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Original Article

Evaluation of physiochemical parameters of the Third River South Iraq

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Abstract: Our study focuses on the physicochemical properties of the Third River in South Iraq and its suitability for irrigation. We collected samples from six stations along the river, each 10 km apart, to assess water quality parameters, viz. temperature, pH, total hardness, and electrical conductivity. Our results highlight seasonal variations and the influence of upstream industrial activities and regional agricultural practices on water quality. We interpret these findings in the context of international irrigation water quality standards and discuss their potential effects on soil health. Importantly, we provide practical recommendations for water management strategies that can be implemented to optimize the Third River for sustainable agriculture in South Iraq.

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Introduction

Water is a significant natural resource in urban and suburban areas in Africa and Asia; surface water resources are used for domestic and agricultural purposes (Kawo and Karuppannan, 2018). According to Al Mussawi (2014), water is an essential source of agricultural irrigation and human drinking water in Iraq, particularly in rural areas of the western desert. Irrigated agriculture is dependent on an adequate water supply of usable quality. Water quality concerns have often been neglected because good quality water supplies have been plentiful and readily available. Water quality is one of the most important determinants of agricultural productivity and environmental sustainability. Irrigation water quality seriously affects crop yield, land feasibility, and agricultural productivity (Ayers and Westcot, 1985).

The rapid decline of clean water resources, imposition of water supply, and increasing water poverty are the world's biggest problems. Climatic changes, droughts, and flawed industrialization result in extremely fast pollution and diminishing water resources. To avoid this problem, reducing the pollutant properties of waste and wastewater and improving the water quality required for water disposal to rivers is necessary. Because of human activities, irregular industrialization, and population increase, all these factors pollute drinking water and other natural resources rapidly. This has made it necessary to conduct operations so that people will become more conscious of such resources, increase the quality of their resources, and determine usage areas according to their quantities. Physical and chemical analyses are done to assess the water's quality and reveal the state of pollution (Gatea, 2018).

Due to increasing urbanization, surface water is contaminated, and more treatment would be required to make surface water usable. Therefore, it is necessary to study the physiochemical characteristics of surface water to find out whether it is fit for drinking or has some other beneficial uses (Abhineet and Dohare, 2014). Murhekar (2011) reported poor water quality, probably due to domestic waste discharge in the Akot River with high levels of TDS, total alkalinity, and sodium content, indicating the need for some treatments (Murhekar, 2011). The Third River is a major water source in South Iraq; therefore, this work aimed to determine some

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Table 1. Physicochemical parameters range of the studied stations.

Parameters	Range	Min-Max
PH	8.1	7.4-8.8
EC	44.8	20.13-56.3
T.H.	277	84-391
Temperature	23.6	23-24.3

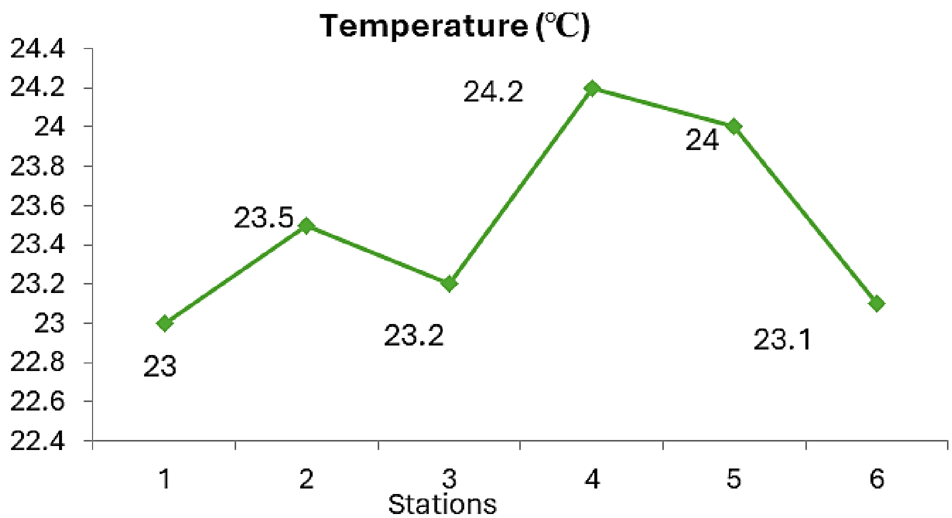

Figure 1. Temperature values in the studied stations.

