The Effect of Heavy Water Waste on the Euphrates River in Increasing the Concentration of Some Heavy Metals

Pengaruh Limbah Air Berat di Sungai Eufrat dalam Meningkatkan Konsentrasi Beberapa Logam Berat

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Abstract*. General Background**: *The Euphrates River, a vital water source for the Thi Qar Province, is increasingly threatened by pollution, particularly from heavy water waste.* ***Specific Background*: The river's proximity to industrial activities, notably a thermal power station, has led to elevated concentrations of heavy metals, raising concerns about environmental and public health.* ***Knowledge Gap****: While prior studies have focused on water quality in various regions, there is limited research on the specific impact of heavy water waste on the Euphrates River's heavy metal concentrations.* ***Aims****: This study aims to assess the concentration of heavy metals in the Euphrates River's water and sediment, investigate the sources of pollution, and evaluate the effectiveness of current waste management practices.* ***Results****: The study, conducted from summer 2022 to spring 2023, revealed that in water samples, heavy metal concentrations followed the order Zn>Cu>Cr>Ni>Pb>Cd, while in sediment, the order was Ni>Zn>Cu>Pb>Cr>Cd. Station 1, near the Nasiriyah thermal power station, exhibited the highest metal concentrations, emphasizing the influence of industrial pollution.* ***Novelty****: This research provides the first comprehensive assessment of heavy metal contamination in the Euphrates River linked specifically to heavy water waste, highlighting the critical impact of industrial discharges.* ***Implications****: The findings underscore the urgent need for enhanced regulation and maintenance of heavy water treatment plants, as well as public awareness campaigns to mitigate pollution. Implementing these measures is crucial for protecting the river's ecosystem and the health of communities relying on its waters*

Keywords – *Heavy Metals, Euphrates River, Water Pollution, Sediment Contamination, Industrial Waste*

Abstrak*. Latar Belakang Umum**: *Sungai Efrat, sumber air vital bagi Provinsi Thi Qar, semakin terancam oleh polusi, khususnya dari limbah air berat.* ***Latar Belakang Khusus*: Kedekatan sungai dengan aktivitas industri, khususnya pembangkit listrik tenaga termal, telah menyebabkan peningkatan konsentrasi logam berat, yang menimbulkan kekhawatiran tentang lingkungan dan kesehatan masyarakat.* ***Kesenjangan Pengetahuan****: Sementara penelitian sebelumnya berfokus pada kualitas air di berbagai wilayah, ada penelitian terbatas tentang dampak spesifik limbah air berat pada konsentrasi logam berat Sungai Efrat.* ***Tujuan****: Penelitian ini bertujuan untuk menilai konsentrasi logam berat di air dan sedimen Sungai Efrat, menyelidiki sumber polusi, dan mengevaluasi efektivitas praktik pengelolaan limbah saat ini.* ***Hasil****: Penelitian yang dilakukan dari musim panas 2022 hingga musim semi 2023, mengungkapkan bahwa dalam sampel air, konsentrasi logam berat mengikuti urutan Zn>Cu>Cr>Ni>Pb>Cd, sedangkan dalam sedimen, urutannya adalah Ni>Zn>Cu> Pb>Cr>Cd. Stasiun 1, dekat dengan stasiun pembangkit listrik termal Nasiriyah, menunjukkan konsentrasi logam tertinggi, yang menekankan pengaruh polusi industri.* ***Hal baru****: Penelitian ini memberikan penilaian komprehensif pertama tentang kontaminasi logam berat di Sungai Efrat yang secara khusus dikaitkan dengan limbah air berat, yang menyoroti dampak kritis dari pembuangan limbah industri.* ***Implikasi****: Temuan ini menggarisbawahi kebutuhan mendesak untuk meningkatkan regulasi dan pemeliharaan instalasi pengolahan air berat, serta kampanye kesadaran publik untuk mengurangi polusi.*

Menerapkan langkah-langkah ini sangat penting untuk melindungi ekosistem sungai dan kesehatan masyarakat yang bergantung pada airnya..

