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Assessment of Some Chemical Properties of Al Khamisah Ditch Water

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Abstract

This study investigated a number of chemical properties ambient for water of Al Khamisah Ditch. During the period from April to September 2024, Samples were collected through 10 sampling station. Samples collected were analyzed to find a number of variables. The variables measured include cations group (Ca, Mg and Na), anions group (Cl, SO_4, and HCO_3), nitrate NO_3, phosphate PO_4, total dissolved solids TDS, in addition to measuring pH, electrical conductivity EC and total hardness TH. Also, Sodium Adsorption Ratio SAR was calculated as the average of 4.32. The results of this study showed that average concentrations of calcium ions to Al Khamisah Ditch was 905.00 Mg.l-1, and the average concentration of magnesium ions was 2512.50 Mg.l-1 and average concentration of sodium ions was 1107.63 Mg.l-1. Average concentration of sulfate ions was 3195.15 Mg.l-1, and average concentration of chloride ions was 4948.70 Mg.l-1, and the average concentration of nitrate ions was 9.62 Mg.l-1 and Phosphate ions concentration rate was 23×10^{-4} Mg.l-1. Average concentration of total dissolved solids was 10727.59 Mg.l-1. Average pH value of the water was 6.02 and EC was 5.62 $dS.m^{-1}$.

Keywords: Chemical properties; AlKhamisah Ditch; Total dissolved solids; Environmental pollution.

Introduction

Iraq relies in its freshwater resources on the water of the Tigris and Euphrates Rivers and their tributaries. The watersheds account for 100% of the country's surface water. As Iraq has arid and semi-arid weather, water is an essential natural resource that controls the population distribution and their associated economic activity. Recently, researchers have shown great interest in the aquatic environment due

to the significant role of water in the lives of communities, due to the deterioration in water quality as a result of pollution, which is attributed to irresponsible behaviors such as agricultural waste disposal, industrial waste disposal, and household waste (including sewage and improperly discarded materials) into water resources. (I Y, Karim et al., 2021; Al-Mayah and Rabee, 2018; Ahmed, N. 2019; Khashroum, 2025) Recently, it has been observed that water quality in Iraq is becoming increasingly poor each day throughout its journey and up to its estuary in Shatt al-Arab.

Additionally, the problem of salinization of agricultural lands in Iraq has increased because of leaching, evaporation, the lack of freshwater, the decrease in water levels, and the lack of rain. (Al-Kenzawi et al., 2011; Hama Salih et al., 2021) Furthermore, drainage system has a negative effect on water quality as well as other pollutants including household waste, herbicides, insecticides, chemical fertilizers, petroleum derivatives, biological pollutants such as bacteria, fungi, parasites, and phytoplankton and zooplankton. The ameliorating of technology, the increase of population density, and human activities has negatively affected water sources, and changed the physical and chemical properties of water. (Al-Ani, et al., 2014) This study aims atassessing some chemical properties of Al-Khamisiyah waterways.

Material and methods

Al-Khamisiyah waterways, which serves as a supply canal measuring 7 km in length and 5 m in width, situated in Al-Khamisiyah area at kilometer 140. This location is significant as it is where the main river approaches marshes, specifically connecting to Al-Sanif Marsh (Fig. 1). The canal has been divided into ten sampling station for the purpose of conducting various analyses and tests on its water quality. The tests included:

Electrical Conductivity: Measures the water's ability to conduct electricity, which indicates the concentration of dissolved salts.

pH: Assesses the acidity or alkalinity of the water.

Positive Ions: Concentrations of cations like calcium (Ca^{2+}), magnesium (Mg^{2+}), and sodium (Na^{+}) were measured.

Negative Ions: Analyzed anions including chloride (Cl^{-}), bicarbonate (HCO_3^{-}), and carbonate (CO_3^{2-}).

Phosphates and Nitrates: Important for understanding nutrient levels that can affect aquatic ecosystems.

Total Dissolved Solids (T.D.S): Indicates the total concentration of dissolved substances in the water.