physicochemical parameters of water in the Third River and their suitability for irrigation. For this purpose, the temperature, pH, total hardness (TH), and electrical conductivity (EC) levels were measured. These properties were analyzed for suitability and potential risks affecting agricultural irrigation, crop productivity, and soil quality.

Materials and Methods

Sampling: The samples were taken from the Third River using clean and dry 1-liter plastic bottles. Before sampling, the bottles were washed to avoid contamination. Sampling was done at six different stations along the river, each 10 km away from the other. The sampling was done 30 cm above the river's bed, parallel to the river's flow. Two samples were collected at each point to ensure the data was representative.

Measurement of parameters

Temperature: The temperature was measured in the field using a calibrated thermometer. The temperature undergoes seasonal and spatial changes that might affect the quality of the water.

pH: A pH meter was used to test whether the water was acidic or alkaline.

Total hardness (TH) and Electrical Conductivity (EC): TH and EC were measured to determine river water's mineral content and salinity, indicating its agricultural appropriateness.

Laboratory analysis: The samplings were transferred to the laboratory for further analysis. The analyses included ions, metals, and pollutants to assess irrigation standards. Temperature, pH, TH, and EC were measured for the physical parameters, and Ca4+, magnesium, sulfate, and chloride were used for chemical analysis.

Results and Discussions

The present study measured eight physiochemical properties at six stations along the Third River (Table 1). All these measurements were done in situ.

Water physical parameters

***Temperature*:** Changes in stream flow also substantially impact water temperatures, even though river, temperatures are often most susceptible to atmospheric conditions, especially during warm, dry

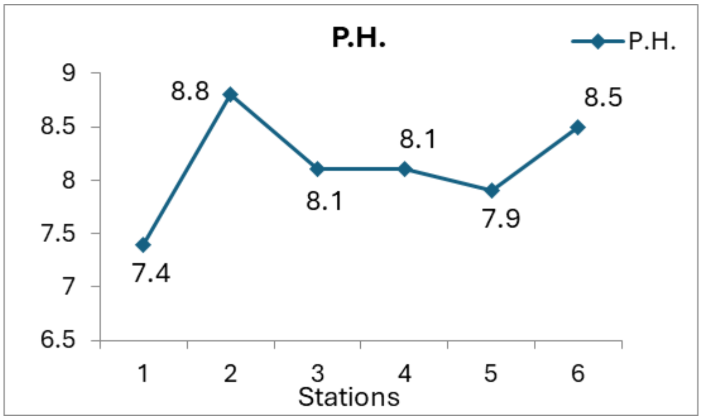

Figure 2. pH values in the studied stations.

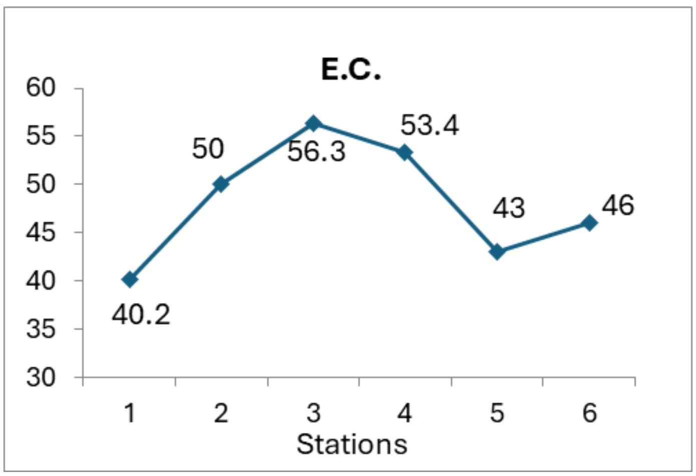

Figure 3. EC values in the studied stations.

times with low river flows. Therefore, when estimating future climate change impacts on river water temperature, the combined effects of atmospheric warming and variations in river flow should be considered (Van Vliet et al., 2013). The results indicated that the studied station's temperature values range from 23 to 24.3°C (Fig. 1, Table 1). These minor differences within the records demonstrate that samples were taken over short periods. The records also show that the rivers' temperatures were constant, with variations depending on seasons, time, and locality.

