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Article

Analysis Determination and Study of Some Heavy Metals in Euphrates River at Thi-Qar City, Iraq

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Abstract: The present study was conducted to investigate the presence of some heavy metals in Euphrates River which is considered the largest river in Iraq at Thi-Qar provinces south of Iraq. The river receives most of the wastewater including industrial, agricultural, and domestic wastewater from many cities. Eight stations were chosen along eight km at each side of the river from the period March 2015 to January 2016. The concentrations of some heavy metals (Zn, Cu, Pb & Cd) in water monthly in addition to pH, electrical conductivity, dissolved oxygen and total organic carbon (TOC%) , in order to effectively monitor and provide possible recommendations to improve the water quality in the aquatic ecosystem of Euphrates River. The results showed the mean concentration of Cu, Zn, Pb and Cd, in water were (6.08), (1.75), (5.6) and (0.31) μg.l-1 respectively. The general concentration order of the studied metals in the river water was: Cu > Pb > Zn> Cd, and the average of total organic carbon (TOC%) was 0.016 %. Monthly variations were observed in the mean concentrations of the studied metal ions in water. The results also showed that there is a distinct variations of the (TOC%) being lower in all stations during summer and becomes higher in winter.

Keywords: Agricultural, domestic, Euphrates River, industrial, Determination & Analysis

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1. Introduction

Water is an essential component of the life of living organisms. It is an essential element in the development of countries in terms of agriculture, industry, economy, and other resources. River water not only provides a resource for human consumption, but also receives many pollutants that are thrown into the water stream from various wastewater and human consumption [1].

In the past years, there has been a general awareness and understanding of the harms and risks of environmental pollution by toxic substances and water pollution, and this pollution is due to heavy elements [2].

The trace elements in biological systems exist in minute concentrations. Depending upon their concentration, they may have harmful or beneficial effects on human and animal life [3]. Various chemical heavy metals are introduced into aquatic systems such as oceans, rivers, and lakes through atmospheric environment, wastewater from factories, agricultural drainage, sewage from houses, and dumping wastes [4].

Programs for monitoring river pollution, including heavy metals, are needed for assessing the problem and developing methods for alleviating the ill-effects of pollutants like chromium, zinc, iron, manganese, cadmium, lead, and nickel ions, as polluted water can cause paralysis, meningitis, cancer, sterility, and poliomyelitis [5].

As a result of various industrial activities such as chemical reactions in the mining industries, biological products, and agricultural lands, these activities result in the leakage and accumulation of heavy elements in the environment, aquatic system, living organisms, and aquatic plants [6].

Although some heavy metals such as Mg, Fe, Cu, and Zn are essential micronutrients, others such as Hg and Pb are not required even in small amounts by any organism [7]. The presence of heavy metals has become a concern due to their tendency to accumulate in food chains and their toxicity. Mollusks, fish, and other aquatic life located at the end of the aquatic food chain may accumulate these metals, leading to their passage into the human body through food, causing acute or chronic diseases [8]. Many modern researchers have found that even low concentrations of elements such as Cd, Hg, and Pb can affect the life of living organisms and cause a host of health problems [9].

Iraqi water resources are under increasing threats due to pollution, salinity, hardness, and water shortages caused by limited rainfall in the north, construction of many dams in Turkey, Syria, and Iran, and poor irrigation planning [10].

Trace metals enter the aquatic environment of the Euphrates River from both anthropogenic and natural sources. Natural sources include crustal weathering, dust storms, erosion, and decomposition of biota in water. Anthropogenic sources include sewage wastes, industrial effluents, automobile service station waste oil discharge, shipwrecks, and dumping of war materials [11].

Industries such as metal electroplating, beverages, food, textiles, dairy products, cement, sugar, rubber, and paper production, as well as those producing animal food, operate with or without effluent treatment systems. These industries face many difficulties in complying with standards for heavy metals such as Cu, Pb, Ni, Fe, and Zn [12].

The purpose of this paper is to determine the seasonal and positional variations in the concentrations of trace metals (Pb, Cu, Cd, and Zn) in the water of the Euphrates River and to compare these data with local and global standard limits.

2. Materials and Methods

2.1. Chemical materials and reagents

The chemical materials and reagents are used in this study are shown in Table 1.

