Water and Environmental Sustainability (WES)
ISSN: 2710-3404
DOI: 10.52293/WES.3.3.5964
H o m e p a g e: https://www.journalwes.com/

ORIGINAL RESEARCH PAPER

Impact of sub-rivers feeding the Shatt Al- Arab River on its water quality

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A R T I C l E I N F O

Keywords:
CCME WQI
Shatt Al-Arab
Water Quality Index
Basra
Iraq

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Article History:
Received: 12 Jan, 2023
Revised: 8 Mar, 2023
Accepted: 10 Mar, 2023

A B S T R A C T

This study's objective was to evaluate the physicochemical characteristics of the Shatt Al-Arab River in the Basra Governorate for irrigation purposes. These characteristics were pH, EC, Total Dissolved Solids, Calcium, Magnesium, Total Suspended Solids, and Nitrate. The Canadian Council of Ministers of the Environment (CCME) Water Quality Index (WQI) was applied to the analytical data of the parameters in order to fulfill the goal and produce a single value that was used to rank the river at each of the sample stations. The findings showed that some parameters studied in the Shatt Al- Arab River increased as it flowed through the study area, which could be primarily attributed to rising wastewater discharges into the river, which has a negative impact on the WQI values for these stations, which range from 41.6 to 43.6. As a result of these analyses, the Shatt Al- Arab River's water quality at the station's Karma Ali and Al-Sindbad is classified as "Poor quality" for irrigation purposes.

Introduction

One of Iraq's major rivers, the Shatt al-Arab provides water for drinking, irrigation, transportation, and other uses, and is significant for the country's agriculture, commerce, economy, and society. The Tigris and Euphrates rivers met near the city of Qurna, north of Basrah, creating a connection between fresh water from the rivers and saltwater from the Arabian Gulf for domestic and industrial uses.

The Shatt Al-Arab River (SHAAR) is one of the important rivers in Iraq due to its agricultural, commercial, economic, and social importance. It supplies water for drinking, irrigation, fishing, transportation, and various industrial uses. It is considered the link between fresh water from the Tigris and Euphrates and salty water from the Arabian Gulf.

SHAAR consists of the confluence of the Tigris and Euphrates rivers in the city of Qurna. The river is 204 m long, (400-2000) m wide, and (8-15) m deep. The depth of SHAAR changes from one region to another, so it is 8 m at the outer barrage in the northern Arabian Gulf. The deepest area of the SHAAR was North of Sindbad Island at 29 m, 24 m at Karmat Ali (Alsodani, 2018).

Throwing sewage directly into rivers is one of the serious breaches of the environment as a result of the increased loads of organic, chemical, and biological pollution of these resources, which leads to an environmental catastrophe because the sewage water is rich in organic substances that are exposed to a series of decomposition and biological oxidation processes by bacteria, especially in anaerobic conditions that lead to the formation of ammonia and hydrogen sulfide, as well as high quantities of fertilizers used for agricultural lands, causing a rise in the concentration of nutrients and negative impact on the ecosystem through the occurrence of cases of eutrophication and an increase in the number of blue–green algae (Yulia et al., 2013), which affects water quality and causes serious diseases to the aquatic environment and humans. The increase in nitrogen compounds, Which has a stimulating effect on cancerous diseases is formed. As for salts, increasing their concentration negatively affects the ecosystem and water quality and causes their increase in the toxicity of many pollutants, while some ions that cause hardness, such as calcium and magnesium ions, play a protective role to mitigate toxic effects, as toxic elements compete for absorption sites and inhibit the mechanical effect of some substances (CCME. 2014), and (Blaszczy, and Chodak, 2013). Therefore, this study came to give an image of the water quality in the SHAAR, in order to know its suitability for irrigation.

Water Quality

Water is one of the most important natural resources on the surface of the globe, especially freshwater related to sustaining life, and the physical, chemical and hydrological properties are affected by the quality of the water coming to it according to the feeding and storage conditions of the upper river basin. Water quality is determined by its components such as salts and minerals dissolved in water are necessary to determine water quality in terms of their impact on aquatic organisms or through their importance in human health or agricultural and industrial uses.

The reasons for the deterioration of the quantity and quality of the SHAAR are due to a group of factors, including the decline in the discharge of the Tigris and Euphrates rivers as a result of the construction of dams, the unstudied agricultural operations and the dumping of sewage water, solid waste, and sewage water directly into the river without treatment, in addition to the salt tide coming from Arabian Gulf (Al-Mudaffar, & Mahdi, 2014), (Al –Asadi, et al. 2015), and (Al- Saad, et al. 2015).

