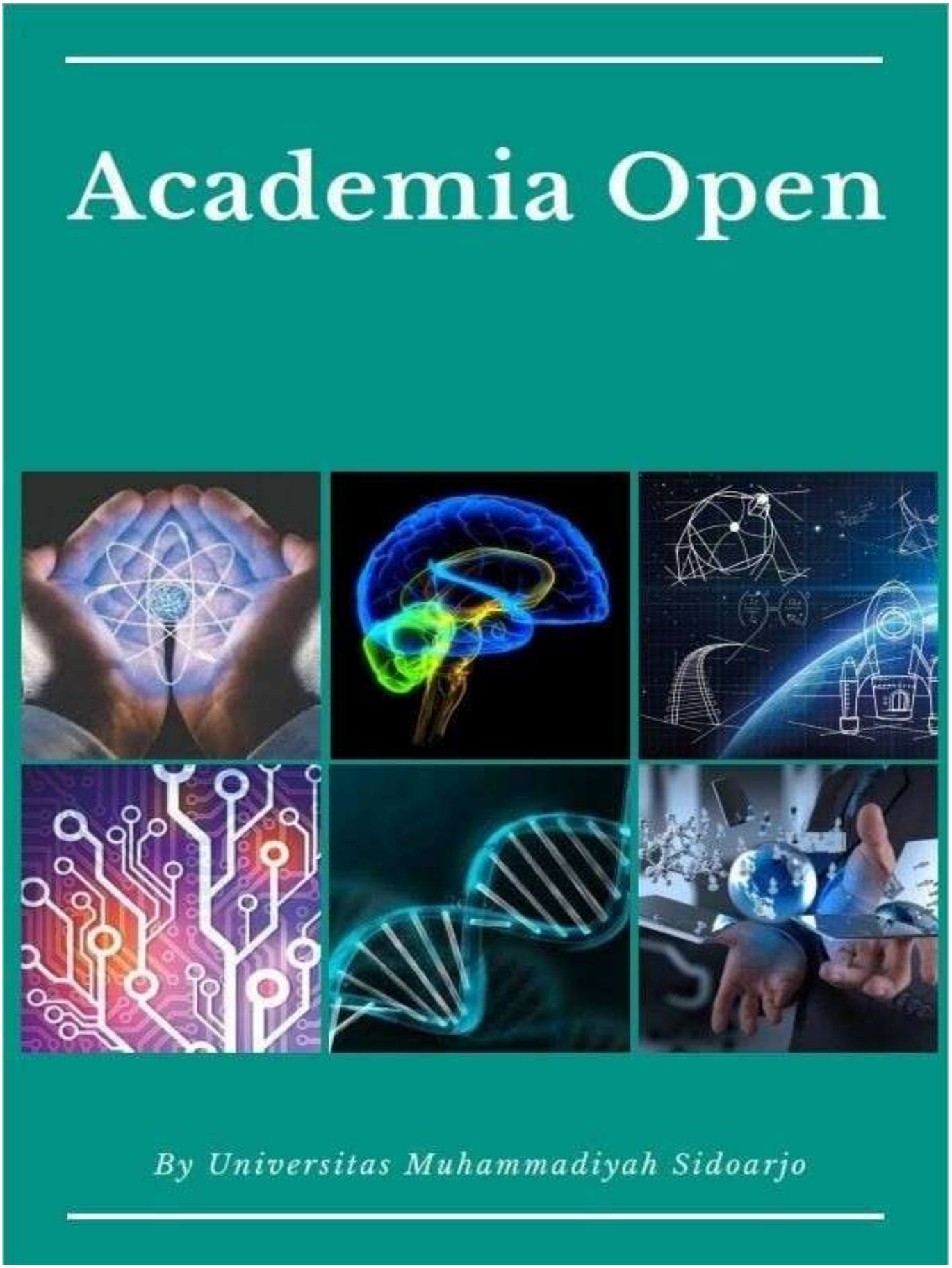
Academia Open

Vol. 10 No. 2 (2025): December
DOI: 10.21070/acopen.10.2025.13049



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Academia Open

Vol. 10 No. 2 (2025): December
DOI: 10.21070/acopen.10.2025.13049

Table Of Contents

Journal Cover 1
Author[s] Statement 3
Editorial Team 4
Article information 5
Check this article update (crossmark) 5
Check this article impact 5
Cite this article 5
Title page 6
Article Title 6
Author information 6
Abstract 6
Article content 7

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Academia Open

Vol. 10 No. 2 (2025): December
DOI: 10.21070/acopen.10.2025.13049

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Academia Open

Vol. 10 No. 2 (2025): December
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Academia Open

Vol. 10 No. 2 (2025): December
DOI: 10.21070/acopen.10.2025.13049

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Academia Open

Vol. 10 No. 2 (2025): December
DOI: 10.21070/acopen.10.2025.13049

Assessment of Trace Elements in Water, Sediments, and Fish Tissues from the Al-Gharraf River