Kata Kunci – *Logam Berat, Sungai Eufrat, Pencemaran Air, Kontaminasi Sedimen, Limbah Industri*

I. INTRODUCTION

The great global interest in water resources and successive studies comes from the importance of this resource of human life mainly, and therefore on the various living organisms from the danger of pollution and pollutants that these sources are exposed to (wastewater, industrial waste, heavy metals, fertilizers, etc.) due to human activities that It is practiced by man in the midst of the development taking place in industry and agriculture, in addition to the large population growth at the level of all countries of the world, which affects the physical and chemical parameters of water bodies, which makes this issue one of the most important issues on the surface of the globe (1 + 2).

The Euphrates River is one of the important rivers of the Republic of Iraq. It contributes greatly to supporting agriculture and industry in the country. Many irrigation projects branch out from it, which benefit from them in various fields due to the rapidly increasing growth in the country. However, it was recently caused by the dams built on the Euphrates Rivers path from the side. Al-Turki, from which this river originates, has affected and greatly reduced Iraqs water quotas (3 + 4), In addition to the impact of the climate, which is another factor that plays an effective role in the scarcity of additional resources that come and support the amount of water available in the Euphrates River, since Iraq suffers from high temperatures throughout the year due to the nature of the desert climate for most of the regions of Iraq through which the Euphrates River passes, which causes low amounts of rain precipitation annually (5).

The Euphrates River is exposed on a daily basis, as a result of its various uses, too many pollutants that flow from agricultural and industrial areas, including heavy metals, for example, which changes the nature of the water in it, which increases the health risks of using it for humans (6 + 7). In addition, the high random and unstudied wastewater waste is also a source of increasing the concentration of heavy metals in the Euphrates River without using modern treatment methods. It is another factor that causes great damage to this national wealth (8 + 9).

On the surface of the earth, approximately 22% of its population has difficulty obtaining clean drinking water, and they also lack the simplest methods of treating heavy water, and this problem is deeply rooted in most developing countries, and the reason for this is due to the lack of a clear vision to support the heavy water treatment project, considering river water as an outlet to get rid of them (10 + 11).

Many sewage plants treat heavy water and then reuse it, while others treat it in a limited way and then discharge it, but there is a percentage of wastewater that is not treated and is released directly to the environment in many countries of the world (12).

Water quality and continuous periodic follow-ups to evaluate these sources that are directly related to human life and living organisms, as the increase in the concentration of heavy metals has long-term effects on water bodies, and thus the accumulation of these pollutants in the food chain, causing many pathological factors in the end (13 + 14).

In the current study, many physical and chemical parameters, concentrations of a number of heavy metals, and changes in them resulting from wastewater waste in the Euphrates River in the city of Nasiriyah and Suq Al-Shuyukh from Thi Qar Province are monitored.

II. METHODS

The Euphrates River enters the Thi Qar Province in the city of Al-Batha, located in the west of the Province, then to the city of Nasiriyah, then from there it passes to the rest of the cities of the Province (15).

This research deals with the changes that occur continuously and periodically in the water of the Euphrates River due to the wastes that are received in it, including heavy water, where some chemical and physical indicators were followed up, as well as the concentrations of some trace metals such as (lead, cadmium, nickel, copper, chromium and zinc) were determined.

Four stations were chosen to conduct the current study in the following order:

(1) The first station when entering the Euphrates River is the city of Nasiriyah, near the Nasiriyah thermal station.
(2) The second station is near Al-Nasiriyah Concrete Bridge.
(3) The third station is in the Al-Fadeliyah district, near Al-Khader shrines.
(4) The fourth station is at the entrance of the Euphrates River in the district of Suq Al- Al-Shuyukh.

Work on this study began between summer 2022 and spring 2023.
Water samples were collected using sterile containers of 1 liter made of polyethylene, then the suspended impurities were removed from the samples approved by filtration.

