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Article

Effect of some heavy metals in the industrial flows on the Shatt Al-Arab River

Jabbar L.K. Al-Darraji[1,], Ilham J. J. Alshami[1,*], and Mujtaba A.T. Ankush[1,*]*
[1] Department of Fisheries and Marine Resources, College of Agriculture, University of Basrah
** Correspondence: mujtaba.tahir@uobasrah.edu.iq, ilham.jalil@uobasrah.edu.iq, almuhndsjabbar@gmail.com*
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ABSTRACT

The current study was conducted in three stations (Alsibah, Alnajibiya and Al-mas-hab marsh) from December 2020 to November 2021 during the course of the Shatt Al-Arab River. A flame Atomic Absorption Spectrophotometer (FAAS) was used to measure the quantities of several heavy metals (lead, cadmium, copper and iron) in water. The results revealed a noticeable seasonal variation of heavy metals in the Shatt Al-Arab water. Lead concentration was 3.246 mg/l in Autumn. Cadmium concentrations reached 0.001 mg/l to 0.008 mg/l during Spring and Winter, respectively. Whereas copper ranged between 0.001 mg/l- 0. and 319 mg/l in Spring and Winter, respectively. The iron ranged from 0.703 mg/l - 9.00 mg/l in Winter and Summer, respectively. According to a recent study, the water of Shatt Al-Arab was contaminated with some heavy metals (lead, copper, and iron) that reached the concentrations of standard Iraqi criteria. In contrast, cadmium concentrations were still within the standard levels.

Keywords: Cd, Cu, Fe, Pb, Shatt Al-Arab, Heavy metals, Water contamination

INTRODUCTION

Pollution of the aquatic environments with organic and inorganic substances is one of the main reasons that may threaten the life of humans who use this water for various purposes, as well as its effect on the survival of aquatic organisms, causing the extinction of aquatic species and decreasing biodiversity .[1,2]

Heavy metals are considered the most dangerous pollutants in ecosystems, especially in aquatic environments; heavy metal concentrations have been recorded to increase in Shatt Al-Arab and Arabian Gulf [3]. It caused significant concern due to its environmental stability, causing multiple harmful effects on aquatic creatures, even at low concentrations [4]. People have received these pollutants by drinking water or consuming fish and other contaminated aquatic organisms[5,6].

Many pollutants were discharged into the Shatt Al-Arab River by many factories that were built on the river edge; the industrial pollutants are characterized by their extreme toxicity and long duration in aquatic systems, as they are complex composition and accumulate their concentration across the food chain and may cause harm to human, animals and plants [7]. Mercury, cadmium, lead, chromium

and arsenic are non-essential heavy metals, as they have no known biological function, but have acute, sub-acute and chronic toxic effects on living organisms, even at low concentrations.[8,9].

Some essential metals such as copper, iron and zinc are trace metals that play a crucial role in maintaining the metabolism of living organisms, but they become toxic at high concentrations[10].

Heavy metals enter into bodies of living organisms in various ways, including respiration, absorption, and food [11]. [12] indicated that levels of heavy metals in local aquatic environments have increased due to industrial waste and agricultural activities.

Rapid population growth accompanied by industrial and agricultural developments influences the environment, negatively affecting the aquatic system. About 90% of the polluted water is discharged into rivers and streams, and the activities are recorded y in developing countries[13,14]. [15] indicated that chemical industries such as petrochemical, paper and fertilizer factories have contributed to rising pollution levels in the water of Shatt Al-Arab River, Khor Al-Zubayr and Shatt Al-Basrah.

Moreover, electrical power plants have a significant role in the thermal pollution of water bodies; it leads to the deterioration of water quality due to sudden changes in temperature affecting aquatic systems 16.[17] indicated that medical and hospital waste are dangerous sources of water contamination that contain large amounts of organic and inorganic pollutants.

[18] showed that agricultural waste reaches aquatic ecosystems due to intensive agriculture in response to increasing demand for food, which contributes to severe mineral pollution; these contaminants represent pesticides, herbicides and fungicides used in agriculture activities.