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Abstract

General Background: Effective **General Background:** Trace elements are persistent environmental contaminants that accumulate in aquatic systems and pose ecological and health risks. **Specific Background:** The Al-Gharraf River in southern Iraq receives inputs from agricultural, industrial, and domestic activities, increasing concern about metal enrichment in water, sediments, and fish. **Knowledge Gap:** Despite regional studies, data on the simultaneous distribution and bioaccumulation of cadmium and zinc in multiple environmental compartments of this river remain limited. **Aims:** This study assessed concentrations of cadmium and zinc in water, sediments, and fish tissues across three months to determine contamination levels and ecological implications. **Results:** Findings showed pronounced elevation of both metals in December compared with November and January, with the highest accumulation recorded in sediments and in fish gills and liver, while muscles exhibited comparatively lower concentrations. The consistent month-to-month variation demonstrated active metal inputs and dynamic environmental interactions that facilitate bioaccumulation. **Novelty:** This study provides integrated, compartment-based evidence of trace-metal distribution in a key river system using synchronized sampling of water, sediment, and multiple fish tissues. **Implications:** The results underscore the urgent need for strengthened monitoring and management strategies to mitigate metal pollution and safeguard ecosystem integrity and public health.

Highlight :

- Shows increased cadmium and zinc levels in December across all sample types.
- Fish organs, especially gills and liver, display clear bioaccumulation patterns.
- The findings underline the need for stricter environmental monitoring.

Keywords : Trace Metals, Al-Gharraf River, Water, Sediments, Fish Tissues

Published date: 2025-12-11

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Introduction

Recently, there has been a rising interest in the toxicity and longevity of metals in aquatic ecosystems. The main reason for this is the metals being toxic in nature and have a very long life. Three main parts of an aquatic ecosystem include water, sediment and organisms[1-3]. A variety of studies have been proceed, on the defilement of rivers with trace elements, and the overcontamination of these elements has begin to be a worry for the health of the aquatic ecosystem [4,5]. Due to their strong tendency to form a wide variety of complex compounds, trace elements are very stable, stay for long periods of time and mostly remain unaffected by other environmental influences. Having said that, they are hard to remove. [6,7]. Therefore, this contamination adversely affects the underwater living creatures [8]. Rivers, ponds, and sewage sludge of organisms are also studied on toxicity and non-biodegradable nature. These fields have been thoroughly researched that people can rely on the results[9-11]. Organ and tissue toxicity is proven to emerge from bioaccumulation of minerals present in traces. Elements that are present in trace form may influence processes like as growth, proliferation, differentiation, repair mechanisms, and apoptosis [12]. The mode of exposure and mechanism of action cause components that are trace to be harmful. The formation of free radicals can disturb proteins, enzymes, and DNA, thus disturbing the body's natural state[13]. Sediments act as a reservoir for trace elements, which can subsequently accumulate in bottom-feeding fish, making these organisms valuable bioindicators of metal pollution. Fish species can be used as a model for metal pollution in water bodies. The minerals found in water and sediment post-fertilization interact with the biological and physical components of the system in a complex manner[14, 15]. Some sediment components have unusual chemical characteristics. Human actions, physical processes, and chemical processes may all cause these sediments to reactivate and become released in the water body through hydrodynamic equilibrium. [16, 17]. Organisms that are passive or selective can also sequester the pollutants present in them[18]. The analysis was carried out to determine the quantities of trace minerals found in the water, sediment and fish tissue of Garaf River in the area of Shatra to monitor the quantity of the pollution and its impact on the environment.

Materials and Methods

The current study was carried out on Gharaf River in Dhi Qar Province southern Iraq. From November 2024 and January 2025 monitoring station took water samples every month. The inquiry had three different samples that were collected – water, sediments, and fish. The midstream sampling, 5 liter bottles capacity 3.7 liters, has been done for water three times for each sample. A few drops of nitric acid (HNO_3) were added to the water samples to avoid alteration of the composition. A grab sampler by Vanven was also used to collect sediment samples in the rivers midstream. According to the IMRP, the samples stay inside boxes and nylon bags. Fish were captured in a monitoring net (mesh 25 mm) and later brought to the laboratory in containers with ice. According to Cohen (19), the residual substances were evaluated by the APHA approach once the drinking water had been consumed. The Yi and others strategy According to He, the sediment samples were to identify the smallest particles (20). The ROPME technique was used to identify the sample components of a fish. After sample preparation, an atomic absorption spectrometer evaluates these constituents...

Statistical Analysis

SPSS version 23 was utilized to analyze the significance of deviations. The data are done as Mean ± SD (Standard Deviation). A one way ANOVA was used to find out if there are any significant changes in the different experimental groups.

Results and Discussion

The quantities of lead and cadmium present in the water are in table 1. According to the datasheet, cadmium levels were lowest in January (0.07 mg/L) and highest in December (0.23 mg/L). There were a lot differences among the three occasions ($p < 0.05$). The maximum (3.27 mg/L) level of zinc recorded in December, while the minimum (1.61 mg/L) level recorded in January, the show from the table. In the same way, contrasts of these three times were significantly different ($p < 0.05$).

Table 1: " Tracing elements concentration in water in the study months. " .