PH: Most natural waters are alkaline due to bicarbonates and carbonates formed by dissolved atmospheric carbon dioxide. pH can be drastically changed due to prevailing biochemical activities in water (Menon et al., 2012). Figure 2 illustrates that the pH records are almost similar across all stations, ranging from 7.4 to 8.8°C (Table 1). At site 1, the pH level is 7.4, which is slightly acidic to neutral; at site 2, it sharply increases to 8.8 (Fig. 2). The trend would be slightly acidic at 7.4 to basic at 8.8. There is an initial increase from site 1 to site two and a gradual decline with minor fluctuations afterward. PH is vital in adjusting biological functions, moderating microbial activities, controlling nutrient availability, and regulating chemical behavior.

Electrical conductivity: Electrical conductivity is caused by the presence of salts, acids, and bases, called electrolytes, capable of producing cations and anions. As conductivity is directly related to the presence of dissolved salts, its magnitude can give a fair idea of the level of dissolved solids (Menon et al., 2012). Figure 3 shows the EC value at site 1 is 40.2, while it increases to 56 at site 3. The general trend is an increase in EC from Site 1 to 3, a decrease to Site 5, and a slight increase at Site 6. High EC values indicate a high concentration of dissolved salts or ions. Variations within a location over time and fluctuations between sites show that the composition may differ between stations (Thompson et al., 2012). ***Total hardness***: Hardness is caused by divalent metallic ions, and there are two types of hardness, viz. temporary hardness known as carbonate hardness, and it is mainly due to the presence of carbonate and bicarbonates of Ca and Mg, which is removed by boiling (Menon et al., 2012). The T.H. value is 275 at site 1, the lowest, and increases at site 4, the highest (Fig. 4). The value of T.H. increased in the percentage of salinity from the first site. The value kept increasing at other locations due to pollutants from the industrial area or the sewages from the villages and natural processes such as dissolving and washing soil in the rain (Najaf et al., 2008).

Water chemical parameters

Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) ions: Calcium, in the form of Ca2+, is a major inorganic cation in saltwater and freshwater. It originates from the dissociation of salts, such as calcium chloride or calcium sulfate, in water. Calcium carbonate is

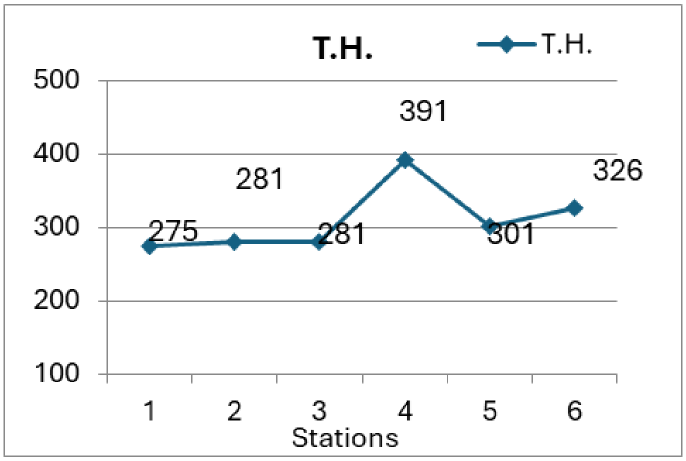

Figure 4. Total hardness values in the studied stations.