The research has adopted Page et al. (1982) model. The Sodium Adsorption Ratio (SAR) was calculated by using the following equation: (Richards, 1954)

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

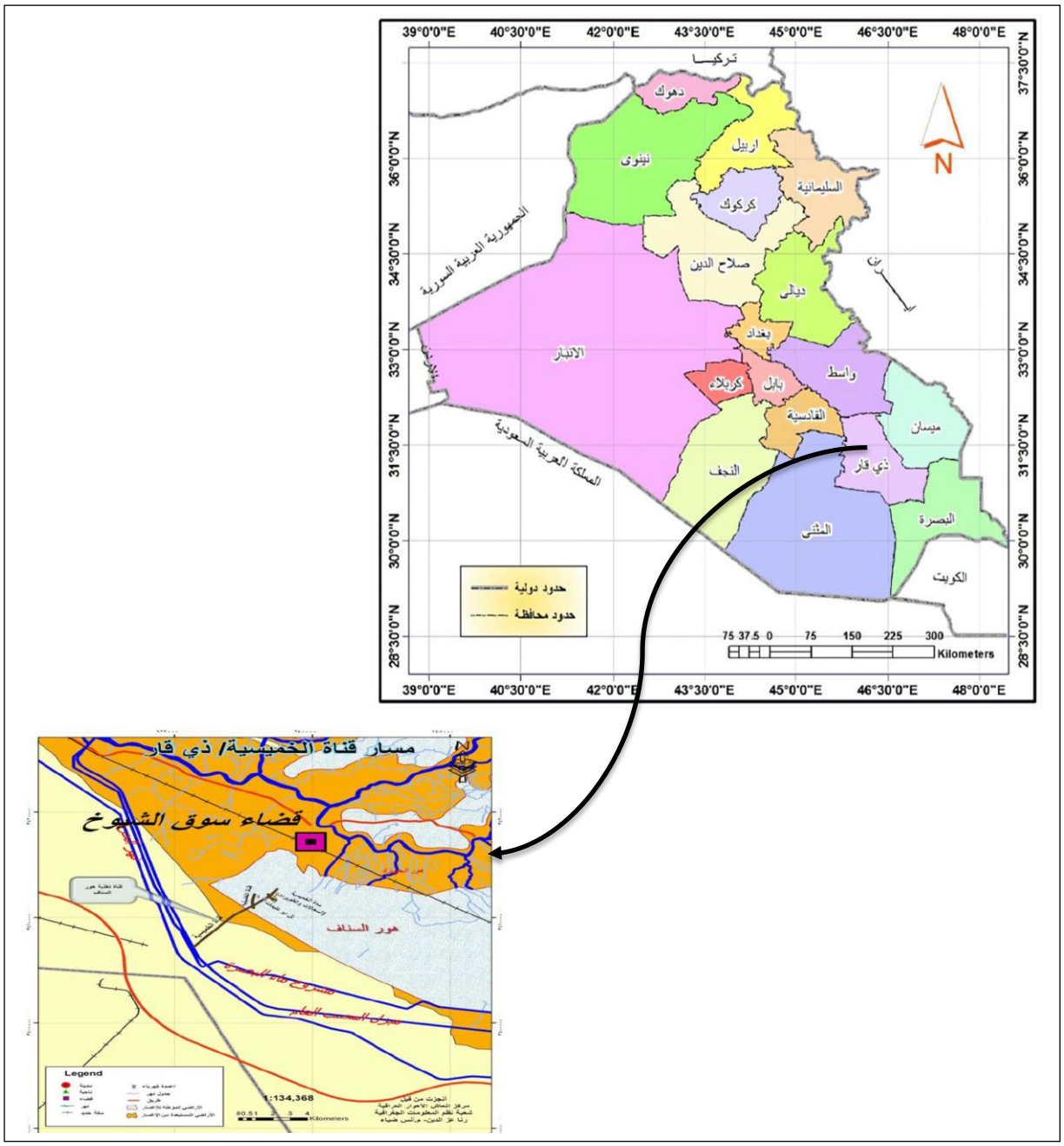

Figure (1): A Map of the Study Area

RESULTS AND DISCUSSION

The results indicated that the pH values in Al-Khamisiyah Canal were moderately acidic, ranging between 5.50 and 6.80, with an average of 6.02 (Fig. 2, Table 1). This is consistent with the nature of the canal, as its water is a mixture of river water, marsh water, and wastewater. The variation in pH values is influenced by the balance of carbon dioxide, bicarbonates, and carbonates. An increase in carbon dioxide concentration tends to lower the pH, while a decrease in carbon dioxide concentration results in a higher pH value (Al-Nimma, 1982; Pescod, 1992).

