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Article

Assessment of Trace Elements Pollution in Sediments & Water of some Rivers in Karbala City

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Abstract: This study aims to assess the levels of trace element pollution, specifically cadmium (Cd) and lead (Pb), in the sediments and water of the Al-Hussainiya River and Shatt Al-Hindiya River in Karbala City, Iraq. The research was conducted over five months, from November 2022 to March 2023, with samples collected at seven different stations. The analysis focused on determining monthly variations in the concentrations of these elements and their correlation with environmental factors. The study employed Atomic Absorption Spectrophotometry (AAS) for the quantification of trace metals. The results indicated significant spatial and temporal variations in Pb and Cd concentrations, with the highest levels recorded at station 6 in January (Pb: 22.9967 µg/L in water, 26.74 mg/kg in sediment) and station 7 in November (Cd: 3.68 µg/L in water, 7.767 mg/kg in sediment). The elevated levels of these metals are attributed to human activities, such as industrial discharges and wastewater runoff. These findings raise concerns about the ecological and health risks posed by metal contamination in these river systems.

Keywords: Pollution, Lead, Cadmium, Trace Metals, Toxicity.

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1. Introduction

The heavy metal pollution in aquatic ecosystems has received significant attention because of their volume, consistency, and toxicity (1). Both human activity and natural processes have a role in the overabundance of heavy metals in the environment (2). However, the human-induced pollution in aquatic habitats causes sediment and water to become contaminated with metals that are heavy (3). The increased presence of heavy metal ions has deleterious effects on fish, humans, and invertebrates (4).

Because of urbanization and industrialization, aquatic ecosystems are increasingly polluted with metals (5). In aquatic ecosystems, sediment is often employed as a pollution indicator in natural waters (6). Most importantly, the natural composition of water and the type of suspended solids affects the behavior of metals (7). River systems have a cyclical progression of alterations in the transport of heavy metals due to precipitation, dissolution, and uptake events (8), which affects the behavior and availability of heavy metals (9). Sediments are significant components of watersheds due to the variety of habitats and ecosystems they harbor (10). River ecosystems may be adversely affected by industrial waste and human activity, these effects can be determined by analyzing the heavy metal composition of water and sediment (11). As a result, it's vital to measure the heavy metal concentrations in sediment and water associated with each impaired river ecosystem. In developing countries, the volume of municipal waste and untreated industrial wastewater that is released into rivers and other waterways is of concern because it is increasing in quantity and negatively impacting the quality of water (12). Toxic metals like lead (Pb) and cadmium (Cd) are different from other metals in that their half-life is long (13). CD is a recognized nephrotoxicant that, among other effects, it can adversely affect the central nervous system, alter the way sexual reproduction is conducted (including infertility), and lead to psychiatric issues (14).

High lead consumption can cause kidney damage, digestive issues, memory loss, and high blood pressure. Additionally, Alzheimer's disease has been associated with lead exposure. Al, Cd, and Pb are recognized as the greatest threat to aquatic systems (15).

The presence of metal traces in riverine sediments is considered paramount to the assessment of pollution levels and environmental conditions (16). Because metals are typically stored in the lowest parts of river water's catchment, the concentration of trace metals in river sediment is much greater than in water (17). Changes in temperature, pH, and other environmental components, as well as other physical or biological perturbations, can cause the release of metals into the water column and their extraction from the sediment (18). Trace metals are crucial to life in organisms at lower concentrations, although higher concentrations of these metals are toxic and have a negative effect on living things (19).

The Euphrates River is the largest river in Karbala, and it's the most important river there. It's increasingly contaminated by heavy metals in wastewater. Large quantities of untreated wastewater are released into the Euphrates River, this river is then polluted by the water and sediment. The two primary metals that are deposited in the river are lead (Pb) and cadmium (Cd). Trace elements are composed of multiple components. The two primary rivers that surround the city are the Husseiniya River and the Hindiya River. They have multiple social and commercial functions, including the practice of fishing, washing, and drinking water. Trace metals can be transported into the river system via multiple avenues, including the air of deposition, soil runoff, industrial wastewater, and chemical leaching from various commercial, industrial, and agricultural endeavors..

Aim of study

The objective of the investigation was to determine the degree to which possible heavy metal pollution could be found in sediment and water, particularly in regards to cadmium, lead and mercury.

Pb &Cd metals

The metals lead (Pb) and cadmium (Cd) have no natural functions in humans. All of the apparent effects are detrimental (20). In fact, cadmium and lead are both listed as 11 of the World Health Organization's (WHO) most significant chemical hazards as a public health concern (21). Without excretion systems, lead and mercury will accumulate in tissues and organs (22). As the population ages, the levels of cadmium and lead in their tissues increase, and the probability of developing common diseases associated with aging increases. Despite the fact that the highest concentrations of cadmium and lead are located in the kidneys and bones, respectively, the adverse effects of these minerals are not limited to diseases that affect the bones and kidneys (20).

The Source and Toxicity of Pb &Cd Metal Ions

Many industrial processes are recognized as significant contributors to lead and cadmium in the aquatic environment, these processes release toxic metal ions into the water's surrounding area (23). These procedures are employed in the glass, agriculture, leather tanning, and battery manufacturing industries. An estimated 10 million tons of lead (II) are produced; the International Lead Association states that 85.10% of this is utilized in the battery industry, 5.5% is utilized in pigments, and the remainder 2.10% is utilized for other purposes. Lead (II) is also employed as a component of gasoline that serves to inhibit the absorption of ultraviolet light(24).

The soil and crust of the planet naturally contain the metal cadmium. Batteries, paints, pigments, coatings, and certain kinds of pricey jewelry all include it. Higher amounts of cadmium in water may result from the use and disposal of things containing cadmium. Water that spills, for example, may have higher levels of cadmium. Cadmium levels were not detectable in the vast majority of water samples collected from public drinking water systems during the last ten years. When testing show high levels of cadmium, steps are taken to ensure that people are not drinking contaminated water.

