in pipes or the inadequate cleaning power of soap. Fresh water can only sustain sporadic plant and animal life if its calcium ion content is over 5 mg/L. The information in Figure 8 is within the World Health Organization's permitted range, which is less than 1000, and the readings were between (56.1 mg/l – 98.2 mg/l).

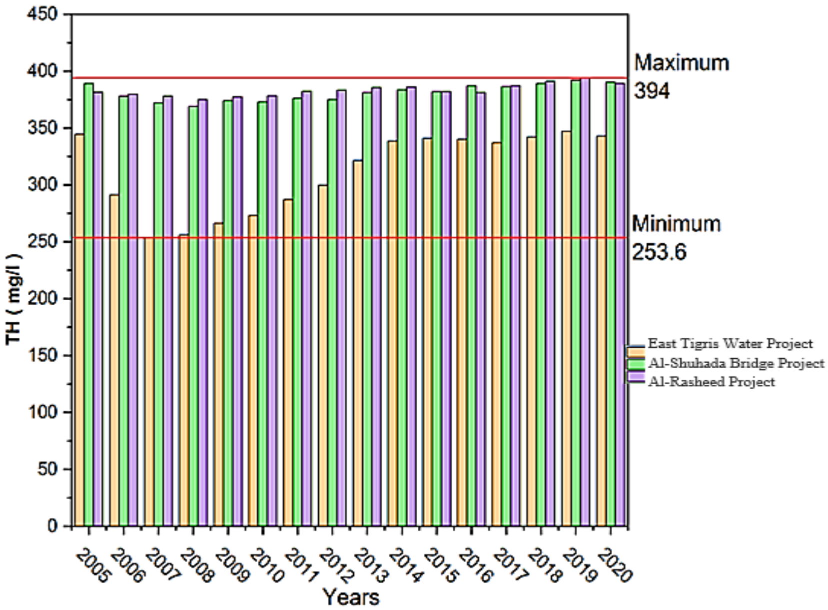

Figure 7. Total hardness (TH) values(mg/l)

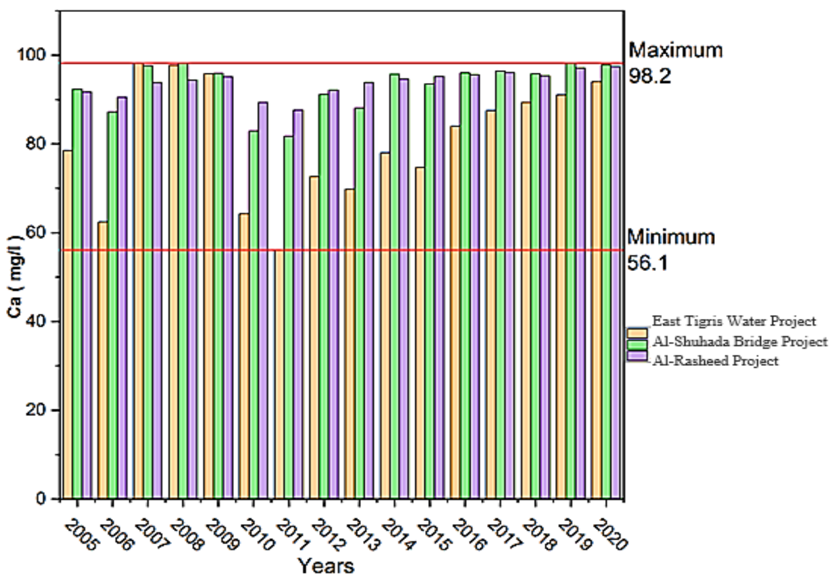

Figure 8. Calcium (Ca) values(mg/l)