The samples were kept in 5 ml (concentrated HNO3 at a concentration of 55%) per liter. The purpose of this procedure is to preserve the approved samples from absorbing their minerals from the inner surface of the containers they are kept in. After that, the samples are transferred to the laboratory and kept under cooling conditions at 4 degrees Celsius until the tests are conducted. necessary laboratory (16)

Sediment samples were collected using the Van Veen Grab sampler (VVGS), the samples were dried and sieved with a sieve of 2.0 mm diameter to remove suspended impurities. After that, they are placed in sterile plastic bags made of polyethylene, and then they are transported in refrigerated containers until they reach the laboratory to conduct the necessary tests on them (17).

Tests of the physical and chemical parameters of the water were carried out, including pH, Ec and Do, according to the method used in (18), using a multimeter from Hannaa, the method used in (19) was also used to measure salinity based on the electrical conductivity results. Turbidity meter Hi 93701 from hannaa was used to measure the turbidity of the water in the samples approved in the experiment.

The heavy metals present in the samples used in this study are evaluated by heating a volume of 50 ml of water in a volumetric measuring flask on a hot plate for a period of time until only 10 ml of the sample remains. After heating, a mixture of concentrated acids (HNO3, Hclo4, H2So4) in order to carry out the necessary digestion of the samples, after that each sample is cooled by adding 40 ml of deionized distilled water until a volume of 50 ml is reached.

The necessary digestion of sediment samples was also carried out by weighing 0.5 g of them, then adding a volume of 5 ml to it a mixture of concentrated acids (HNO3, HCl4, H2So4), after that the samples are diluted by adding 20 ml of deionized distilled water until a volume of 30 ml is reached.

Samples prepared and preserved by AAS from Spectra are examined according to the method followed in (20). The various sets of data collected from the stations were compared with two-way ANOVA test (SPSS) v.26 software.

III. RESULT AND DISCUSSION

RESULT

After the physical and chemical factors tests were completed, different results were obtained in the stations of this study, showing the differences in the values between these factors in different seasons in Table 1. The results showed the highest pH value in station 2 (7.63) in winter and the lowest value in station 3 (7.30) in summer season. The results also showed the highest value of turbidity in station 4 (31.72 NTU) in the winter and the lowest value in station 3 (18.56 NTU) in the summer. The laboratory results also showed the highest value of dissolved oxygen in winter in Station 1 (8.69 mg/L) and the lowest value in Station 2 (6.50 mg/L) in summer. The results also showed the highest value of electrical conductivity in Station 1 (5291.33 µs/cm-1) in the winter season and the lowest value in Station 3 (3280.00 µs/cm-1) in the spring season. The results also showed salinity values for the study samples, where the highest value was in Station 2 (3.70) in the winter and the lowest value at Station 3 (2.65) in the spring.

The results of the heavy metals tests in the water showed different concentrations of the samples examined, as Figure 1 shows the highest value recorded for cadmium in station 1 (0.09 µg/l) in the winter season and the lowest value recorded at station 3 (0.01 µg/l) in the autumn season. Figure 2 also showed the highest value recorded for lead in Station 1 (2.12 µg/l) in the summer and the lowest value recorded in Station 3 (1.06 µg/l) in the autumn. Figure 3 also shows the highest value recorded for copper in Station 1 (24.31 µg/l) in the summer and the lowest value recorded in Station 3 (17.12 µg/l) in the spring. Figure 4 also shows the highest value recorded for zinc in Station 1 (48.15 µg/l) in the winter and the lowest value recorded in Station 4 (25.17 µg/l) in the summer. Figure 5 also shows the highest value recorded for nickel in Station 1 (3.97 µg/l) in the autumn season and the lowest value recorded in Station 3 (2.01 µg/l) in the summer. Figure 6 also shows the highest value recorded for chromium in Station 1 (3.99 µg/l) in the summer and the lowest value recorded in Station 3 (1.93 µg/l) in the autumn.