Many studies have focused on the contamination of sediments and water by these two elements. Between December 2012 and November 2013, the river water and sediments of Bani Hasan Creek, a tributary of the Euphrates River in Karbala Governorate, were investigated for possible contamination with various pollutants. The results showed that the average concentrations of heavy elements (Cu, Cd, Fe, Pb, and Cr) in the dissolved phase of water were (0.51, 0.06, 2.78, 2.45, and 0.15 μg/L), while their average concentrations in water were (0.51, 0.06, 2.78, 2.45, and 0.15) μg/L, respectively. The dry weights of the particulate phase were (29.93, 0.65, 1233.80, 20.19, and 30.64) μg/g, respectively. The average concentrations of heavy elements in the sediment exchange phase were (13.91, 0.40, 610.57, 26.98 and 34.31) μg/g dry weight, respectively, while the average concentrations of heavy elements in the residual phase were (16, 36, 0.07, 710.31, 13.13 and 187.48) μg/g dry weight, respectively (25).

Further investigation was conducted to determine the concentrations of seven heavy metals (iron, copper, zinc, lead, nickel, cadmium and chromium) in water at four sites of the Babylon Mashroo AL-Musayyib Canal Project/Euphrates River Branch in central Iraq (26). The order of detection of heavy metals in the dissolved phase of water was: Zn>Fe>Cu>Ni>Pb>Cr>Cd. In spring, the zinc abundance was highest at site 2, while the cadmium abundance was lowest at site 1. In spring, the zinc abundance was highest at site 2, while the cadmium abundance was lowest at site 4 in the same season. This applies to the particulate phase: Zn > Cu > Fe > Ni > Pb > Cr > Cd. The arrangement of elements in sediments is: Zn > Cu > Fe > Pb > Ni > Cd > Cr; at site two, Zn abundance was highest in the spring, while Cr abundance was lowest in the same season. Cd levels were lowest at site one in the fall, and highest at site four in the winter. Researchers (27) found trace metal lead levels in water samples ranging from 0.4 to 109 μg/L, and copper levels ranging from 0.006 to 0.09 μg/L. When examining trace metals in surface water and sediments from contaminated coastal areas in Bangladesh, sediment samples from the Chittagong shipbreaking area had the highest lead levels (41 mg/kg dry weight), exceeding the Canadian sediment quality guidelines.

A study conducted using atomic absorption spectrophotometer (AAS) (28) showed that the trace metal contents found in 60 composite sediment samples were in descending order: lead (Pb) (29.21 mg/kg) > arsenic (As) (5, 18 mg/kg) > cadmium (Cd) (1.8 mg/kg). This investigation clearly shows that metals from natural and artificial sources (especially from various industries) are associated with river sediments. At regular intervals, the levels of trace metals (especially Cd, Pb, and Cr) have an impact on species in the sediments. In other words, from a biological point of view, these concentrations have a harmful effect on aquatic organisms. Due to the estimated potential ecological impacts of mercury, aquatic ecology is at serious risk.

Study Design

The five-month experiment, which included seven stations and a factorial Randomized Complete Block Design (RCBD), was planned from November to March.

Study Site

Karbala Governorate is located within the Middle Euphrates Governorates in Iraq. It is about 100 km away from the capital, Baghdad. Seven locations within Karbala governorate were selected to conduct this study, as shown in the Table (1).

Table 1: Site of Sampling

No.	Stations	The Coordinates of the sites
1.	S1	(N 34.06'32 °37, E 57.14'2 44°)
2.	S2	(N 46.74'32 °37 , E 31.96'3 °44)
3.	S3	(N 18.75'32 °40 , E 24.65'44 °10)
4.	S4	(N 41.16'32 °40, E 12.00'44 °11)
5.	S5	(N 39.29'32 °32, E 36.09'44 °13)
6.	S6	(N 47.58'32 °32, E 29.74'44 °13)
7.	S7	(N 33.26'32 °32, E 40.78'44 °13)

Figure 1: Study areas' map (Source :https:/ earth.google.com).S1,S2,S3,S4,S5,S6,S7 represent the locations of the study's sampling sites.

2. Materials and Methods

The increased monitoring of trace minerals (Pb, Cd) was conducted at the Environmental Health Laboratory, Department of Environmental Health, Faculty of Applied Medicine. Sediment and water samples were gathered in seven different

locations over five months from November of 2023 through March of 2024 in Al-Hussainiya River and Shatt Al-Hindiya (Tuwairej).
According to (29) It, the operation procedure was as follows:

A_ Sediment: The sediment was spread until completely dried and then digested through the following steps:

1. The soil was ground and 0.2g was taken from it.
2. Add 2 mL nitric acid, add 6 mL hydrochloric acid.
3. The samples were heated by a hot plate device until completely dried.
4. After the sample is completely dry, add 20 ml of distilled water and stir with a spatula..
5. Recommended by filter paper.
6. It was placed in a cup to determine by Atomic Absorption devise .
7. Water: pH, E.c., TDS, Temperature were measured by a pH meter in the health lab .

3. Results

Lead concentration in water and sediments

The findings demonstrated distinct, noteworthy variations in the lead and cadmium concentrations across the several research locations and throughout the course of the study months. The findings in Figures (2,5) illustrate the variations in lead concentrations across the study stations over the course of the study months. In January, station 6 had the highest concentration of this element in the water, measuring 22.9967µg/l, while station 2 had the lowest concentration, measuring 0.9333 9967µg/l in November. Regarding sediments, station 6 showed a rise in lead concentrations in January, measuring 26.74 mg/kg, while station 1 had the lowest value in March, with 11.8133 mg/kg.