Additionally, the average electrical conductivity (EC) of Al-Khamisiyah Canal ranged from 3.63 to 6.22 dS m^{-1}, with an overall mean of 5.62 dS m^{-1} and a standard deviation of 0.75 dS m^{-1} (Fig. 3, Table 1).

The total dissolved solids (TDS) are significant as they indicate the quantity of dissolved salts that cannot be removed through conventional filtration methods in drinking water treatment plants. TDS is also used to classify water as freshwater, brackish, or saline. Water with TDS values below 1500 Mg.l-1 is classified as freshwater, while water with TDS values ranging from 1500 to 5000 Mg.l-1 is classified as brackish. Water with TDS values exceeding 5000 Mg.l-1 is considered saline (Tchobanoglous and Schroeder, 1985; Wendell, 2007; Hoshan, 2022).

Table 1 shows that the average TDS value for Al-Khamisiyah Canal is 10727.59 Mg.l-1, with a standard deviation of 2781.13 Mg.l-1. This indicates that water in Al-Khamisiyah Canal is classified as saline. Figure 4 illustrates the variation in TDS values along the canal's course, reflecting the salts and pollutants carried by the water from natural sources, geological characteristics of the land, and municipal, agricultural, and industrial discharges. Consequently, this leads to the accumulation of pollution loads along waterway.

Phosphates and nitrates are considered key variables in aquatic environments and are crucial factors for the growth of phytoplankton, which forms the base of the food web. Physical processes play an important role in the redistribution of phosphates and nitrates. Additionally, high concentrations of phosphates and nitrates in aquatic environments lead to eutrophication (Withers and Lord, 2002), which is a significant cause of environmental pollution.

The average phosphate concentration in Al-Khamisiyah Canal is 2.23×10^{-4} Mg.l-1, with a standard deviation of 1.38×10^{-4} Mg.l-1 (Fig. 5, Table 1). Regarding nitrates, the average concentration in Al-Khamisiyah Canal is 9.62 Mg.l-1, with a standard deviation of 2.77 Mg.l-1 (Fig. 6, Table 1).

The chloride concentrations in Al-Khamisiyah Canal ranged from 1668.50 to 5857.50 Mg.l-1, with an average of 4948.70 Mg.l-1 and a standard deviation of 1239.65 Mg.l-1. The sulfate concentrations varied between 1507.77 and 3682.52 Mg.l-1, with an average of 3195.15 Mg.l-1 and a standard deviation of 635.72 Mg.l-1. Meanwhile, the bicarbonate concentrations ranged from 259.01 to 427.00 Mg.l-1, with an average of 320.84 Mg.l-1 and a standard deviation of 58.78 Mg.l-1. Figure 7 illustrates the variations in chloride, sulfate, and bicarbonate concentrations along the course of Al-Khamisiyah waterway.

Calcium and magnesium are the primary contributors to water hardness in most aquatic environments. Observations from the results in Table 1 indicate that the average calcium concentration in Al-Khamisiyah Canal is 905.00 Mg.l-1,with a standard deviation of 207.43 Mg.l-1. The average concentration of magnesium ions in the canal is approximately 2512.50 Mg.l-1, with a standard deviation of 803.31 Mg.l-1, as illustrated in Figure 8. The elevated levels of these two ions contribute to an increase in the overall hardness of the water.