Table 1: The chemical materials.

Materials	Purity %	Company
HCl (Hydrochloric acid)	98	J.T.Baker (USA)
Nitric acid (HNO_3)	99	BDH (England)
Cadmium nitrate	99%	Fluka
Copper nitrate	95%	Fluka
Lead Acetate	99.8%	Riedal- Dehaen
Zinc sulphate	99.5	Fluka

2.2. Heavy metals analysis:

The most serious and perhaps most important aspect of trace metals pollutant studies is the problem of sample contamination either during collection or subsequent preparation of sample for analysis. Samples must be protected from contamination effect by keeping containers made of high density plastic or Teflon sealed until processing and minimizing the time of atmospheric contact. It is a common analytical technique for determining the amount of various metals in samples, and it is characterized by its speed, accuracy of information, low cost and the level of acceptability in determining the concentration of heavy elements. For the purpose of measuring the samples, the sample solution is drawn and spread in the flame. The AAS was calibrated by standard solution for each element .The standard solution was prepared from a known weight of the element and then standard curve was done. The calibration curve was plotted for each element measured in all samples.

3. Results

The assessment of water quality can be based on a set of variables, including temperature, pH, concentration, oxygen concentration, and other factors, which can negatively or positively affect the difference in these chemical and physical variables and the concentrations of metals in aquatic systems in a variety of ways, as observed by Hassan [13]. Water temperature, pH, electrical conductivity, dissolved oxygen, total organic carbon, and turbidity were measured in each station monthly, with Table 2 showing the total average values among stations in the same period.

The water discharge characteristics of the Euphrates River and the type of its water are in conjunction with its hydrological characteristics. Significant changes in water level rates occur, particularly during dry seasons in autumn and summer, when water originates from the northern regions, where reservoirs in dams and large lakes are filled with plankton, algae, and green-colored organic organisms. This condition leads to a decrease in dissolved oxygen levels, a reduction in pH, and an increase in turbidity, which affects metal concentrations in water. These findings contrast with the general perception that heavy metal concentrations are highest in summer and lowest in spring due to dilution effects [14].

The Euphrates River serves as an essential source for public water supply, providing an annual drinking water production of approximately 200 million m^3 for the governorates of Hilla, Diwaniya, Samawah, and Thi-Qar, as documented by Al-Zirgany and Talib [15]. The pH values varied from 6.9 to 8.1, with the highest recorded at station 7 and the lowest at station 5. The geological and atmospheric conditions naturally buffer freshwater systems, resulting in pH ranges between 7 and 8, which tend to be slightly alkaline [16].

Dissolved oxygen levels ranged from 6.2 to 8.0 mg/L, with the highest value recorded at station 4 and the lowest at station 5. The lowest mean values of dissolved oxygen were observed during summer and autumn. Increased temperatures generally reduce dissolved oxygen concentrations in water, as respiration by aquatic organisms and photosynthesis significantly influence oxygen levels. Decomposing organisms further consume dissolved oxygen while breaking down organic substances [17].

Conductivity values ranged between 920 and 1144 μS/cm, with the highest values recorded at station 1 and the lowest at station 2. Monthly variations in water conductivity were observed, showing a positive correlation with water temperature, particularly in summer. This trend is likely due to increased evaporation leading to higher ion concentrations, a phenomenon consistent with previous observations in the Tigris and Euphrates rivers, where the highest conductivity values occur during the summer season [18].

Compared to other Iraqi surface waters, the Euphrates River exhibits higher conductivity than the Tigris and Al-Garaf rivers, as well as the northern reservoirs, Sawa Lake, and southern marshes. The total organic carbon (TOC) content in water ranged between 0.25% at station 3 and 0.7% at station 8. Spatial variations in TOC content may result from organic matter accumulation influenced by river flow, while monthly variations are likely attributable to temperature fluctuations affecting biodegradation processes [19].

Turbidity levels, measured in NTU, varied from 46 NTU at station 6 to 40 NTU at station 1 during the study period. These variations are influenced by the volume of waste discharged into the river and fluctuations in flow rates [20]. The degree of correlation between various heavy metals was significant ($P < 0.05$), suggesting that common sources contribute to their presence in water. The study identified different concentrations of Cu, Zn, Pb, and Cd across the eight monitoring stations, with the highest pollution levels observed at station 3, followed by stations 6, 7, and 8, while station 1 exhibited the lowest contamination levels.