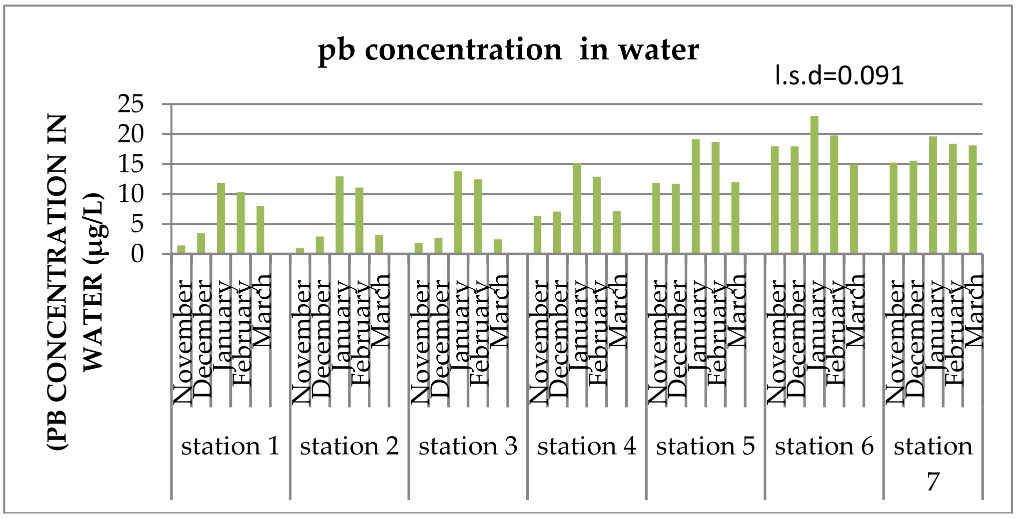

Figure (2) Pb concentration in water for all stations during study months

Regarding the influence of location on lead (Pb) concentrations in water and sediment, the results demonstrated significant changes in the component concentration. As illustrated in Figure (3,6), the greatest Pb content in water was 18.724 µg/L at Station 6, and the greatest sedimentary content was 2.558 mg/kg at Station 7. Conversely, the lowest concentrations in water and sediment were 5.6166 µg/L and 0.52533 mg/kg at Station I, respectively..

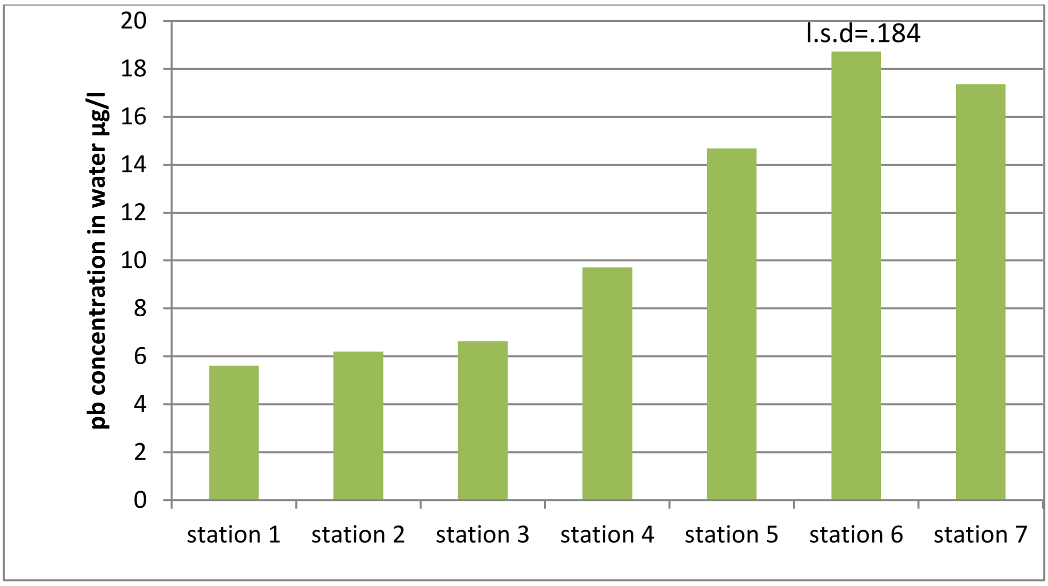

Figure (3) Concentration of pb in water for stations

Figures (4,7) show that the quantities of lead in water and sediments varied significantly during the course of the study's months. January had the greatest concentrations, with 16.3748 µg/l and 21.4486 mg/kg, respectively.