3.8 Results of magnesium (Mg) values

Eriochrome black T is used as an indicator during a complex metric titration with EDTA standard solution under pH 10.0 buffer conditions. Mg^{2+} is the most prevalent aquatic species. More complex than calcium reactions, magnesium carbonate equilibrium reactions often result in direct precipitation of dolomite in natural waters. Magnesium salts are an important cause of water hardness, and they decompose at high temperatures and produce scales in boilers. Magnesium is found in the water and the crust of rocks because the study area is within the Tigris River, so it gains part of the magnesium through its passage Runoff through the rocks located in southern Turkey and northern Iraq, and the percentage of magnesium was low because of the large distance between the water source and the study area. The associated hardness of magnesium is reduced to acceptable levels using chemical softening, reverse osmosis, or ion exchange. Magnesium is necessary for the formation of red blood cells and chlorophyll. Some magnesium salts can be harmful when ingested or inhaled. The values in Figure 9 ranged between (27.1 mg/l - 37.4 mg/l), which is less than what is allowed by the World Health Organization (220-260) and more than what is permitted according to the modified Iraqi Rivers Conservation System No. 25 of 1976 Determinants of the Iraqi Ministry of Environment for river water (0.1 mg/l). Concentrations greater than the concentration of magnesium in the water are useful when this water is used for irrigation [22].

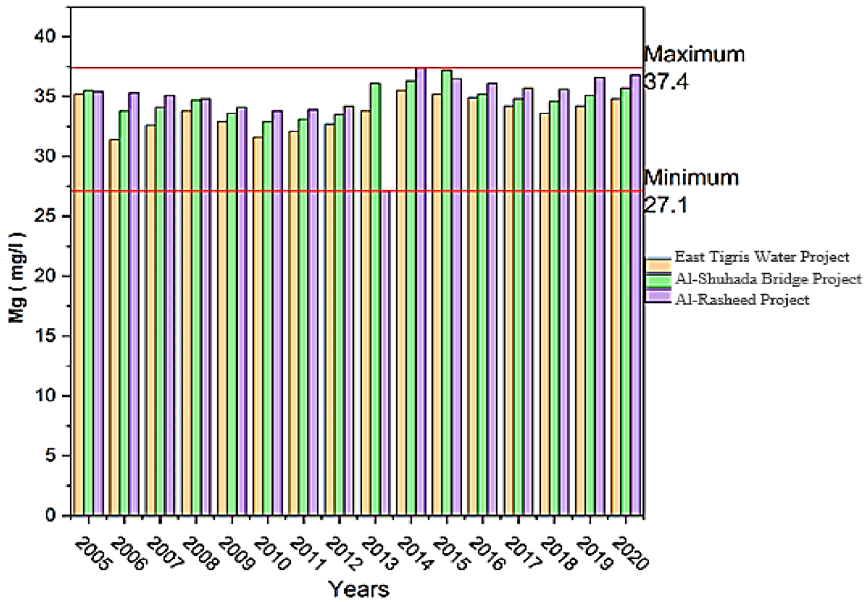

Figure 9. Magnesium (Mg) values(mg/l)