Table 1 also shows that the average sodium concentration in Al-Khamisiyah

Canal is 1107.63 Mg.l-1, with a standard deviation of 180.37 Mg.l-1, and the values range from 675.30 to 1318.00 Mg.l-1. Figure 8 further illustrates this variation. The results indicate that the combined concentrations of calcium and magnesium ions in Al-Khamisiyah Canal exceed that of sodium ions, resulting in a reduced Sodium Adsorption Ratio (SAR) (Abed, M. M. and Abdul Jabar, R. A. 2023). The SAR values ranged from 3.60 to 5.34, with an average of 4.32 and a standard deviation of 0.58.

The recorded total hardness values for Al-Khamisiyah Canal ranged from 1575 to 4450 Mg.l-1, with an average of 3417.50 Mg.l-1 and a standard deviation of 908.53 Mg.l-1 (Table 1). Based on the classifications by Boyd (2000) and Todd and Mays (2005), the water in Al-Khamisiyah Canal can be described as very hard. The results of this study are consistent with several other studies that have reported elevated total hardness values in Iraqi waters (Ewaid, S. H. and Abed, S. A. 2017; Khadim, H. J., and Oleiwi, H. O. 2021; Lateef, Z. Q., et al. 2020). Figure 9 illustrates the variations in total hardness values recorded along the waterway of Al-Khamisiyah Canal.

Table (1): The Chemical Properties of Water in Al-Khamisiyah Canal

Sample	pH	EC ($dS.m^{-1}$)	$PO_4^{=}$	NO_3^{-}	Cl^{-}	$SO_4^{=}$	$CO_3^{=}$	HCO_3^{-}	Mg^{+2}	Ca^{+2}	T.H.	Na^{+}	T.D.S.	SAR
1	6.30	5.60	1.08×10^{-04}	6.05	5147.50	3347.57	-	280.60	3000.00	975.00	3975.00	1017.00	11750.00	3.60
2	5.70	5.70	9.30×10^{-05}	7.02	5200.75	3473.79	-	298.90	2775.00	950.00	3725.00	1050.00	11484.35	3.85
3	5.65	5.84	1.65×10^{-04}	5.56	5314.35	2939.81	-	277.55	2825.00	875.00	3700.00	1079.00	11665.50	3.95
4	5.80	6.14	4.28×10^{-04}	12.51	5857.50	3682.52	-	317.20	3600.00	850.00	4450.00	1184.00	13050.00	3.92
5	5.50	6.19	4.35×10^{-04}	9.59	5477.65	3430.10	-	305.00	3200.00	800.00	4000.00	1211.00	12801.00	4.23
6	5.60	5.59	3.89×10^{-04}	11.66	5555.75	3087.86	-	268.40	2750.00	1050.00	3800.00	1236.00	11900.00	4.51
7	5.60	6.22	1.80×10^{-04}	11.66	5822.00	3633.98	-	378.20	2450.00	1250.00	3700.00	1318.00	11750.00	4.94
8	6.50	5.95	1.70×10^{-04}	12.88	5218.50	3529.61	-	427.00	2100.00	1100.00	3200.00	1231.00	11300.00	4.97
9	6.70	5.38	1.65×10^{-04}	11.28	4224.50	3318.45	-	396.50	1475.00	575.00	2050.00	1075.00	7500.00	5.34
10	6.80	3.63	9.81×10^{-05}	7.96	1668.50	1507.77	-	259.01	950.00	625.00	1575.00	675.30	4075.00	3.93
Mean	6.02	5.62	2.23×10^{-04}	9.62	4948.70	3195.15	-	320.84	2512.50	905.00	3417.50	1107.63	10727.59	4.32
SD	0.50	0.75	1.38×10^{-04}	2.76	1239.65	635.72	-	58.78	803.31	207.43	908.53	180.37	2781.13	0.58