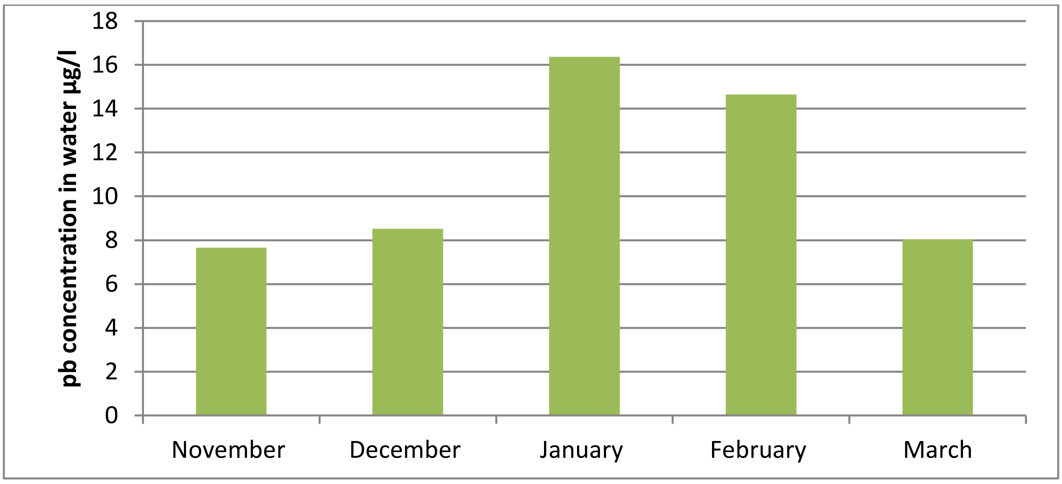

Figure (4) Concentration of pb in water for months

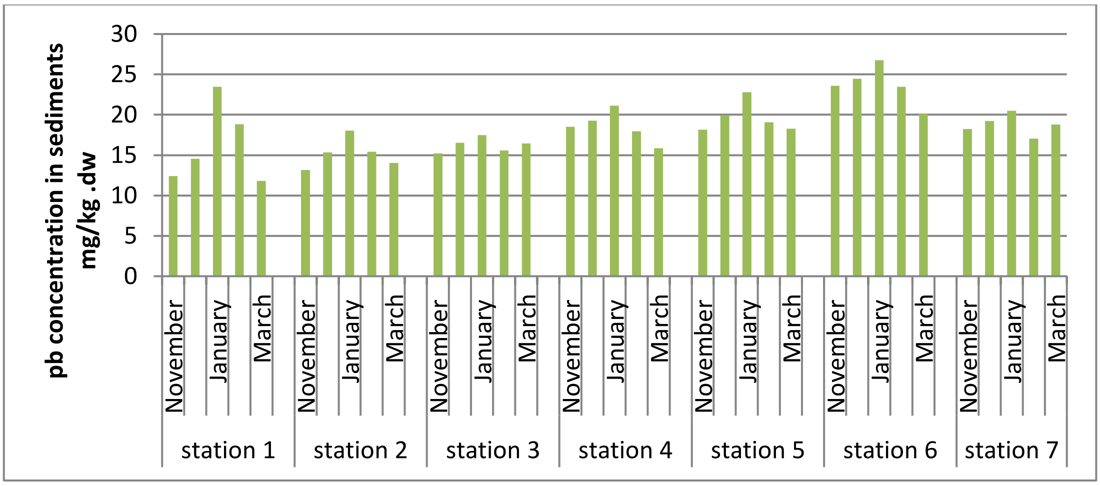

Figure (5) Pb concentration in sediments for all stations during study months

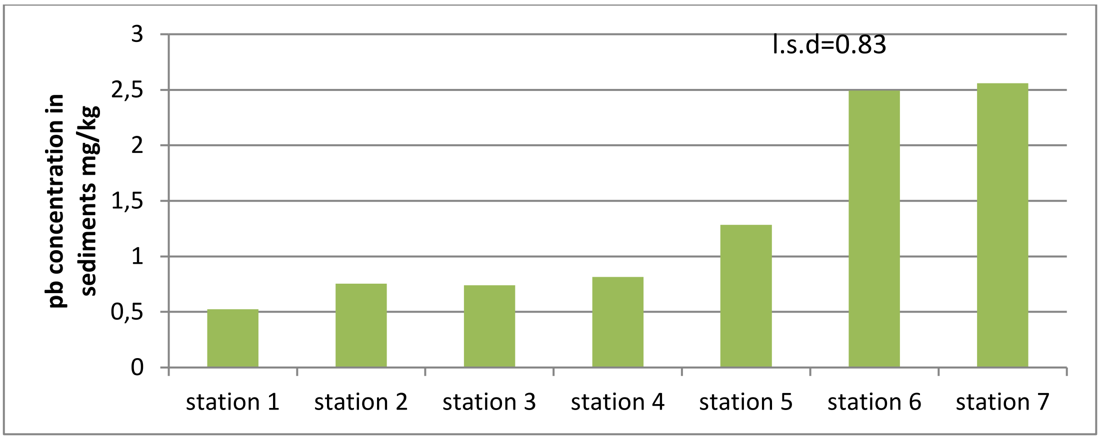

Figure (6) Concentration of pb in sediments for stations

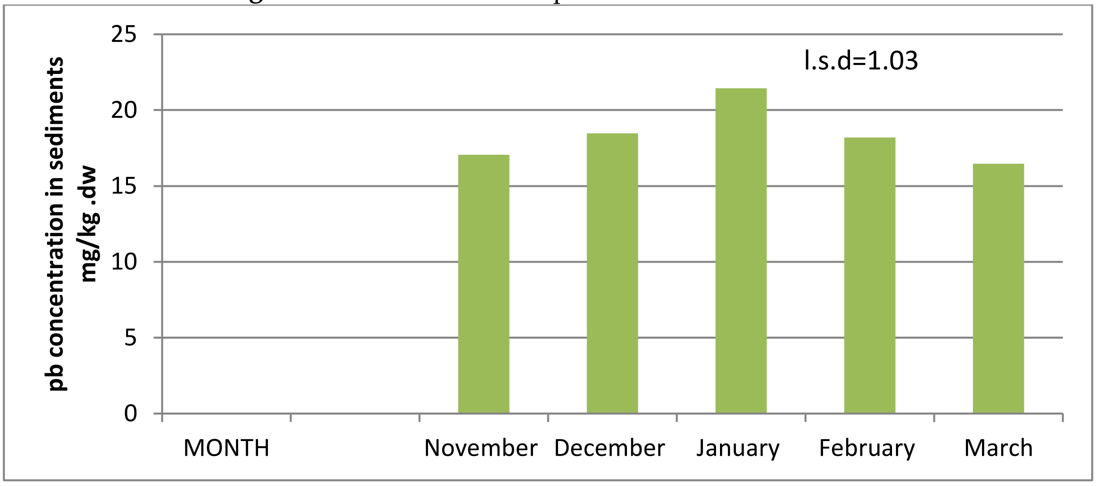

Figure (7) Concentration of pb in sediments for months

Cadmium concentration in water and sediments

The findings in figures (8,9,10,11,12,13) demonstrated how the circumstance and month affected the cadmium concentrations. In water, the maximum concentration was 3.68 µg/l in November at station 7, and in sediments, it was 7.767 mg/kg in January at station 6. The greatest concentration of Cd was found in stations 6 for sediment and 7 for water, indicating that location has a major impact on Cd content.