The results of the heavy metals tests in the sediments showed different concentrations of the samples examined, as Figure 7 shows the highest value recorded for cadmium in station 1 (0.14 µg/l) in the winter season and the lowest value recorded at station 3 (0.05 µg/l) in the autumn season. Figure 8 also showed the highest value recorded for lead in Station 1 (9.16 µg/l) in the summer and the lowest value recorded in Station 3 (7.83 µg/l) in the autumn. Figure 9 also shows the highest value recorded for copper in Station 1 (25.90 µg/l) in the winter and the lowest value recorded in Station 3 (18.89 µg/l) in the summer. Figure 10 also shows the highest value recorded for zinc in Station 1 (49.80

µg/l) in the spring and the lowest value recorded in Station 4 (38.46 µg/l) in the summer. Figure 11 also shows the highest value recorded for nickel in Station 1 (51.97 µg/l) in the autumn season and the lowest value recorded in Station 4 (33.74 µg/l) in the spring. Figure 12 also shows the highest value recorded for chromium in Station 1 (4.20 µg/l) in the summer and the lowest value recorded in Station 3 (2.11 µg/l) in the autumn.

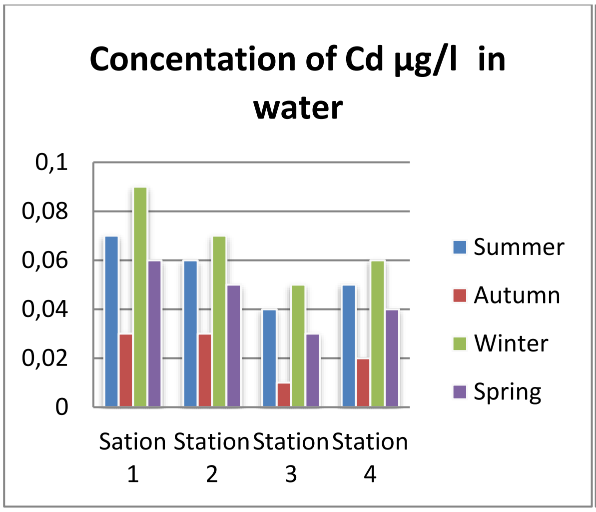

Figure 1 Concentration of Cd in water

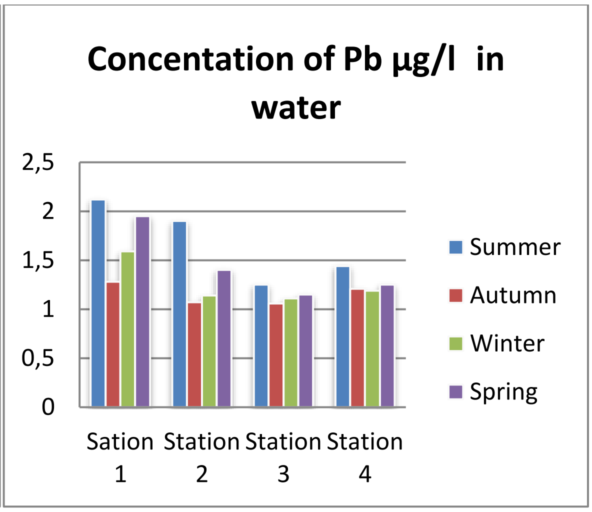

Figure 2 Concentration of Pb in water

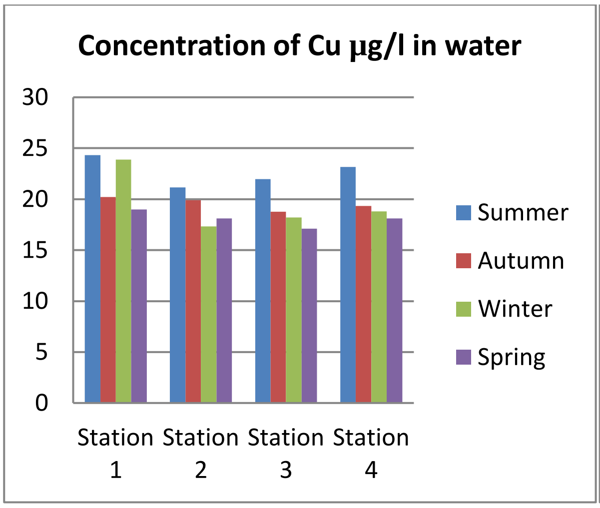

Figure 3 Concentration of Cu in water

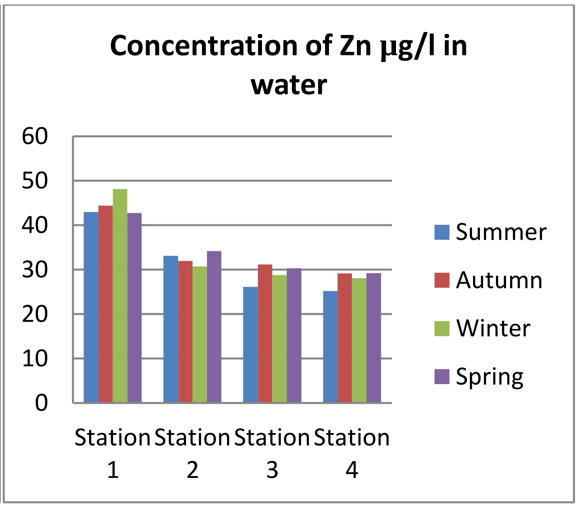

Figure 4 Concentration of Zn in water

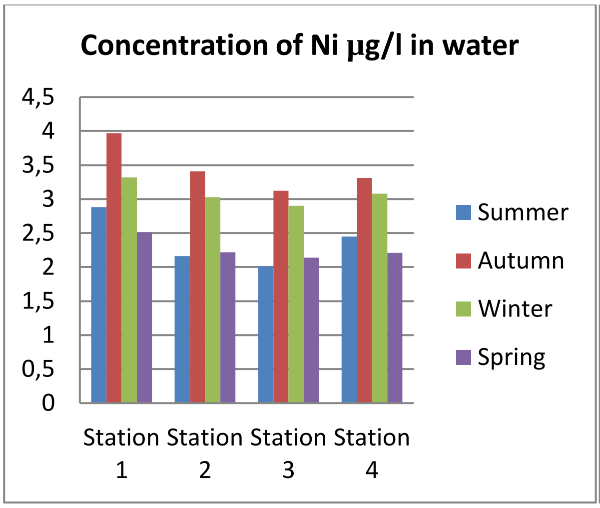

Figure 5 Concentration of Ni in water

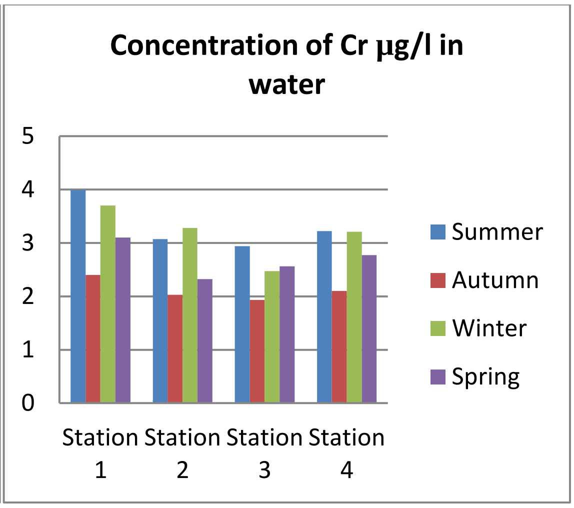

Figure 6 Concentration of Cr in water

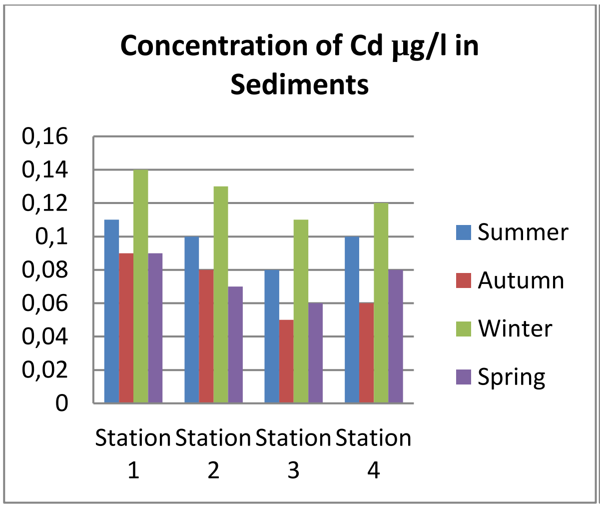

Figure 7 Concentration of Cd in sediments

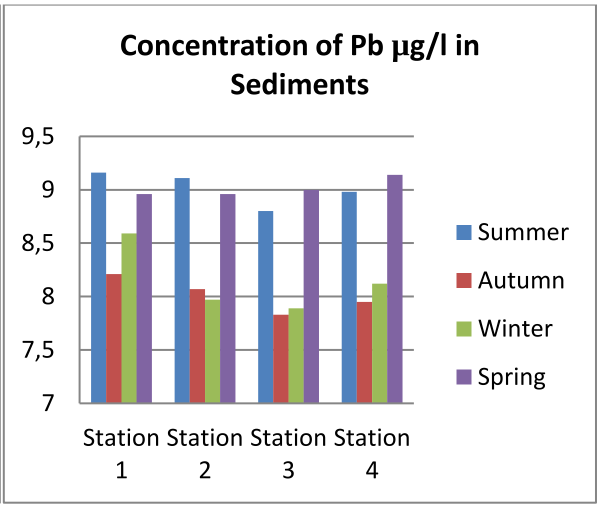

Figure 8 Concentration of Pb in sediments

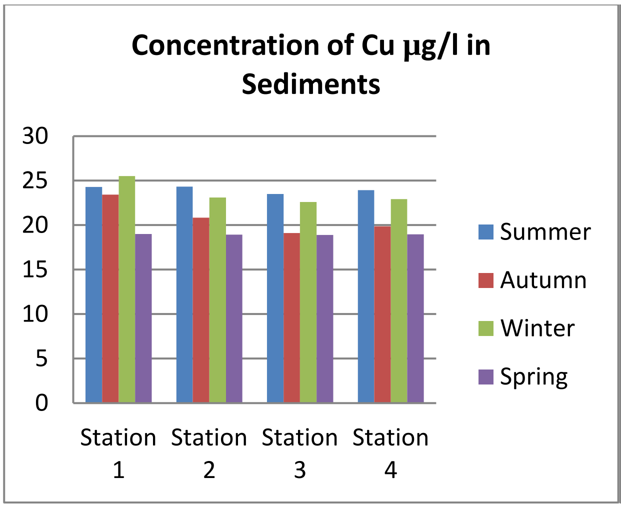

Figure 9 Concentration of Cu in sediments