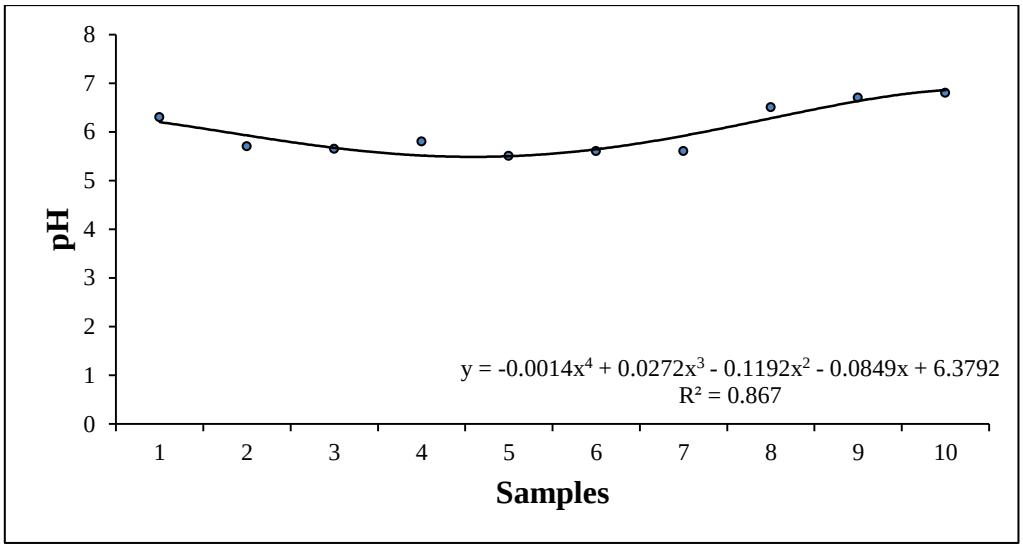

Figure (2): The pH level of Al-Khamisiyah Canal

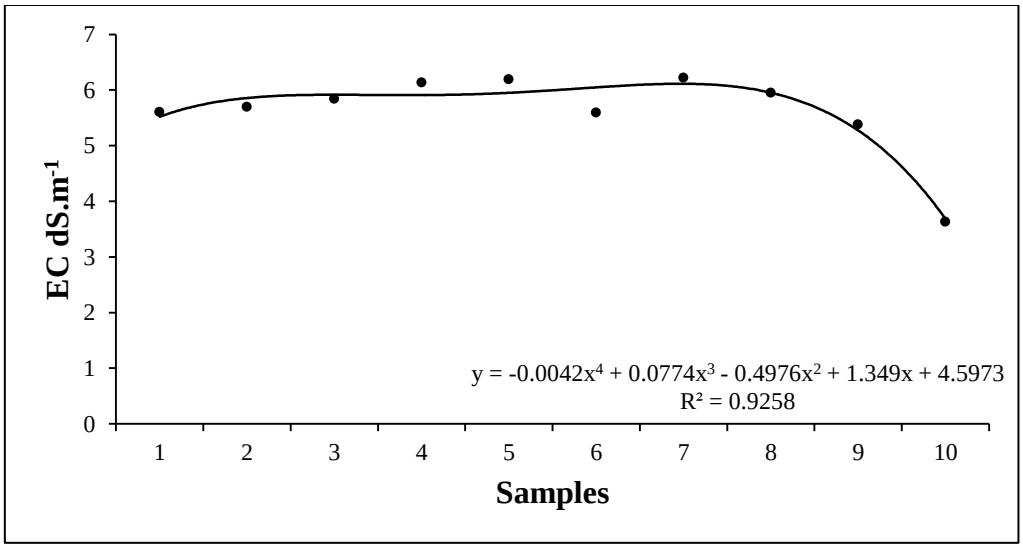

Figure (3): The electrical conductivity (EC) of Al-Khamisiyah Canal

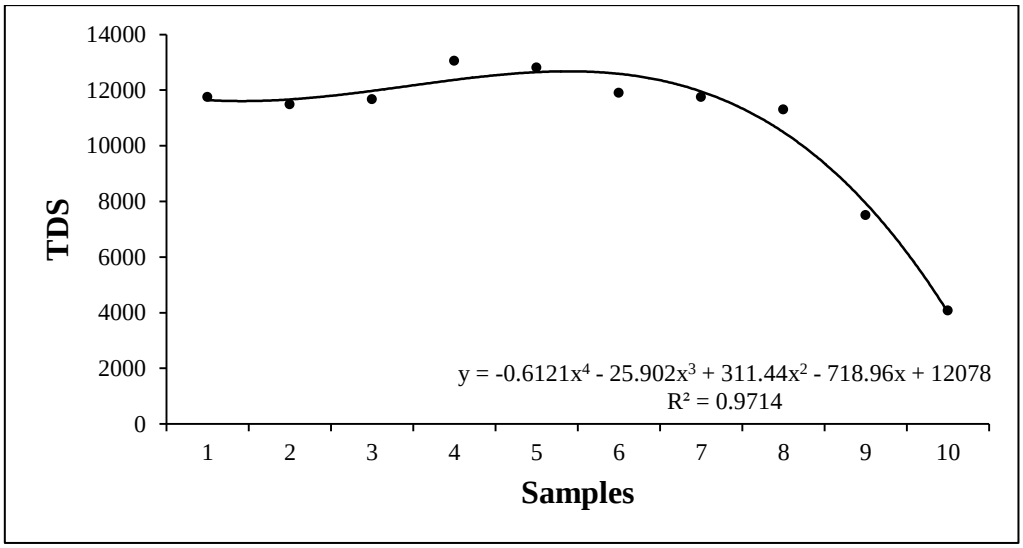

Figure (4): Total Dissolved Solids (TDS) in Al-Khamisiyah Canal

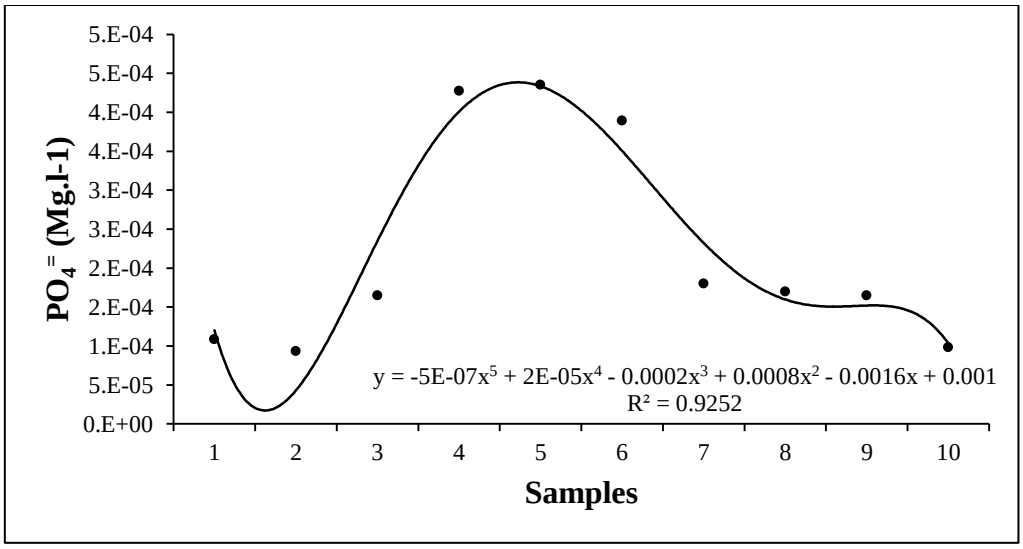

Figure (5): Phosphate Concentration in Al-Khamisiyah Canal

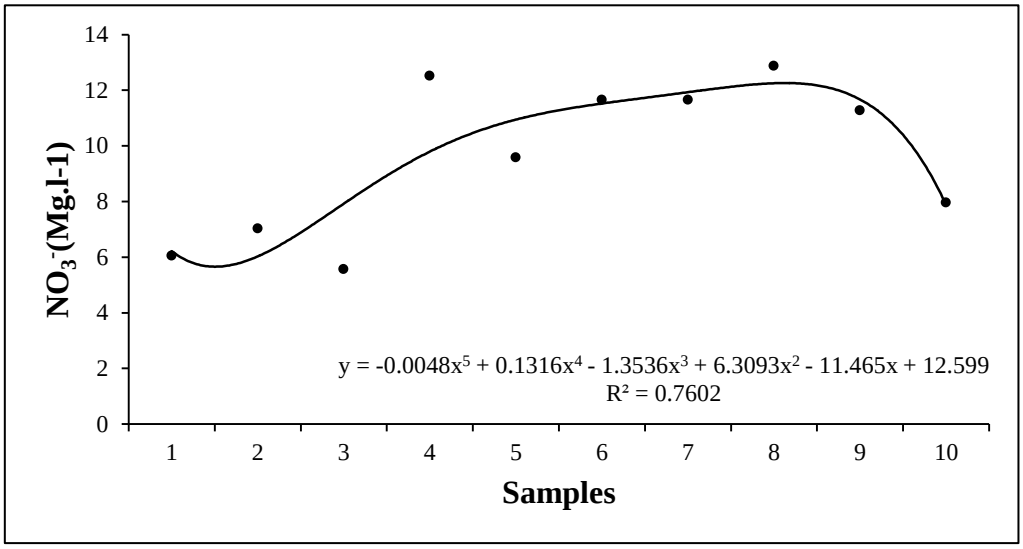

Figure (6): Nitrate Concentration in Al-Khamisiyah Canal

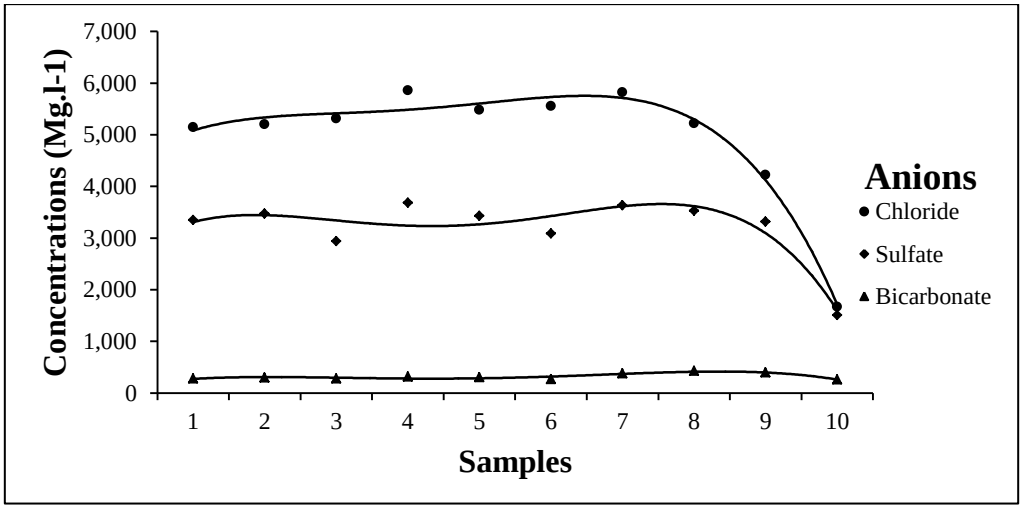