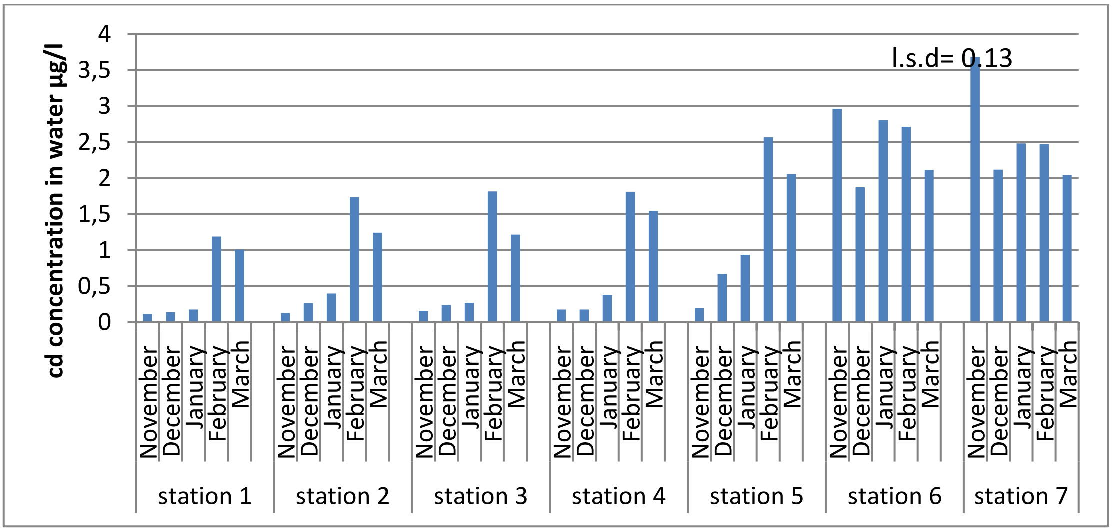

Figure (8) Cd concentration in water for all stations during study months

The same thing occurred to the concentration of the element during the months of the study, where the results showed clear significant differences, the highest concentration was in February in water and in January in the sediment. Which were 2.04381 µg/l ,3.83 mg/kg.