MATERIAL AND METHODS

Study Area

Two stations were identified on the SHAAR, namely Sindbad Island, and Karmat Ali River, to study the extent of the impact of these two stations on the course of the river within that region, as shown in Figure 1. Samples were collected at the rate of one sample per month from each station, starting from January 2021 to December 2021. The water quality was calculated using the Canadian Model CCME WQI Model and as per the following equations:

First Factor $$F_1 = \left(\frac{Number\ of\ failed\ variables}{Total\ number\ of\ variables}\right) \times 100 \quad (1)$$

Second Factor $$F_2 = \left(\frac{Number\ of\ failed\ variables}{Total\ number\ of tests}\right) \times 100 \quad (2)$$

$$excursion = \left(\frac{failed\ test\ calc.i}{objective\ j}\right) - 1 \quad (3)$$

$$nse = \left(\frac{\sum_{i=1}^{N} excursion}{Number\ of\ test}\right) \quad (4)$$

Third Factor $$F_3 = \left(\frac{nse}{0.01\ nse + 0.01}\right) - 1 \quad (5)$$

$$CCME\ WQI = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732}\right) \quad (6)$$

The CCME WQI is based on the world's most complete set of data on water quality. This indicator is distinguished by condensing a significant quantity of information on the biological, chemical, and physical characteristics of water into a single figure that is used to assess the water quality.

This indicator provides a single value between zero, which represents the lowest water quality, and one hundred, which represents the finest water quality. Table 1 lists these numbers in five categories (Lumb, et al. 2006).

Table 1. the various kinds of water based on the quality index value.

Classification	Values
Excellent	95-100
Good	80-94
Fair	65-79
Marginal	45-64
Poor	0-44

Results and Discussion

Water Quality Guide

The results of the water quality index values and the various factors for the two studied stations of SHAAR in Basrah Governorate are shown in Table 2, as it is noted that the water quality index values decreased, which ranged between (41.6-44.0), and this indicates that the quality of the SHAAR in the study area is of poor quality. The decrease in the two stations reflects the impact of liquid pollutants discharged to the SHAAR, and this information can be used in the management of water resources.

Table 2 the values of the water quality index

Station	F1	F2	F3	CCME WQI	\Ranking
Sindbad Island	71.4	46.8	48	41.6	poor
Karmat Ali	71.43	50.0	50.96	43.6	poor

1- PH

The Appropriate range for good water quality ranges from (6.5-8.4). Outside this range, it has negative effects on water quality. A decrease in the pH values will lead to the dissolution of mineral elements and thus increase the negative effect on the water. The results are shown in fig. (2), which indicate that the average values of the pH of the study area tended towards alkalinity, ranging from (7.7-8.21), (7.6-8.2) for Sindbad and Karmat Ali, respectively. Thus, the waters of Sindbad and Karmat Ali are considered light alkaline, and there are no problems with irrigation water.

2- Electrical Conductivity

It is one of the important indicators and as a measure of water salinity, the results in figure 3 indicate that the electrical conductivity (EC) values ranged between (4.6-21.1), (5.3-19.9) mS/m for Sindbad Island, and Karmat Ali, respectively. The rise in the EC values is due to the salt tide coming from Arabian Gulf, the increase in the evaporation processes of the river water during the hot months of the year because the EC increases with the increase in temperature, and the increase in the concentration of ions in the draining water of agricultural drainage water, which are carries of high concentration of salts (Moyel, & Hussain, 2015), and (Xia, et al., 2019).

3- Total Dissolved Solids (TDS)

It is one of the important properties of water, and it represents the concentration of dissolved salts in the water, whether ionized or non-ionized, which is an indicator of water quality. Figure 4 shows the concentration of TDS for Sindbad, and Karmat Ali, which ranged between (3278-13409), (and 3708-12759) mg/l, respectively. These rises are due to the increase in the concentration of ions in the drained sewage water, in addition to the increase in evaporation rates due to the increase in temperature, which works to increase the concentration of salts, as well as, the human consumption resulting from the villages located on these sites (Hamdan, 2015). In terms of its suitability for irrigation, the used water was of increasing danger when used.

4- Calcium Ca, and Magnesium Mg

The concentration of calcium and magnesium ions in natural water depends on the type of rock the water has passed through. It is considered one of the most important causes of water hardness. The results shown in Figures 5 and 6 indicate that the average concentration of Ca in the water of Sindbad and Karmat Ali ranged between (170-568), (and 161-545) mg/l, respectively. While, the average concentration of Mg is ranged between (170-463), (and 118-463) mg/l, respectively. The increase in these concentrations is due to the excretion of sewage and agricultural waste that contain a high percentage of Ca and Mg. As well as, the salt tide coming from the Arabian Gulf, as well as, the effect of the electric power plant contributes to raising the Ca, and Mg caused by the high temperatures of the water leaving the river (Anitha **&** Sugirtha, 2013). These high concentrations exceeded the specified limits for the validity of the water for irrigation purposes.