Heavy metals can reach aquatic ecosystems, especially freshwater, through two sources: one from nature and the second from anthropogenic activity. It should be noted that the main source of heavy metal pollution is always received from various human activities [19]. For these reasons, this study was carried out to measure the concentrations of heavy metals and determine the level of potential pollution for some serious heavy metals (lead, cadmium, copper and iron) in the industrial flows of Shatt Al-Arab water.

2. Materials and methods

Study area

This study was accomplished in three stations in Shatt Al-Arab river (Table 1, Figure 1).

Station	Northern	Eastern
Alsiba	N 20° 30’ 14.07”	E 48° 48’ 3.81”
Alnajibiya	N 34° 30’ 18.57”	E 46° 47’ 42.72”
Almas-hab marsh	N 37° 30’ 50.67”	E 42° 47’ 2.40”

Table 1. Geographical coordinates of the study stations

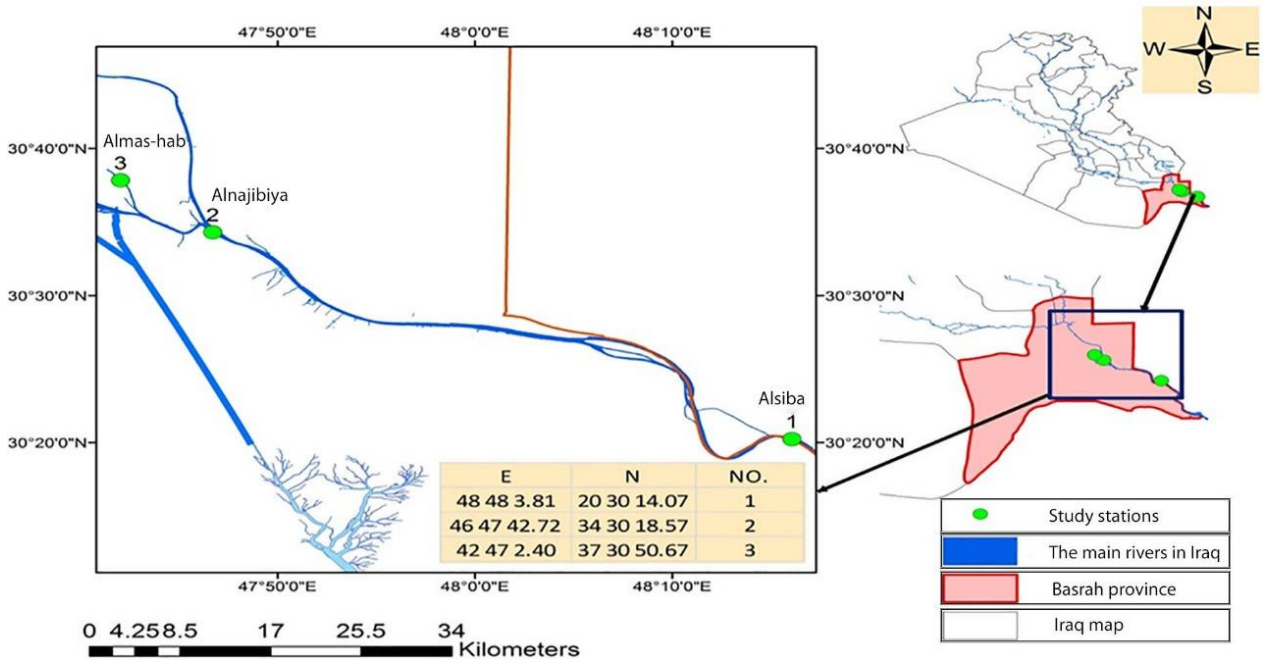


Figure 1. The map shows study stations of the Shatt Al-Arab river

Heavy metals

Heavy metals concentrations in water (lead, cadmium, copper and iron) were measured by Flame Atomic Absorption Spectrophotometer (FAAS) with a cathode lamp depending on the wavelength for each element Table 2.

Heavy metals	Lead	Cadmium	Copper	Iron
Wavelengths	217.0	228.8	324.7	248.3

Table 2. Wavelengths (nanometers) of heavy metals in this study

Analyzing of heavy metals

Concentrations of selected heavy metals were measured according to the method of [20].