3.9 Results of total dissolved solids (T.D.S) values

Currents involve solids in three different states: suspended, volatile, and dissolved. The sources of TDS are from sanitary and industrial wastewater plants and the surface runoff of agricultural irrigation water because the solids in the soil and rocks (minerals, salts and organic materials) are in suspended or dissolved form, but the volatiles are from chemical particles from the combustion of plants and animals or industrial chimneys. And TDS is not bad because it contains some minerals such as carbonate deposits and mineral springs, and it may end up in drinking water from water seepage from the sea, or from the addition of some snow removal materials from the roads. Examples of suspended solids are silt, agitated bottom sediments, decomposing plant residues, and wastewater treatment effluents. Filters allow dissolved material to pass through but not suspended particles. Several factors affect the amount of dissolved solids in a body of water [22]. Various ions can be added to the stream by fertilizers used in lawns and farms. Runoff from salt-filled roads throughout the winter can also cause an increase in TDS. Larger amounts of nitrate or phosphate ions may be produced by organic matter from wastewater treatment facilities. Many aquatic life forms are affected by large concentrations of dissolved solids, especially when dissolved salts are present. Salts cause dry skin of animals. TDS concentrations in lakes and streams generally vary from (50 to 250 mg/L). Dissolved solids (TDS) readings may be up to (500 mg/L) in areas of exceptionally hard water or excessive salinity. The solids in water or other liquids that are lost when the dry particles burn at a temperature of 1020°F are known as volatile solids (550°C). It is a measure of water quality derived from the total loss of suspended particulate matter in the ignition. They are essential for sewage and water treatment. It usually refers to the volume of organic matter present in the water. In the case of wood pulp extraction waste fluids, it is useful to quantify the biologically inert organic matter, such as lignin. It is said that any substance can rapidly transition from its solid phase to its vapor phase without going through a liquid phase that is volatile. Domestic wastewater contains 50% of organic solids that pollute fresh water and land. The majority of these solids are made up of synthetic chemical molecules, dead animals, and dead plants. It may be set on fire or incinerated. They are referred to as volatile solids because the organic component may be forced out at high temperatures. We note that all the data in Figure 10 exceeded the permissible limit, ranging between (498.9 mg/L - 668 mg/L) for the World Health Organization (WHO) and (500 mg/L) for freshwater or river water.

3.10 Results of electrical conductivity (Ec) values

Temperature, alkaline pH level, total hardness, calcium, total solids, total dissolved solids, the necessary chemical oxygen chloride, and iron content in water are closely related to conductivity. The geology of the location where the water flows have a significant impact on the conduction of streams and rivers. Granite contains more inert minerals that do not ionize (dissolve into ionic components) when washed in water, and thus areas of granite bedrock tend to have lower conductivity [23]. Since clay soils contain substances that ionize when washed with water, currents traveling through these places tend to have greater conductivity. The effects of groundwater flows can be the same regardless of the bedrock through which they pass. Depending on their composition, the discharge can turn into conductive fluxes. due to the presence of Chlorides, phosphates, and nitrates in the failure of the sewage system, the conductivity will rise; Oil spillage will cause conductivity reduction. The information in Figure 11, some readings were higher than the permissible according to the World Health Organization (1000 µm/cm), it shows that the electrical conductivity is higher than the permissible range between (825.4 µm/cm - 1047 µm/cm) due to the increase of minerals in the water and for the three sites.

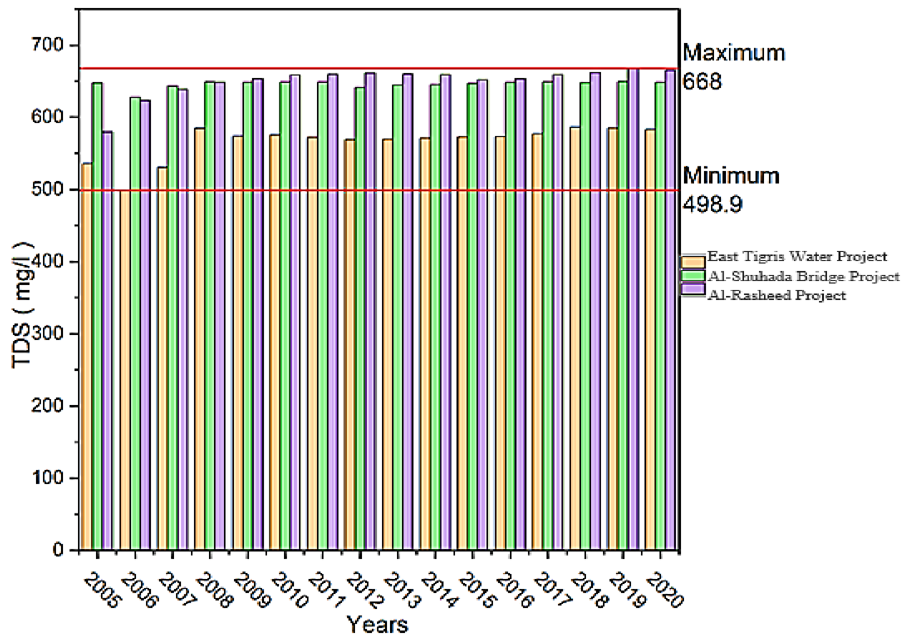

Figure 10. Total dissolved solids (TDS) values(mg/l)