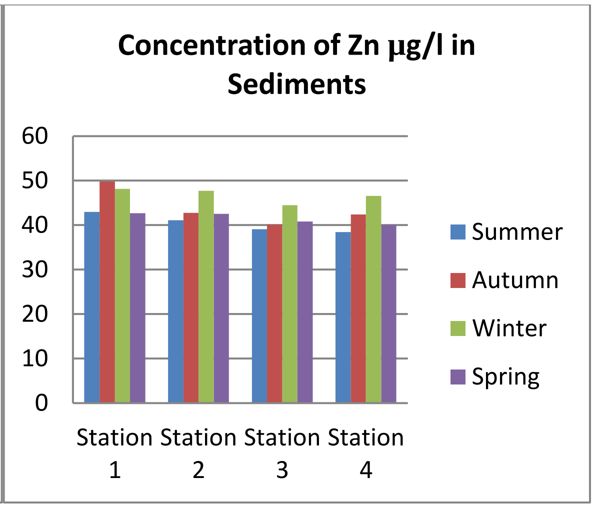

Figure 10 Concentration of Zn in sediments

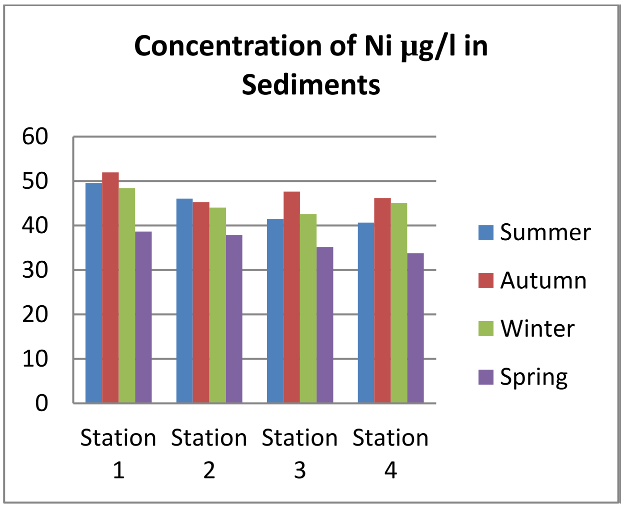

Figure 11 Concentration of Ni in sediments

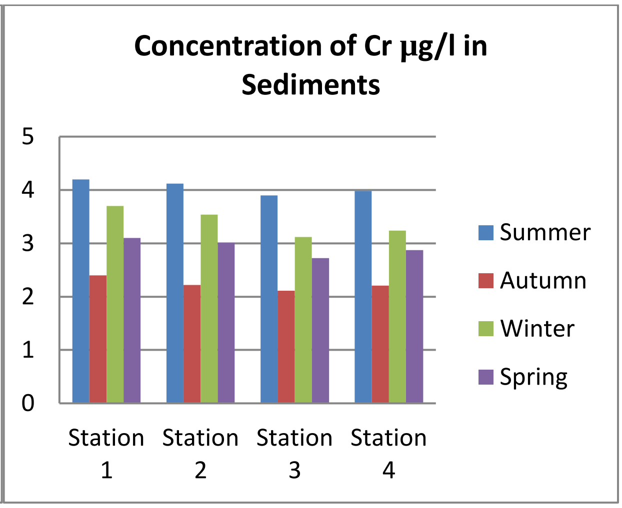

Figure 12 Concentration of Cr in sediments

Table 1: The values of the chemical and physical factors tests in this study

Station	pH		Turbidity NTU		Dissolved oxygen DO (mg/L)		Electrical Conductivity EC (µS/cm^{-1})		Salinity	
	Mean	SD±	Mean	SD±	Mean	SD±	Mean	SD±	Mean	SD±
Summer										
St. 1	7.40	0.000	19.39	0.310	6.97	0.115	3810.66	134.500	2.83	0.057
St. 2	7.39	0.005	19.07	0.500	6.50	0.000	3890.00	9.000	2.73	0.057
St. 3	7.30	0.100	18.56	0.321	7.50	0.000	3795.66	4.932	2.66	0.208
St. 4	7.31	0.010	20.22	0.391	7.32	0.010	3936.66	30.550	2.75	0.050
Total	7.35	0.064	19.31	0.710	7.07	0.401	3858.25	84.354	2.74	0.115
Autumn										
St. 1	7.48	0.046	24.21	0.904	7.20	0.015	4801.66	111.329	3.13	0.057
St. 2	7.43	0.023	23.51	0.422	7.01	0.005	4693.33	30.550	3.10	0.000