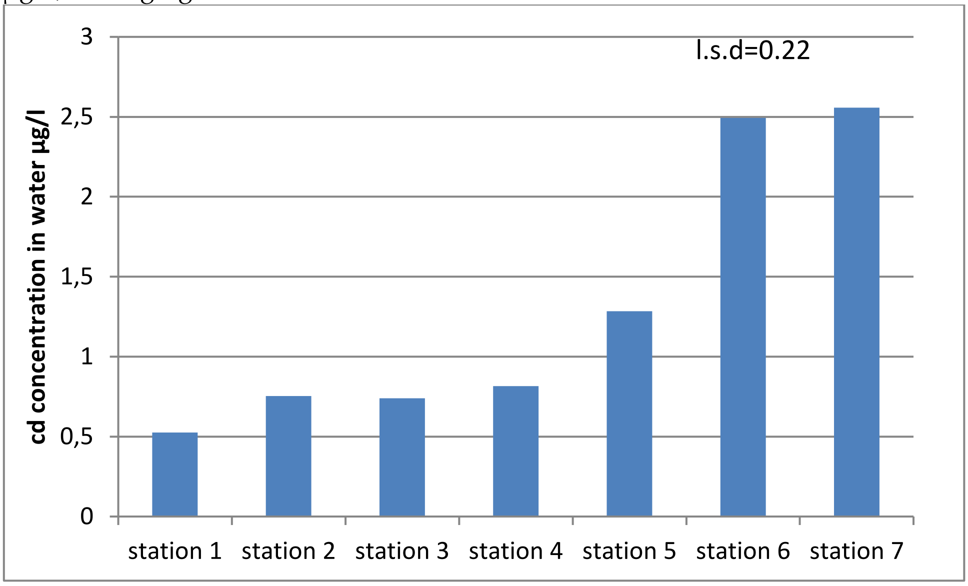

Figure (9) Cd concentration in water for stations

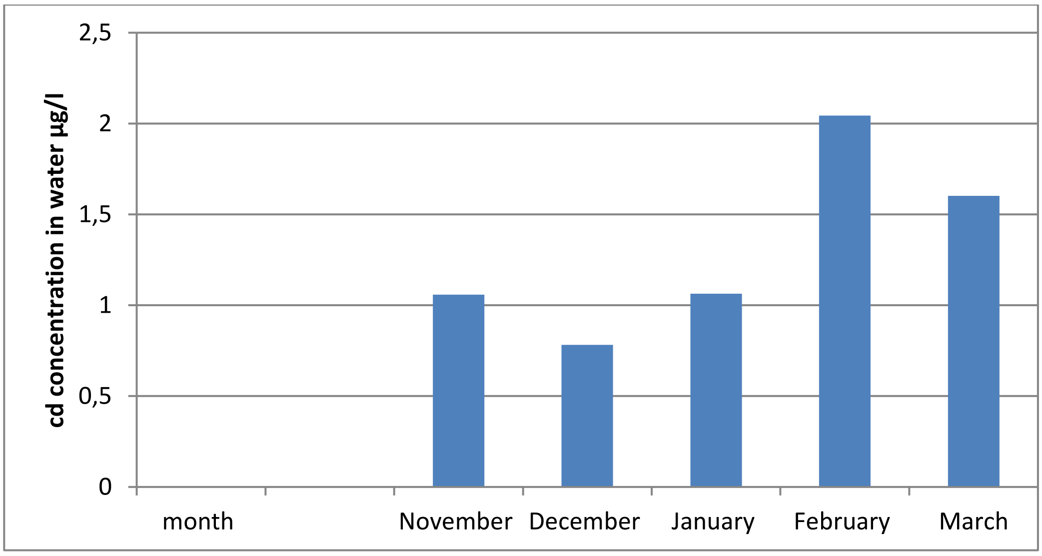

Figure (10) Cd concentration in water for months

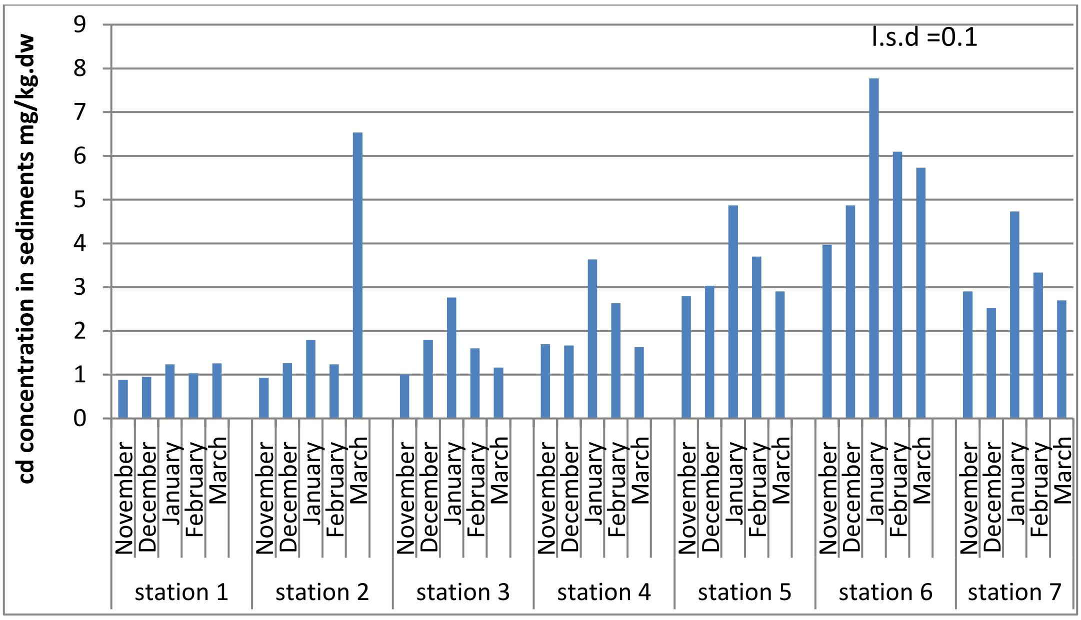

Figure (11) Cd concentration in sediments for all stations during study months

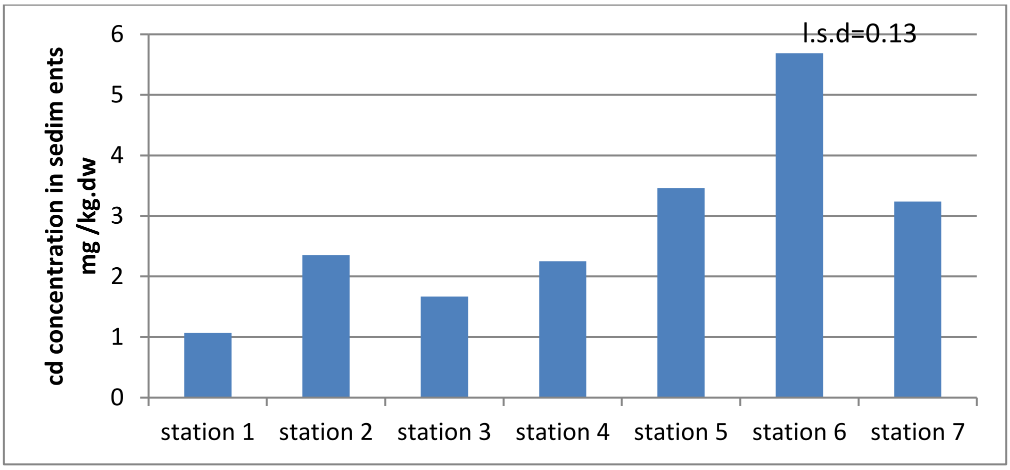

Figure (12) Concentration of Cd in sediments for stations

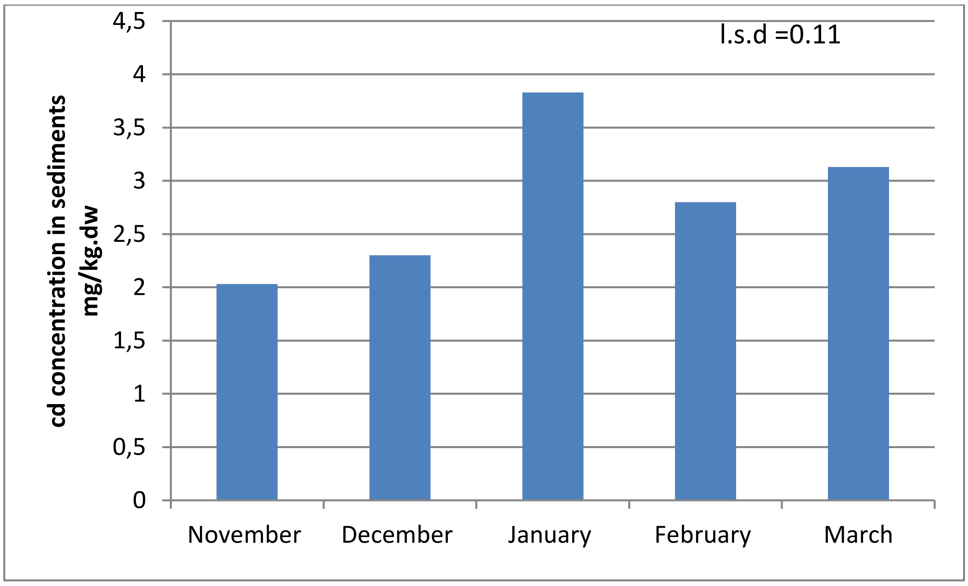

Figure (13) Concentration of Cd in sediments for months

Table 4: Tempreture , PH, Electron Conductivity and TDS for water samples during the study