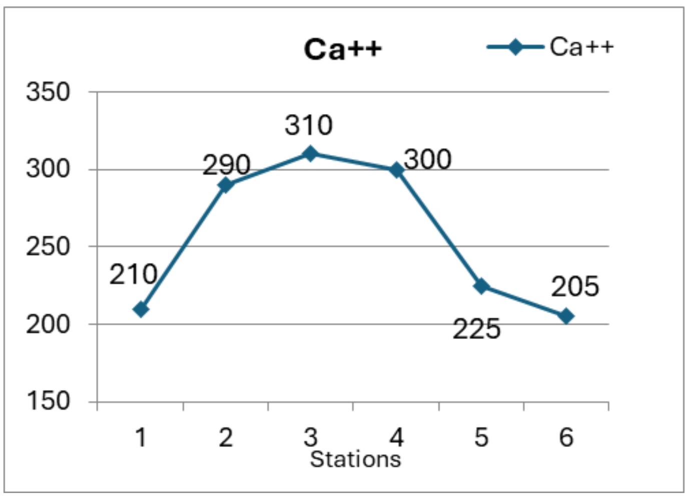

Figure 5. Calcium ion values in the studied stations.

relatively insoluble in water but dissolves more readily in water with significant levels of dissolved carbon dioxide (Bhateria and Jain, 2016). The calcium value is 210 at site 1, sharply increasing to 310 at site 3 (Fig. 5). The carbonate equilibrium reactions for Mg^{2+} are more complicated than for calcium, and conditions for direct precipitation of dolomite in natural waters are uncommon. Magnesium salts are important contributors to the hardness of water; they break down when heated, forming scales in boilers (Bhateria and Jain, 2016). the magnesium value is 120 at site 1, increasing to 219 at site 3 (Fig. 6). The results show that the water is hardened due to human activities such as sewage entering the river directly. In addition, the study area is located within the region of geological tectonics (Bhatnagar and Devi, 2013).

Sulphate **(*SO_4^{2-}*):** Sulphate ions usually occur in

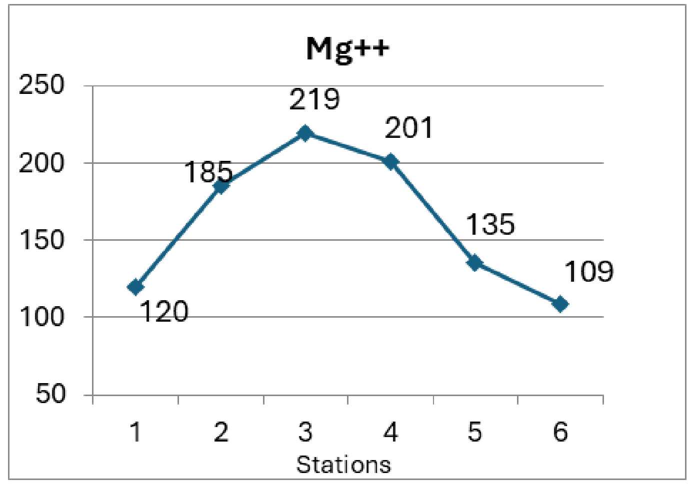

Figure 6. Magnesium ion values in the studied stations.

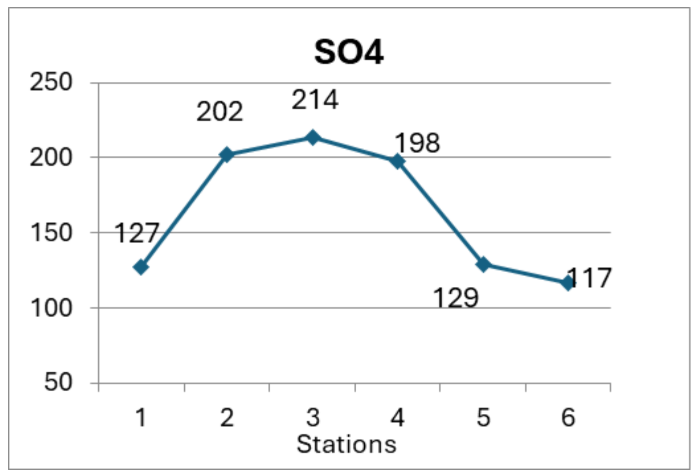

Figure 7. Calcium ion values in the studied stations.