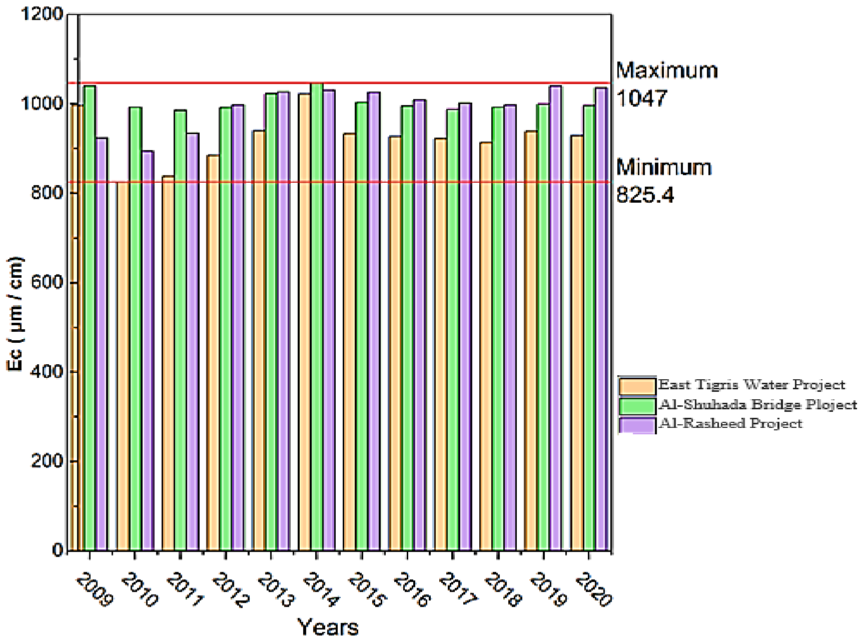

Figure 11. Electrical conductivity (Ec) values (µm/cm)

3.11 Results of potassium (K) values

Potassium is a silvery-white alkaline substance that is highly reactive to water. All human, animal, and plant tissues contain potassium because it is essential for the health of the body. Plant cells in particular contain potassium. There is between 110 to 140 g of potassium in the average human body. It is essential for performing bodily processes including protecting the heart, controlling blood pressure, protein breakdown, muscle contraction, and stimulating nerves. A rare potassium deficiency can cause sadness, muscle weakness, irregular heartbeat, and other problems. WHO guidelines state that the maximum amount of potassium that should be present in river water is 50 milligrams per liter [22]. The results shown in Figure 12 showed that the potassium concentrations in the study areas, which ranged from (1.8 mg/1 to 3.5 mg/1), were within the acceptable limits (WHO) that allow (50 mg/1).