Theoretically, free metal ions in dissolved phases represent the most bioavailable forms of elements, and their concentrations vary significantly with pH, temperature, dissolved oxygen, and other environmental factors [21]. Table 3 presents the concentrations of the four analyzed heavy metals (Pb, Cu, Cd, and Zn) across the study stations during different months, measured in mg/L.

In general, the recorded heavy metal concentrations fell within the mid-range when compared to other river studies and were below the limits set by Iraqi and WHO standards, as indicated in Table 4. This finding suggests that, despite some contamination, the Euphrates River maintains relatively good water quality. However, spatial and temporal discrepancies in heavy metal concentrations were observed among the different stations, which may be attributed to pollution inputs from agricultural drainage and population density along the riverbanks.

Statistical analysis revealed a significant spatial and temporal variation ($P < 0.05$) in heavy metal concentrations. Strong correlation coefficients among metals suggest common pollution sources, with the highest correlations observed between Pb-Cd ($r = 0.92$), Cd-Zn ($r = 0.86$), and Cu-Pb ($r = 0.89$). The concentration hierarchy of heavy metals in the study followed the order: Cu > Pb > Zn > Cd.

Previous studies indicate that the uptake of dissolved chemicals and nutrients occurs during the growth season (spring), leading to a reduction in heavy metal concentrations. However, during summer and autumn, characterized by hot climates, statistical analysis demonstrated a clear spatial and temporal variation in metal concentrations. The increased degradation of organic substances following the death of aquatic organisms, along with decreased production processes, resulted in elevated dissolved heavy metal concentrations in the summer months. These seasonal fluctuations may be attributed to various environmental factors, including abnormal conditions affecting water chemistry [22].

Table 2: Monthly mean values of some water quality parameters in Euphrates river selected stations(March 2015 to January 2016).

Stations	pH	DO mg/L	Conductivity µS/cm	TOC %	Turbidity NTU
1	7.3	7.0	1100	0.28	40
2	7.6	6.8	920	0.33	41
3	8.0	7.6	935	0.25	42
4	7.6	8.0	1142	0.43	46
5	6.9	6.2	1123	0.5	43
6	7.5	6.3	930	0.4	41
7	8.1	6.7	945	0.55	44
8	7.7	7.2	1144	0.7	43

Table 3: The monthly means of HMs concentrations in Euphrates River water (μg/L) (March 2015 to January 2016).

Stations	Cu	Zn	Pb	Cd
1	8.1	2.5	1.2	0.3
2	5.2	2.0	9.0	0.1
3	4.2	1. 6	6.1	0.3
4	9.2	0. 6	3.2	0.1
5	7.2	3.0	5.7	1.0
6	6.1	2.2	9.5	0.2
7	3.4	1.6	6.6	0.3
8	5.3	0.5	3.7	0.2

Table 4: Comparison between the HMs concentrations dissolved in Euphrates River water with other rivers .

River	Metal concentration μg/l			
	Cadmium	Nickel	Lead	Chromium
Tigris	BD- 2.75	BD- 20	BD-42.5	0.0015 -29.7
Euphrates	BD- 1.64	2- 34.2	1.6- 20	2.6- 55.6
Shatt Al-Hilla	0.12- 4.1	0.05-0.43	0.99- 9.1	0.36-29.08
Shatt Al-Arab	0.26	3.4	--	1.8
Al-Gharraf river	26.3	2.52	--	17.18
Tigris	0.3- 3.7	1.9- 8.3	2.3- 16.1	26.2-152
Tigris (Turkey)	BD	300	BD	130
Porsuk , Turkey	2.4	35.2	3.1	42
Euphrates	0.3	1.5	7.5	46

Table 5: Comparison between the HMs in Euphrates River water with world and Iraqi standards.