Figure (7): Sulfate and chloride concentrations in Al-Khamisiyah Canal

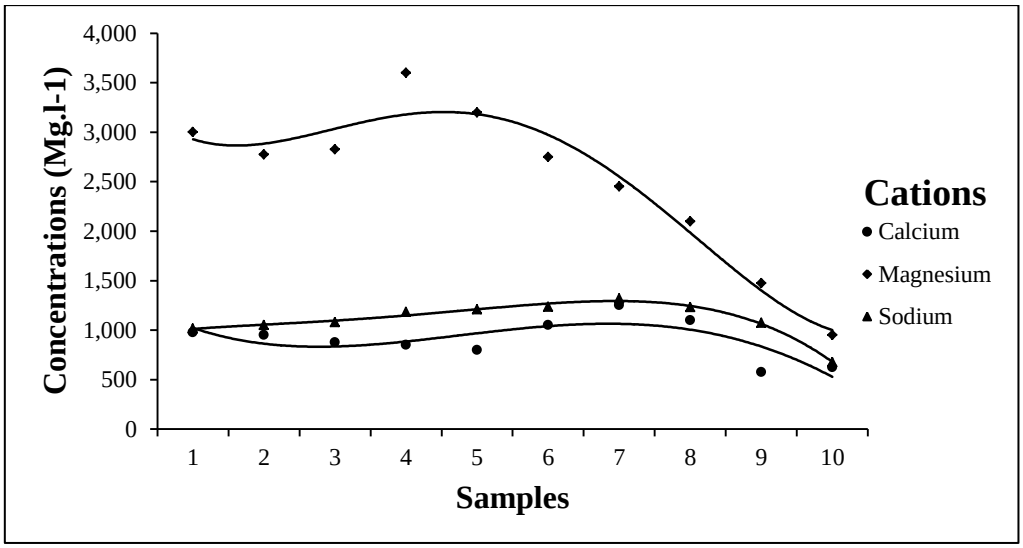

Figure (8): Calcium, magnesium and sodium Concentrations in Al-Khamisiyah Canal

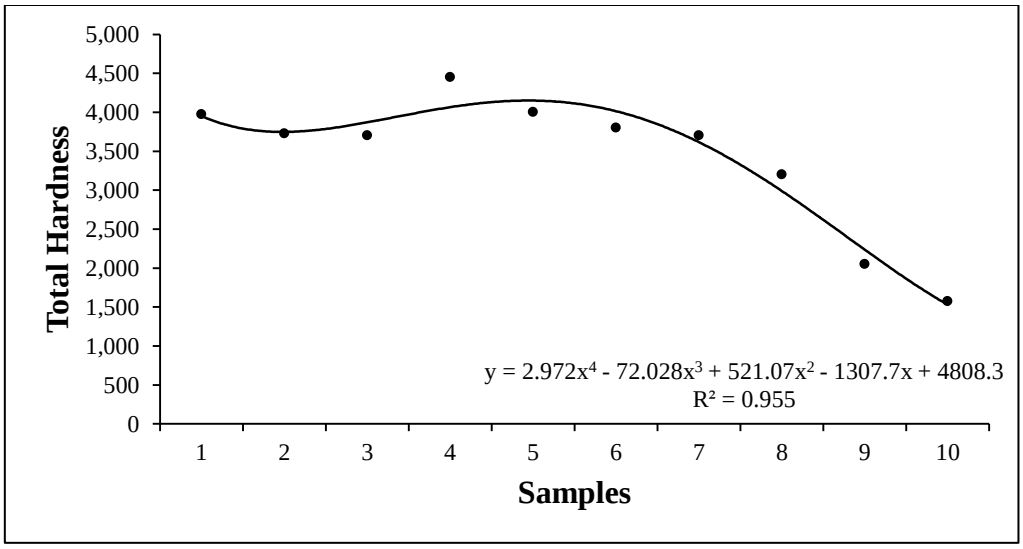

Figure (9): The Variation in Total Hardness Values along the Progress of Al-Khamisiyah Canal

CONCLUSIONS

In the light of the previous results, the study has come up with the following conclusions:

1. The pH values in Al-Khamisiyah Canal were moderately acidic, this is consistent with the nature of the canal, as its water is a mixture of river water, marsh water, and wastewater.
2. The water in Al-Khamisiyah Canal is classified as saline.
3. Physical processes play an important role in the redistribution of phosphates and nitrates. Additionally, high concentrations of phosphates and nitrates in

aquatic environments lead to eutrophication, which is a significant cause of environmental pollution.

4. Calcium and magnesium are the primary contributors to water hardness in most aquatic environments, the elevated levels of these two ions contribute to an increase in the overall hardness of the water.
5. The results indicate that the combined concentrations of calcium and magnesium ions in Al-Khamisiyah Canal exceed that of sodium ions, resulting in a reduced Sodium Adsorption Ratio (SAR).
6. The water in Al-Khamisiyah Canal can be described as very hard water.
7. It has become necessary to establish a classification system for the quality of Iraqi water instead of relying on other classification systems.

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The authors declare that they have not received fund.

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