RESULTS

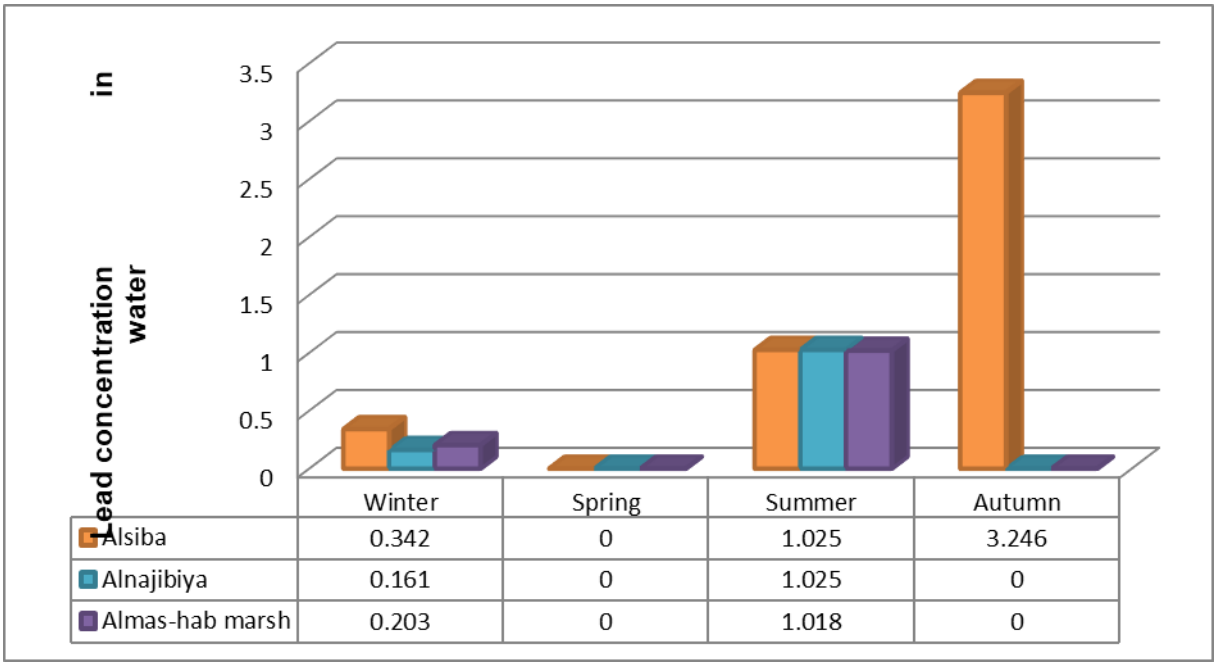
The study results showed seasonal changes of selected heavy metals (lead, cadmium, copper and iron) in the composition of study station water in the Shatt Al-Arab River Table 3.

Lead (Pb)

As shown in Figure 2, the lead concentrations recorded in water ranged from 0.161 mg/l to 3.246 in Winter and Autumn, respectively. The highest value was recorded in Alsiba during Autumn, whereas the lowest was in Alnajibiya during Winter. Lead was not recorded during Spring in all study stations, but only (3.246mg/l) in Autumn at Alsiba station. Statistical analysis showed no significant differences between the study stations and seasons at $p>0.05$ probability level.

Seasons	Stations	The concentration of heavy metals in water (mg/l)			
		Lead	Cadmium	Copper	Iron
Winter	Alsiba	0.342	0.008	0.319	4.310
	Alnajibiya	0.161	0.005	0.230	1.350
	Almas-hab marsh	0.203	0.005	0.087	0.703
Spring	Alsiba	0	0.002	0.014	5.120
	Alnajibiya	0	0.001	0.001	5.190
	Almas-hab marsh	0	0.002	0.031	3.990
Summer	Alsiba	1.025	0.004	0.180	4.950
	Alnajibiya	1.025	0.004	0.110	8.800
	Almas-hab marsh	1.018	0.004	0.090	9.000
Autumn	Alsiba	3.246	0.004	0.119	2.120
	Alnajibiya	ND	ND	0.019	1.820
	Almas-hab marsh	ND	ND	0.028	2.150
Mean		0.585	0.004	0.102	4.125