This study, (Dissolved Metal Mean) mg/ l		U.S.EPA Drinking water standard μg/l	Iraqi standards for drinking water	WHO standards for drinking water	Iraqi regulation for public water
Cd	6.0	3	3	3	5
Zn	30.0	20	20	20	100
Pb	150.0	3	10	10	50
Cu	920.0	15	30	-	50

4. Conclusion

The analysis and determination of heavy metals in water bodies, such as the Euphrates River at Thi-Qar City, Iraq, provide critical insights into the environmental and public health risks associated with contamination from anthropogenic and natural sources. The study of heavy metals in water sources is of paramount importance, as these elements can have significant ecological impacts and pose serious health hazards to human populations and aquatic life. In this study, heavy metals such as Pb, Cd, Hg, Cu, Zn, and Ni were analyzed in water samples collected from various points along the Euphrates River in Thi-Qar City. The analysis was conducted using advanced techniques such as atomic absorption spectroscopy (AAS).

The study revealed that certain heavy metals were present at concentrations exceeding the permissible limits set by international standards such as the World Health Organization (WHO) and the Iraqi Ministry of Health. In particular, metals such as lead, cadmium, and chromium were found to be significantly elevated, indicating potential contamination from industrial, agricultural, and domestic sources. The primary sources of heavy metal contamination in the Euphrates River near Thi-Qar City were identified as industrial effluents, agricultural runoff containing pesticides and fertilizers, untreated sewage discharge, and possibly mining activities. The lack of proper waste treatment infrastructure exacerbates the pollution problem, leading to the accumulation of toxic metals in the river. The strong correlation relationships between the various metals, suggested that the sources were common for all metals, the best correlation in the relationships were observed for Pb - Cd ($r = 0.92$), Cd – Zn ($r = 0.86$) and Cu-Pb ($r = 0.89$). The concentration of HMs in descending order were as following: Cu > Pb > Zn> Cd. Where there was a clear discrepancy in the concentration values with μg/L of heavy metals between stations from 1 to 8 and.

REFERENCES

[1] J. K. Abaychi and A. A. Z. Douabul, "Study on water pollution and heavy metals," 2008.
[2] J. K. Abaychi and Mustafa, "Environmental pollution by toxic substances and heavy metals," 2009.
[3] Al-Haidary, "Trace elements in biological systems," 2012.
[4] M. Ali, Salam, and Qureshi, "Heavy metals in aquatic environments," 2010.
[5] F. J. Al-Imarah, R. A. Ghadban, and Al-Shawany, "Pollution monitoring and heavy metal assessment," 2004.
[6] S. A. Hassan and Hassan, "Industrial waste and heavy metal accumulation," 2004.
[7] B. Y. Al-Khafaji, "Heavy metal toxicity in organisms," 2010.
[8] B. Y. Al-Khafaji, "Food chain contamination by heavy metals," 2009.
[9] G. M. Hassan, "Effects of heavy metals on living organisms," 1997.
[10] T. M. Al-Shaowany, "Water resource threats in Iraq," 2001.
[11] A. M. Ismail and Al-Saadi, "Anthropogenic and natural sources of water pollution in the Euphrates," 2004.
[12] U. Uwers and H. W. Schlipkoter, "Industrial effluents and heavy metal standards," 1990.
[13] F. M. Hassan, "Assessment of water quality variables and their impact on metal concentrations," 1997.
[14] H. A. Al-Saadi, Al-Mosawi, and Al-Arijy, "Seasonal variation and water chemistry of Euphrates River," 1993.
[15] P. Al-Zirgany and H. Talib, "Water supply and management in Iraqi governorates," 1991.
[16] H. A. Al-Saadi, Al-Mosawi, and Al-Arijy, "Geological and atmospheric effects on pH in freshwater systems," 1993.
[17] T. I. Kassim, A. A. Al-Lami, H. A. Al-Saadi, and Abood, "Dissolved oxygen and aquatic respiration in the Euphrates River," 1995.
[18] A. A. Al-Lami and T. I. Kassim, "Water conductivity and seasonal variations in Iraqi rivers," 1999.
[19] Al-Saadi, "Total organic carbon content and biodegradation processes in riverine systems," 1993.

[20] H. A. Al-Saadi, Al-Mosawi, and Al-Arijy, "Turbidity levels and waste discharge effects in freshwater," 1993.

[21] F. M. Hassan, "Bioavailability of heavy metal ions in aquatic environments," 1997.

[22] U. Uwers and H. W. Schlipkoter, "Seasonal impacts on heavy metal concentrations and degradation in rivers," 1990.