St. 3	7.40	0.000	23.27	0.011	7.22	0.000	4603.33	5.773	2.90	0.000
St. 4	7.42	0.010	24.12	0.030	7.12	0.010	4643.33	5.773	3.03	0.060
Total	7.43	0.039	23.78	0.594	7.14	0.086	4685.41	91.970	3.04	0.100
Winter										
St. 1	7.72	0.015	29.25	0.800	8.69	0.257	5291.33	88.376	3.53	0.152
St. 2	7.63	0.118	29.88	0.386	8.14	0.066	5193.33	82.548	3.70	0.100
St. 3	7.50	0.015	29.83	0.382	8.45	0.030	5083.33	30.550	3.20	0.100
St. 4	7.48	0.010	31.72	0.623	8.22	0.010	5200.00	10.000	3.38	0.076
Total	7.58	0.115	30.17	1.085	8.37	0.253	5192.00	93.682	3.45	0.214
Spring										
St. 1	7.43	0.057	22.81	1.386	7.48	0.230	3469.33	67.337	2.94	0.492
St. 2	7.36	0.057	23.02	0.575	7.46	0.217	3375.33	51.733	2.88	0.645
St. 3	7.40	0.000	22.60	0.100	7.32	0.100	3280.00	1.000	2.65	0.540
St. 4	7.38	0.010	23.10	0.000	7.12	0.000	3410.00	0.000	2.79	0.530
Total	7.39	0.043	22.88	0.672	7.34	0.207	3383.66	80.322	2.81	0.548
LSD	0.07		0.94		0.18		97.85		0.15	