Table 3. Seasonal concentrations of heavy metals at study stations (mg/l) during the study period (December 2020 to November 2021). ND: Not detected

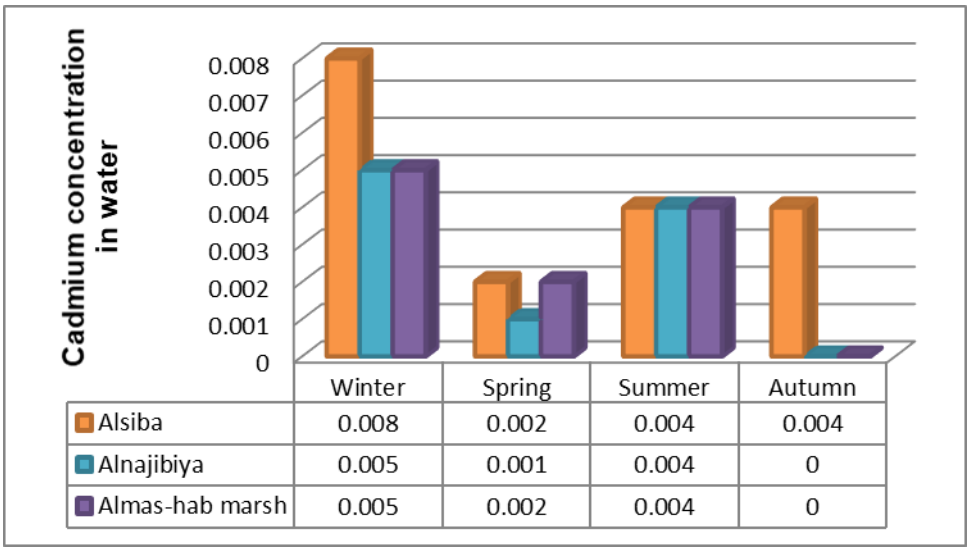


	Winter	Spring	Summer	Autumn
Alsiba	0.342	0	1.025	3.246
Alnajibiya	0.161	0	1.025	0
Almas-hab marsh	0.203	0	1.018	0

Figure 2. Seasonal changes of lead concentrations (mg/l) in water at study stations

Cadmium (Cd)

The highest value of cadmium concentration was recorded in water (0.008 mg/l) at Alsiba station during Winter (Figure 3). In contrast, the lowest value (0.001 mg/l) was recorded in Alnajibiya station during Spring. As with lead, the result showed that cadmium concentration was not recorded during Autumn at Alnajibiya and Almas-hab marsh stations. The results of the statistical analysis showed there are no significant differences between the study stations ($p>0.05$), while it was observed significant differences between seasons ($p<0.05$).

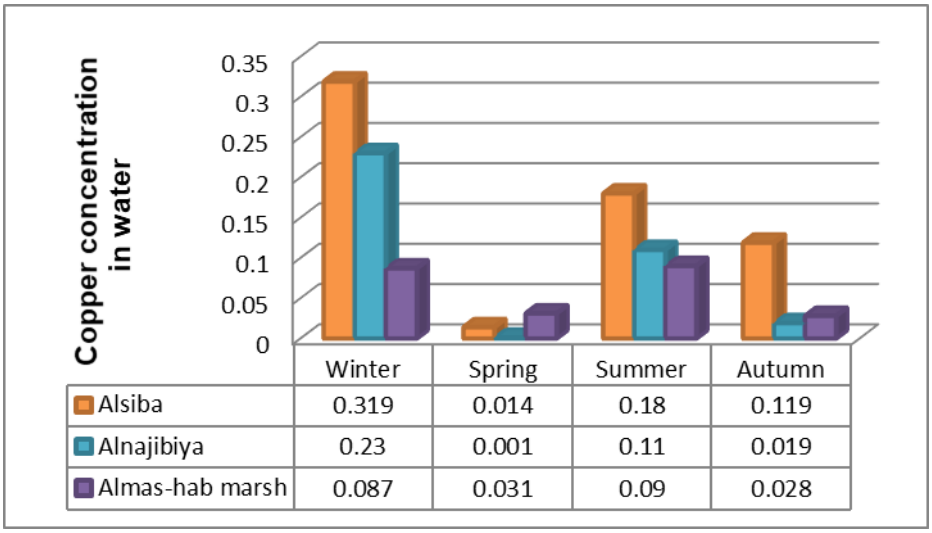


	Winter	Spring	Summer	Autumn
Alsiba	0.008	0.002	0.004	0.004
Alnajibiya	0.005	0.001	0.004	0
Almas-hab marsh	0.005	0.002	0.004	0