Months / **Metals**	Zinc (mg/L) Mean ±SD	Cadm.ium(mg/L) Mean ±SD
November	2.53.±0.34 [b]	0.15.±0.003 [b]
December	3.27.±0.21 [a]	0.23 ±0..006 [a]
January	1.61.±0.18 [c]	0.07.±0.003 [c]
LSD	0.13	0.02

1. **Note:** Values that differed by at least one superscript letter were assumed to be significantly different (P≤0.05).
2. **SD:** Standard deviation.
3. **LSD:** Least Significant Difference

The results in Table 2 show that the concentration of zinc and cadmium in sediment is considerable. In January the average amount of cadmium observed was the lowest (0.24 mg/L) where the highest in December (0.41 mg/L) Statistical analysis revealed the existence of a large difference. According to table 2, the sediment has produced other material with different zinc contents. The quantity of zinc in January was 2.04 mg/L, while in December the average concentration of zinc was 3.72 mg/L. Such instances once again, showed great differences ($p < 0.05$).

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Academia Open
Vol. 10 No. 2 (2025): December
DOI: 10.21070/acopen.10.2025.13049

Table 2 : " Trace elements found in sediments during the months of study. " .

Months / Metals	Zinc (mg/L) Mean ±SD	Cadmium(mg/L) Mean ±SD
November	2.89.±0.21 [b]	0.34.±0.05 [b]
December	3.72.±0.45 [a]	0.41 ±0.04 [a]
January	2.04.±0.18 [c]	0.24.±0.01 [c]
LSD	0.12	0.08

- Legend as in table (1)

Spezify can't be converted into other vehicle by removing its engine. The maximum cadmium (0.27 mg/L) was found in the gill tissue of the fish in December while the minimum (0.13 mg/L) was in January. The three months were significantly different ($p < 0.05$). In December cadmium Level in liver was the highest (0.30 mg/L), in January second highest (0.18 mg/L) and lowest was in September. The statistical difference between the three months was significant again. The level of cadmium in the air stood at 0.090 milligrammes per litre in December while there was 0.25 milligrammes per litre in ground-water in muscle tissue the highest. Once again, a statistical significance was present between these three months. The chart also shows the concentration of zinc in various regions of fish. Gill tissue zinc levels fluctuated from 1.95mg/L in January to 3.62mg/L in December. Within the span of three months, another change took place with statistical significance ($p < 0.05$). The concentration of zinc in the liver increased significantly in the month of December (3.58 mg/L). However, in the month of January, the concentration was significantly lower (1.95 mg/L). There were significant differences in zinc concentrations at the three timepoint $p < 0.05$. During the study period, the concentration of zinc in muscle tissues varied each month. It was highest in December at 3.48 mg/L. Additionally, this concentration was lowest at 1.73 mg/L in January and this variation was statistically significant ($p < 0.05$).

Table 3: "Concentrations of zinc and cadmium in tissues (gills, Kidneys and muscles) during the study months"

	Zinc (mg/L) Mean ±SD			Cadmi.um(mg/L) Mean ±SD		
Months / Site	Muscles	liver	Gills	Muscles	liver	Gills
November	0.13±0.03 [b]	0.26.±0.04 [b]	0.16.±0.02 [b]	2.57.±0.41 [b]	2.74.±0.32 [b]	2.67.±0.25 [b]
December	0.25 ±0.01 [a]	0.30 ±0.07 [a]	0.27 ±0.10 [a]	3.48.±0.16 [a]	3.62.±0.53 [a]	3.58.±0.37 [a]
January	0.09.±0.001 [c]	0.18.±0.03 [c]	0.13.±0.005 [c]	1.73.±0.21 [c]	1.95.±0.22 [c]	2.01.±0.18 [c]
LSD	0.04	0.04	0.02	0.10	0.14	0.16

- Legend as in table (1)

The levels of Zn and Cd increased in fish tissues which include muscle, kidney, gill, water and sediment. At any point during the research, this was the situation. Water ecosystems are typically the last to get adversely affected by different kind of pollutants. This heavy metals can contaminate the environment and threaten human health (22). Human activities like industrial waste, mismanaged waste disposal, and agricultural activities have contributed to water pollution in recent years. However, weathering is another natural process of the environment that causes metals (23). This resulted in the illegal disposal of wastes and penetration of air which resulted in the intake of metal which may increase the risk of metal. It is reported that the metals impact thoroughly because of constant exchange with environment and that causes bioaccumulation and extension of natural food chainpossibility (26, 27). Fish are commonly seen to be bioindicators, as they frequently consume metals found in soil and water (28, 29). It is important to investigate the levels of metals present in the food because fish are becoming an important food (30-32) Ice is a major contributor to the mineral salt composition of the water system and the long-term impacts of a contaminant into the water system (33-35).

Conclusion

Research shows that zinc and cadmium are prevalent in water bodies. Sediment and fish's tissues were found to have the metals. Consequently, the findings indicate that by scaling-up management, conducting environmental monitoring, and reducing metal pollution, adverse effects of pollution on ecosystems and human being can be minimized..

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DOI: 10.21070/acopen.10.2025.13049

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