LOCATION	MONTH	Temp	PH	E.C. (µS/cm)	TDS ppm
station 1	November	22.8	6.6	2590	1280
	December	17	7.8	4180	1290
	January	16	7.8	3380	1680
	February	16.8	8.5	2800	1390
	March	21	7.9	2830	1420
station 2	November	22.9	7.2	2610	1290
	December	17	8.3	4150	1450
	January	16.1	7.5	3420	1700
	February	16.9	8.3	2830	1410
	March	21	7.7	2930	1450
station 3	November	22.8	6.7	2580	1290
	December	17	8	3670	1610
	January	16.3	7.6	3260	1640
	February	16.9	8.1	2870	1430
	March	20.8	8.2	2830	1410
station 4	November	22.9	6.9	2550	1270
	December	17	8.1	3550	1290
	January	18.1	7.6	3290	1610
	February	16.7	8. 2	2230	1420
	March	20.6	8.2	2820	1410
station 5	November	23.4	7.4	2640	1310
	December	16.8	7.8	3460	1730
	January	16.6	7.3	3420	1700
	February	16.8	7.5	2830	1410
	March	20.6	8	2850	1420
station 6	November	23.4	6.6	2560	1310
	December	16.8	6.9	4140	2040
	January	16.8	6.9	4000	2000
	February	16.8	8.3	2830	1420
	March	20.4	7.8	2900	1440
station 7	November	23.5	7.3	2640	1340
	December	16.8	7.9	3500	1710
	January	16.7	7.9	3400	1720
	February	16.8	7.2	2870	1420
	March	20.5	7.9	2870	1430

4. Discussion

The findings demonstrated that there were discernible variations in the Pb and Cd concentrations during the research periods in addition to a discernible impact on the study station. In comparison to the other study stations, there was a rise in the concentrations of these two elements in the stations that experienced an increase in pollution releases into the aquatic environment from industrial activity, which is represented by the three stations (5,6,7). This is because there was an increase in the factory wastes being discharged into the surface water sources in the Shatt al-Hindiya, as previously stated in the sources. Waste from homes and industries contains cadmium. These findings concur with the justification provided in (24, Since its concentration is influenced by the discharge of water, it is possible to be transported with suspended particles during the flood period. The results show that lead and cadmium concentrations are highest during periods of floods and rain, and they decrease during periods of low discharge rates and high temperatures.As the river's flow rate increases, so does surface runoff and the proportion of suspended matter, which is made up of colloidal materials, organic colloids with a large surface area and a high capacity to store trace elements like pb and cd, and semi-mineral colloidal materials.Consistent with other studies that demonstrated a linear connection between the chemicals' concentrations Trace element relationships and concentrations in the sediment (30).

A major component influencing the aquatic environment throughout the study months is temperature variations. Physical and chemical alterations, as well as the effects they have on aquatic life and the characteristics of the water, such as salinity, electrical conductivity, different compound solubility, dissolved oxygen content, and variations in pH and carbon dioxide levels Composting of organic matter and other factors (31),According to (32) it is crucial to the process of cellular metabolism as well as the development and reproduction of living things.

5. Conclusion

1. The research found that there are signs of contamination in the Shatt al-Hindiya environment, with substantially higher mineral (pb, Cd) values recorded in January.
2. The level of pollution with these two elements decreases when temperatures rise as a result of the activity of living organisms.
3. The effects of the presence of industrial services near rivers increases the chances the pollution of these rivers, especially when disposal of industrial waste without any treatment .

6. Recommendations

1. Identify sources of pollution and work to limit its access to the riverine environment .
2. Raising environmental and health awareness among the residents of the areas through which the river passes .
3. Conducting biological treatment of water waste by establishing simple treatment units in industrial places or homes before exposing it to the aquatic environment
4. Conducting a periodic evaluation of the extent of pollution in rivers by monitoring bodies to reduce pollution levels in trace elements.

REFERENCES

1. Islam, M.S., Ahmed, M.K., Habibullah-Al-Mamun, M., Hoque, M.F.,(2015a) .Preliminary assessment of heavy metal contamination in surface sediments from a river in Bangladesh. Environ. Earth Sci. 73, 1837–1848
2. Wilson, B., Pyatt, F.B., (2007). Heavy metal dispersion persistence, and bioaccumulation around an ancient copper mine situated in Anglesey, UK. Ecotoxicol. Environ. Saf. 66, 224–231