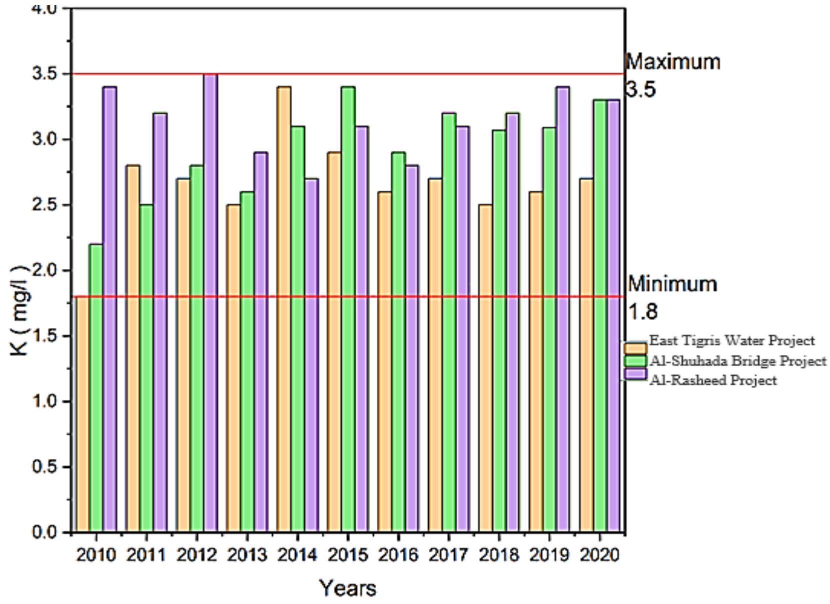

Figure 12. Potassium (K) values(mg/l)

3.12 Results of sodium (Na) values

Standardize the device. According to the information in Figure 13, the East Tigris Project's greatest reading was (77.3 in 2014), while the lowest reading (41.8 in 2012) was recorded there. By way of the sodium exchange process, relatively high quantities can be found in brine and hard water. In human illness and agriculture, the sodium to total cation ratio is crucial. High salt level has the potential to alter soil permeability. Water with a reduced salt content is necessary for those with specific disorders. Distillation or hydrogen exchange are two methods for removing sodium. Potassium is a crucial component of plant and human nutrition and is present in groundwater due to the dissolving of minerals [22].

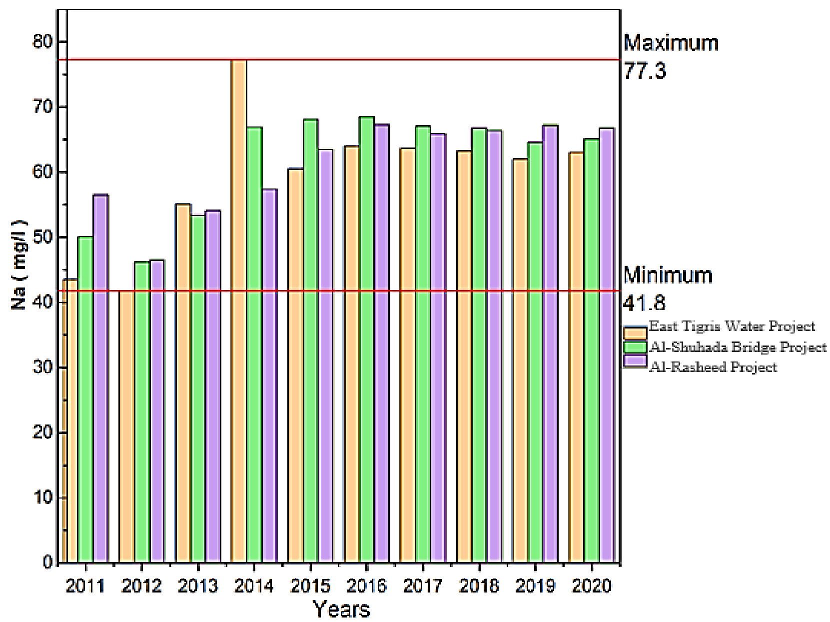

Figure 13. Sodium (Na) values(mg/l)

4. CONCLUSIONS

By analyzing the data from the three stations (East Tigris Water Project, Al-Shuhada Bridge Project, and Al-Rasheed Project), it was discovered that some elements fall within the WHO permissible limits and the Iraqi Ministry of Environment's specifications for river water, while others are less or more than they should be. due to the river's pollution-causing elements. As a result, both the percentage change and the change in the items inside it must be taken into consideration. The Iraqi Ministry of Environment's restrictions on municipalities, hospitals, industries, and other entities that discharge water directly into rivers should be somewhat strengthened in order to protect the river's wildlife. contaminated so that it may be used directly for irrigation, which has no negative effects on the soil or agriculture, and simplifying water treatment so that it costs less to treat in drinking water treatment facilities.

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