Figure 3. Seasonal changes of cadmium concentrations (mg/l) in water at study stations

Copper (Cu)

Figure 4 shows that the highest concentration of copper recorded in water was 0.319 mg/l at Alsibah station during Winter, and the lowest was 0.001 mg/l at Alnajibiya station during Spring. Statistical analysis showed no significant differences between the study stations ($p>0.05$), while it was observed significant differences between seasons ($p<0.05$).

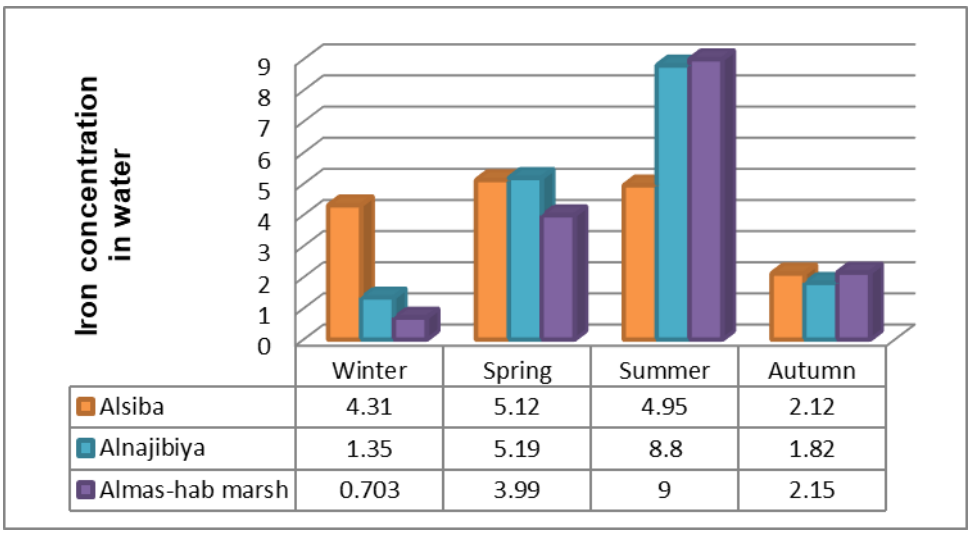


	Winter	Spring	Summer	Autumn
Alsiba	0.319	0.014	0.18	0.119
Alnajibiya	0.23	0.001	0.11	0.019
Almas-hab marsh	0.087	0.031	0.09	0.028

Figure 4. Seasonal changes of copper concentrations (mg/l) in water at study stations

Iron (Fe)

The results showed that the iron concentrations in water recorded the highest values compared to the current study's heavy metals. The highest concentrations were 8.800mg/l – 9.000mg/l at the Alnajibiya and Almas-hab stations, respectively, during Summer, but the lowest was 0.703 mg/l at the Almas-hab marsh station during Winter Figure 5. The results showed no significant differences between stations ($P>0.05$), while there were significant differences between the seasons ($P<0.05$).



	Winter	Spring	Summer	Autumn
Alsiba	4.31	5.12	4.95	2.12
Alnajibiya	1.35	5.19	8.8	1.82
Almas-hab marsh	0.703	3.99	9	2.15

Figure 5. Seasonal changes of Iron concentrations (mg/l) in water at study stations

DISCUSSION

The results showed seasonal changes in heavy metals concentrations (lead, cadmium, copper and iron) between study stations. These metals were sequenced in the following order depending on high to low concentrations: iron> lead> copper> cadmium, and their mean concentrations were 4.125, 0.585, 0.102, and 0.004 mg/l, respectively.