5- Total Suspended Solids (TSS)

The value of suspended solids TSS gives a direct idea of the pollutant loads and suspended impurities in the river. Figure 7 shows the concentration of TSS, which ranged from (16-79.3), (18.9-65.7) mg/l for Sindbad Island, and Karmat Ali respectively. The rise of TSS is observed, the reason is attributed to the tidal waters coming from the Arabian Gulf, which carry TSS with them during the tidal period, in addition to that they work to excite the sediment, where the movement of water currents is in the form of vortices and is redistributed in the river water. It is clear from figure 6 that the values of TSS lie within the permissible limits of irrigation, except for some months exceeded the permissible limit for irrigation water.

6- Nitrate NO3

The nitrate ion values as shown in Figure 8 ranged between (21.7-37), (and 22.4-35.9) for Sindbad station, and Karmat Ali, respectively. The concentration of NO3 increase when the discharge of sewage water rich in organic materials and detergents increases, or may be due to the increase in agricultural activities, which are not toxic unless they are at high levels. We notice a decrease in the values of NO3 in the summer due to the absorption of NO3 by algae, whose growth increases due to high temperatures and the availability of nutrients in the river water. In the current study, the NO3 rate did not exceed the limits of the Iraqi specification for irrigation water.

Figure 1. Karmat Ali and Sindbad Island

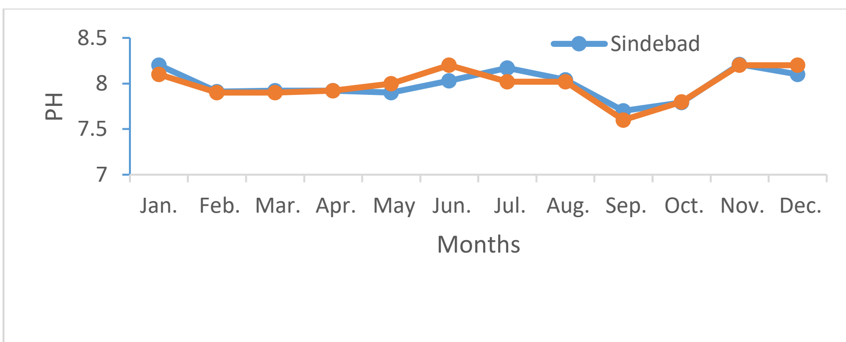

Figure 2. Values of pH vs. months

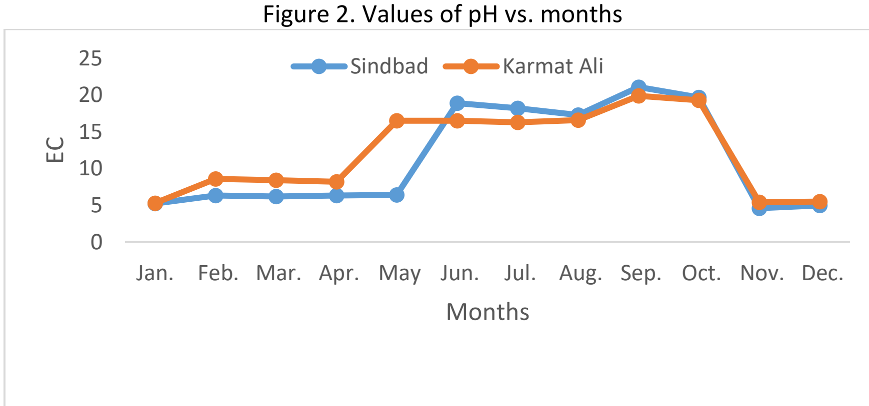

Figure 3. Values of EC vs. months

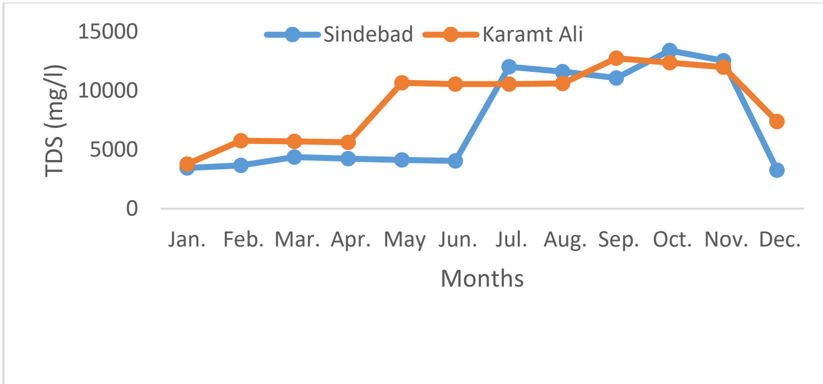

Figure 4. Values of TDS vs. months

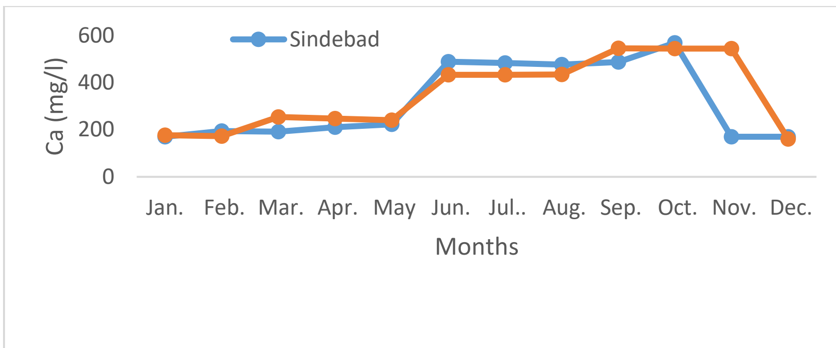

Figure 5. Values of Ca vs. months

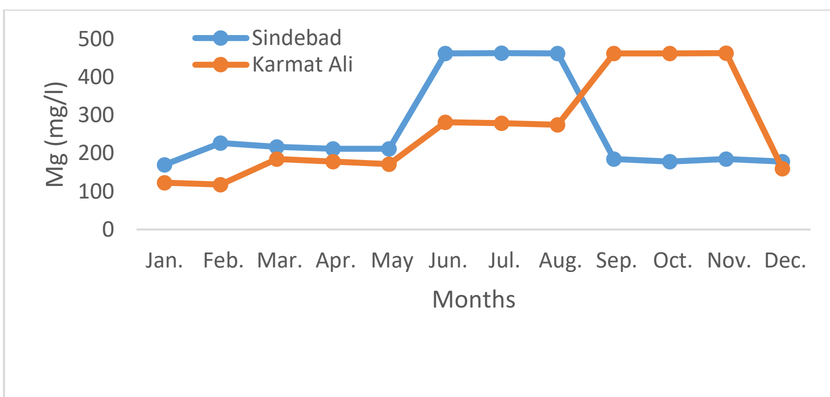

Figure 6. Values of Mg vs. months

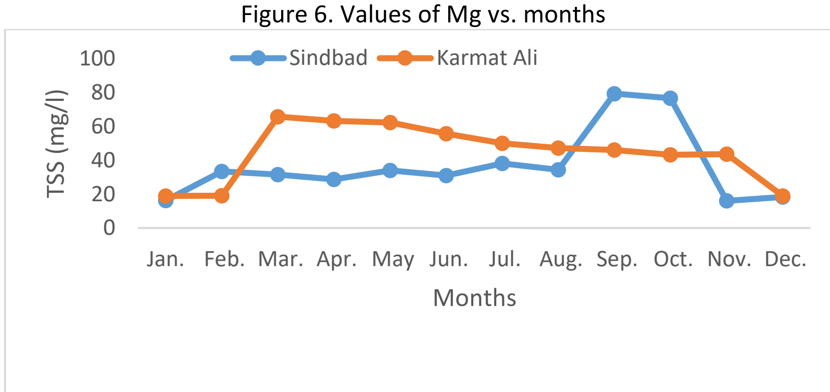

Figure 7. Values of TSS vs. months

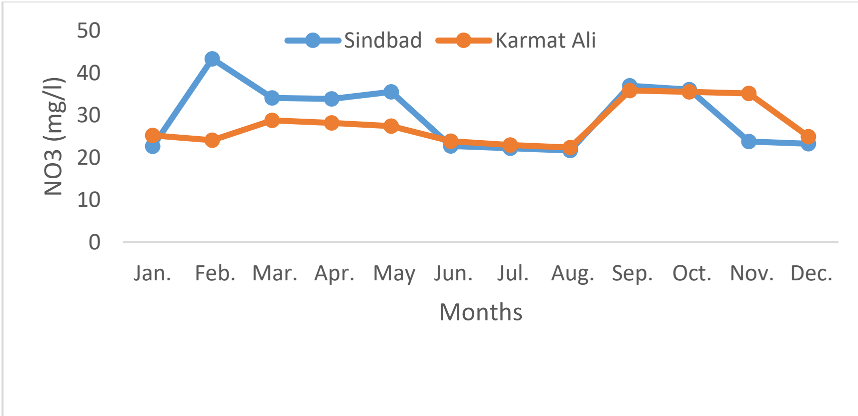

Figure 8. Values of NO3 vs. months

Conclusion

According to the results of this study, it concludes that:

1- The studied water was characterized by high standards, especially the values of EC, TDS, and the concentration of Ca, which will negatively affect the water quality.

2- The current study indicates that the water quality of SHAAR in the Sindbad Island and Karmat Ali stations is not suitable for irrigation purposes and that the water quality according to the Canadian classification is poor.

Conflict of interest

The author declare there is no conflict of interest.

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