Discussion

The study of physical and chemical criteria and indicators of importance in aquatic ecosystems. The pH values in this study ranged between (7.30-7.63), where many sources indicated the tendency of Iraqi water to alkaline nature, as it came in agreement with (21 and 22), it also came in agreement with (23) who mentioned that all water bodies are characterized by the transfer of salt compounds such as carbonates and bicarbonates during their flow. The turbidity values in this study ranged between (31.72-18.56 NTU), The reason for the turbidity, which increased in value in winter, is due to soil leaching operations by rainwater that pushed polluted materials, sand, and various microorganisms into the river, in addition to wastewater that is periodically released into the river which came in agreement with (24). The dissolved oxygen values in this study ranged between (8.69-6.50 mg/L), The low dissolved oxygen value in summer in this study is due to wastes through multiple outlets of waste water on the Euphrates River path in the city containing organic materials that are decomposed by the vital activity of microorganisms consuming dissolved oxygen, and the study was consistent with (25). The electrical conductivity values in this study ranged between (5291.33-3280.00 µs/cm-1), The high values of electrical conductivity in the winter season are caused by the low water level and the lack of discharge rates, or the reason may be due to the salty soil washing operations that take place during the winter season, or because of the rainwater washing operations that wash away the salts from the neighboring lands, this study was compatible with (26). The salinity values in this study ranged between (3.70-2.65), salinity recorded high values during the winter season, due to the same reasons that led to the high values of electrical conductivity due to the low water level of the river at the beginning of the winter season or to the salts flowing from the surrounding lands as a result of soil leaching operations or resulting from the rain water flowing from the land into the river and this agree with (27).

The tendency of heavy metals to accumulate in the components of the various environmental systems causes a decrease in the concentration of minerals such as cadmium in the water, as it agreed with (28), and the reason for the decrease in the values of this metal may be due to the lack of industrial activities near the studied area, as the study agreed with (29). The presence of lead in the aquatic environment is a harbinger of danger for the neighborhoods that live in it or if it is used as drinking water for the residents of the region. The increase in the concentration of this element results from the decomposition of waste batteries, oils and fuel for cars, in addition to the wastes resulting from heavy water, which undoubtedly is an additional source for increasing the concentration of the element in the aquatic environment and came in agreement with (30). The increased concentration of Copper, Zink, Nickel and chromium in the studied stations is due to the fact that it is constantly exposed to releases of sewage pollutants, oil spills from fishermens boats and agricultural diesel generators, in addition to the waste and chemicals used in catching fish. The study agreed with (31 and 32).

The sediments are the final site where heavy metals accumulate, whether resulting from natural or human sources (33). Through the results that appeared, we notice the high concentrations of heavy metals in the sediments compared to water, and this is due to the fact that the deposits are considered as stores of many pollutants in the water environment, including heavy metals, where this result is compatible with (34). This study showed that the concentrations of heavy metals in the sediments are high compared to water, as shown in Figures 7, 8, 9, 10, 11, and 12. This is additional evidence indicating the existence of activities related to human origin, as the influx of heavy water into the water leads to an increase in the concentration of heavy metals significantly expected in the sediment, as this result was consistent with a study in (35). Water quality is greatly affected by the heavy metals accumulated in the sediment, followed by the impact of these pollutants on human health through the water on which they depend for drinking and watering crops. On the other hand, the accumulation of these pollutants in the bodies of aquatic organisms that depend on them for food such as fish is another risk factor affecting human health, as the study agreed with (36).

IV. CONCLUSION

The importance of following up the work of heavy water treatment plants and conducting periodic maintenance of them and not throwing their waste directly into the river water, in addition to directing awareness campaigns for the residents of agricultural areas of the need to follow health guidelines when using river water and not throwing pollutants into it

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