By comparing the current concentrations of heavy metals in this study with the System Maintenance of River and Public Water Pollution in Iraq(2011) , the concentration of iron, lead and copper exceeded the slandered limits. They recorded higher values than other international water limitation except the cadmium, which was under the level of Iraqi limitation. At the same time, it exceeded the required drinking water limits according to WHO (2011) as shown in table 4.

The results of the current study were consistent with [21], who recorded high concentrations of iron and copper in the southern marshes of Iraq. Similarly, [22] found high concentrations of lead, cadmium, copper and iron in the Shatt Al-Arab River, which exceeded our data in the present study for cadmium and iron.

[23] recorded high concentrations of lead, copper and iron in the Shatt Al-Arab River and some branches that exceeded the present study for lead, copper and iron.

Likewise, some studies[24,25] recorded an increase in the concentrations of lead, iron, cadmium and copper in the Shatt Al-Arab River, which exceeded what was recorded in the current study, and they exceeded the Iraqi and international determinants as shown in Table 4.

High levels of heavy metals recorded in the Shatt Al-Arab River may be due to the dumping of industrial, agricultural and household waste containing heavy metals, as well as boat activities that released the disposal of liquid waste such as fishing boat exhausts, materials used in boat coating, waste of washing vehicles and some agricultural fertilizers.

In addition, high levels of heavy metals found in base sediments of rivers may also be attributed to interacting with the water and releasing it back into the water column. [26,23,27,28,29,30].

A high lead concentration was recorded during Summer for all study stations; this may relate to increases in agricultural discharges and industrial activities from the Iranian Abadan refinery. These discharges are untreated sewage that was rejected to the Shatt Al-Arab River. Furthermore, high temperatures during Summer, which increase the evaporation rate, tend to reduce water levels, subsequently increasing pollutants in water. [22,25,31,32,33].The lead results showed no significant differences between stations and seasons ($P>0.05$).

Cadmium and copper recorded the highest concentrations during Winter and Summer due to rainfall and drainage from the washing of agricultural land rich in chemical fertilizers and pesticides used excessively in agricultural land. Furthermore, urban and human activity growth, population density changes, and economic development are contributing to an increase in wastewater discharge and industrial waste[34,35,36]. The results of cadmium and copper showed no significant differences between stations ($P>0.05$), while significant differences ($P<0.05$) between the seasons were observed.

Iron concentrations were higher than other metals, and it was highly different in its concentration between stations and seasons. The iron concentrations are sequenced in the following order: Summer >Spring > Winter > Autumn. The rise of iron concentration in the Shatt Al-Arab River may be due to an increase in the untreated sewage in the river. Also, continuing human activities, such as

agriculture, play a key role in water pollution in Shatt Al-Arab [37,38,39] . The results of the current study were consistent with previous studies, for instance, [40], [22] and [25]. Moreover, Shatt Al-Arab river sediments are clay silty that make iron to adsorption it. [41]. The results of iron showed no significant differences between stations (P>0.05), while there were significant differences between the seasons (P<0.05).

Heavy metals	System Maintenance of River and Public Water Pollution in Iraq	[42] Irrigation water	US.EPA. 2012	WHO (2004,2011) drinking water and household	Current Study 2022
Lead	50	5000	10	10	585
Cadmium	5	10	5	3	4
Copper	50	200	1000	2000	102
Iron	300	5000	300	50	4125

Table 4. Comparison of the concentrations of heavy metals (µg/l) for the current study with international and Iraqi permissible levels.

CONCLUSIONS

The results of this study proved that the water of the Shatt al-Arab River is polluted by different kinds of flows that reach the water in high concentrations of metals, including lead, cadmium, copper and iron. These metals arise mainly from industrial and agricultural wastes discharged directly into the river or its canals, untreated domestic sewage pollutants and atmospheric deposition.

As a result, the concentrations of heavy metals in Shatt Al-Arab recorded high concentrations of iron, lead and copper that exceeded Iraqi standards except for cadmium. The current study indicated that the concentrations of heavy metals during seasons and among stations were different in their levels in the Shatt Al-Arab River. This leads to a focus on further studies in the future about the regions and sources of mineral pollution in rivers.

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