natural waters, and many sulphate compounds are readily soluble in water. Most of them originate from the oxidation of sulphate ores, the solution of gypsum and anhydrite, the presence of shale, particularly those rich in organic compounds, and industrial wastes. Atmospheric sulfur dioxide formed by the combustion of fossil fuels and emitted by the metallurgical roasting processes may also contribute to the sulphate compounds of water (Bhateria and Jain, 2016). The sulfate value is 127 at site 1, increasing to 214 at site 3 (Fig. 7). Sulphate is especially problematic where acidic soils and mine tailings are periodically affected by drought and rain and where sulfate acid is used to process ore and mineral concentrates. Sulphate may enter surface and groundwater from industrial sources by discharging or disposing of sulfate-containing tailings and seepage from acidic tailings ponds

(Moreno et al., 2009).

***Chloride* (CL) *ion*:** Chlorides are readi ly soluble in water and difficult to remove, and thus, concerns have been raised over their short-term and long-term risks to water quality, aquatic organisms, and human health. The chloride salts applied on winter roads can migrate into nearby surface waters and impact them via various pathways (Nazari et al., 2015). The chloride value is 286 ppm at location 1 and increases to 367 ppm at site 3 (Fig. 8).

In short, temperatures varied between 23 and 24.3°C, showing differences across the six stations due to seasons and local factors. The pH measured ranged from 7.4 to 8.8°C, acceptable under allowable limits for irrigation purposes. Therefore, the water is neutral or slightly alkaline, hence suitable for plant growth. The variation of TH and EC were notable, with total hardness values ranging from 84 to 391 mg/L, while their EC varied between 20.13 to 56.3, showing water mineral content and salinity, respectively. Different mineral contents in the soil may be due to soil erosion through natural processes and industrial activities. The results showed the presence of Ca2+, Mg2+, SO_4^{-2}, and Cl ions within permissible limits for agricultural irrigation. Variations in the concentrations of these ions across various sites are evident, probably because they occur naturally or from human activities. Industrial discharges and local farming have led to certain areas having high levels of sulfate ions relative to other locations, leading to increased chloride ion concentration in a few cases (Nazari et al., 2015).

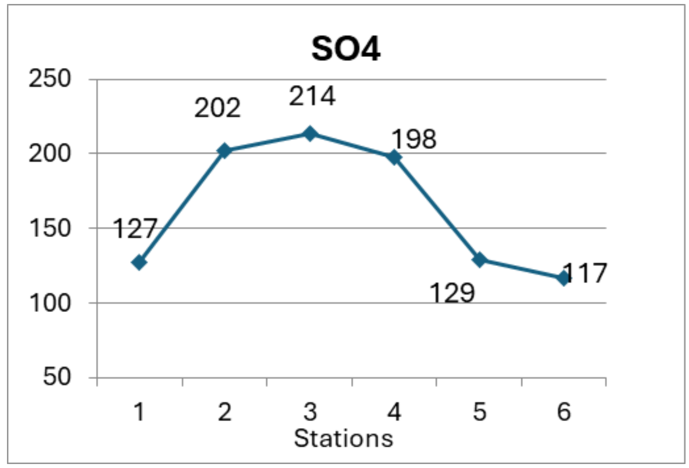

Figure 8. Chloride ion values in the studied stations.

Conclusion

In conclusion, the river's water quality was suitable for irrigation. The results recommend continued monitoring and management practices dealing with emerging challenges toward promoting sustainable water use in agricultural practices. Variations and risks detected make it possible to ensure, in the conditions of South Iraq, sustainable agricultural productivity and guarantee farming activity for the long term. Urbanization and deforestation can be stopped to maintain the quality of water. Water conservation and water treatment can save water from being polluted. The government is therefore called upon to enact strict laws and treatment technologies such as sedimentation, water treatment plants, and aeration to contain water pollution. Green agriculture will also help limit the amount of chemicals that enter the water (Jaffar et al., 2020; El Bilali and Taleb, 2020; Kumar et al., 2022; Anyango et al., 2024).

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