3. Sanchez-Chardi, A., Lopez-Fuster, M.J., Nadal, J., (2007). Bioaccumulation of lead mercury, and cadmium in the greater white-toothed shrew, Crocidura russula from the Ebro Delta (NE Spain): Sex- and age-dependent variation. Environ Pollut. 145, 7–14.
4. Islam, M.S., Ahmed, M.K., Habibullah-Al-Mamun, M., Islam, K.N., Ibrahim, M Masunaga, S.(2014). Arsenic and lead in foods: a potential threat to human health in Bangladesh. Food Addit. Contam. Part A 31 (12), 1982–1992.
5. Sekabira, K., Oryem Origa, H., Basamba, T.A., Mutumba, G., Kakudidi, E.,(2010) .Assessment of heavy metal pollution in the urban stream sediments and its tributaries. Int. J. Environ. Sci. Technol. 7 (4), 435–446.
6. Islam, M.S., Ahmed, M.K., Raknuzzaman, M., Habibullah-Al-Mamun, M., Islam, M.K (2015c). Heavy metal pollution in surface water and sediment: a preliminary assessment of an urban river in a developing country. Ecol. Indic. 48, 282–291.
7. Mohiuddin, K.M., Otomo, K., Ogawa, Y., Shikazono, N., 2012. Seasonal and spatial distribution of trace elements in the water and sediments of the Tsurumi river in Japan. Environ. Monit. Assess. 184, 265–279.
8. Abdel-Ghani, N.T., Elchaghaby, G.A. (2007). Influence of operating conditions on the removal of Cu, Zn, Cd and Pb ions from wastewater by adsorption. Int. J. Environ. Sci. Technol. 4, 451–456.
9. Nicolau, R., Galera, C.A., Lucas, Y.(2006). Transfer of nutrients and labile metals from15- the continent to the sea by a small Mediterranean river. Chemosphere 63,469–476.
10. Morillo, J., Usero, J., Gracia, I.(2004). Heavy metal distribution in marine sediments from the southwest coast of Spain. Chemosphere 55, 431–442.
11. Zheng, N., Wang, Q.C., Liang, Z.Z., Zheng, D.M.(2008). Characterization of heavy metal concentrations in the sediments of three freshwater rivers in Huludao City, Northeast China. Environ. Pollut. 154, 135–142.
12. Khadse, G.K., Patni, P.M., Kelkar, P.S., Devotta, S.(2008). Qualitative evaluation of Kanhan river and its tributaries flowing over central Indian plateau. Environ Monit. Assess. 147, 83–92.
13. Davidson, T.; Ke, Q.; Costa, M. (2007). Selected Molecular Mechanism of Metal Toxicity and Carcinogenicity. In Handbook on the Toxicology of Metals, 3rd ed.; Nordberg, G.F., Fowler, B.A., Nordberg, M. Friberg, L., Eds.; Academic Press: Cambridge, MA, USA, 2007.
14. Godt, J.; Scheidig, F.; Grosse-Siestrup, C.; Esche, V.; Brandenburg, P.; Reich, A.; Groneberg, D.A. (2006). The toxicity of cadmium and resulting hazards for human health. J. Occup. Med. Toxicol. 1, 22,14.
15. Carpenter, D.O. Effects of metals on the nervous system of humans and animals. (2001). J. Occup. Med. Environ. Health . 14, 209–218.
16. Ali, M. M., Rahman, S., Islam, M. S., Rakib, M. R. J., Hossen, S., Rahman, M. Z., et al. (2022). Distribution of heavy metals in water and sediment of an urban river in a developing country: A probabilistic risk assessment. Int. J. Sediment Res. 37 (2), 173–187.
17. Jolly, Y. N., Rakib, M. R. J., Islam, M. S., Akter, S., Idris, A. M., Phoungthong, K., et al. (2021). Potential toxic elements in sediment and fishes of an important fish breeding river in Bangladesh: A preliminary study for ecological and health risks assessment. Toxin Rev., 1–14.
18. Agarwal, A., Singh, R. D., Mishra, S. K., and Bhunya, P. K. (2005). ANN-based sediment yield river basin models for Vamsadhara (India). Water sa. 31 (1), 95–100.
19. Ahmed, A. S. S., Hossain, M. B., Semme, S. A., Babu, S. M. O. F., Hossain, K., Moniruzzaman, M., et al. (2020). Accumulation of trace elements in selected fish and shellfish species from the largest natural carp fish breeding basin in asia: A probabilistic human health risk implication. Environ. Sci. Pollut. Res. 27 (30), 37852–37865.
20. Satarug, S.; Vesey, D.A.; Gobe, G.C. Health risk assessment of dietary cadmium intake: Do current guidelines indicate how much is safe? Environ. Health Perspect. 2017, 125, 284–288.
21. World Health Organization (WHO). Preventing Disease through Healthy Environments: Ten Chemicals of Major Public Health Concern, Public Environment WHO, Geneva, Switzerland. Available online: https://www.who.int/ipcs/features/10chemicals_en.pdf?ua=1 (accessed on 12 August 2020.
22. 22-Satarug, S.; Haswell-Elkins, M.R.; Moore, M.R.(2000).Safe levels of cadmium intake to prevent renal toxicity in human subjects. Br. J. Nutr., 84, 791–802.
23. Singh, V.; Mishra, V. Microbial(2021) .Removal of Cr (VI) by a New Bacterial Strain Isolated from the Site Contaminated with Coal Mine Effluents. J. Environ. Chem. Eng., 9, 106279. [Google
24. Quinn, M.J.; Sherlock, J.C.(1990) The correspondence between U.K. 'action levels' for lead in blood and in water. Food Addit. Contam., 7, 387–424.

25. Al-Sharifi, A.A.(2011). possible contamination with heavy elements and some ecological parameters of water Bani-Hassan stream in the province of Karbala- Iraq. master thesis , college of Education for pure sciences ,Karbala University, Iraq.
26. Kaizal A.F. , Salman J.M., and Kot ,p. (2023). Evaluation of Some Heavy Metals, Their Fate and Transportation in Water, Sediment, and Some Biota within AL-Musayyib River, Babylon Governorate, Iraq , Baghdad Science Journal Vol. 20 No. 2 ,Issue 2,pp(600-615(
27. RaknuzzamanaM. Ahmed, K., Islamd S., -Al-Mamuna,H, Tokumuraa ,H. , Sekinea ,M., Masunagaa,S.(2016). Journal of Water and Environment Technology, Vol.14, No.4: 247–259
28. Kubra,K., Mondol ,A.H. Al,i M., Palash ,A., Islam ,S.,Ahmed ,S., Masuda ,A, Abu Reza Md. Islam ,T, Md Bhuyan ,S. Rahman,Z. and Rahman,M.(2022). Pollution level of trace metals (As, Pb, Cr and Cd) in the sediment of Rupsha River, Bangladesh: Assessment of ecological and human health risks. Front. Environ. Sci. Vol.10, No.4: 1–17.
29. A.O.A.C.(1984)Official methods of analysis ,14theds. Williams S,ed. Arlington,VI,USA: Association of official Analytical chemists.
30. Iraqi Ministries of Environment, Water Resources, Municipalities and Public Works.(2006). New Eden master plan for integrated water resources management in the marshlands area. Vol. 1, book 1water resources. The Italian ministry for the environment and territory and free Iraq foundation. Italy-Iraq.
31. Salman, J. M. (2006). Environmental study of potential pollution in the Euphrates River between Al-Hindiya Dam. and the city of Kufa - Iraq. PhD thesis. College of Science - University of Babylon. Iraq.
32. Gupta, N.; Yadav, K. K.; Kumar, V. and Singh, D. (2013).Assessment of Physicochemical Properties of Yamuna River in Agra City. Int .J. Chem. Tech Res. 5(1): 528-531.