Effect of physical and chemical properties on the concentration of heavy elements in the waters and sediments of Shatt al-Hilla

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Abstract

The study was conducted on the Shatt al-Hilla in Babylon Governorate show the potential levels of pollution of water and sediments. Six stations were identified: (Sinjar, Al-Farsi, Al-Nabi Ayoub, Al-Muaymirah, Al-Ibrahimiya, and Al-Hashimiyah), The results showed that the Shatt water was highly affected by sewage and household waste. It was noted that the heavy elements increased in the summer more than in the winter, as follows: lead> iron> cobalt >cadmium. The study included measuring some chemical properties of the water of Shatt al-Hilla, and the results also showed an increase in heavy elements in the sediments as follows: iron> lead> cobalt >cadmium, and a study of some physical and chemical properties of the sediments.

Keywords: Heavy elements, pollution, water pollution, sediment pollution.

Introduction

Environmental pollution is one of the major challenges of modern societies and polluted water represents a serious threat to aquatic ecosystems and humans. Often, the deterioration of water quality is caused by organic and inorganic pollutants, In particular, heavy elements are well known to be of great concern due to their toxicity to living organisms, and are natural elements that persist in the environment for a long time and do not biodegrade [1,2]. The Hilla River has been affected by the liquid discharges of the cities and farms spread on its banks, and seasonal changes in climate have affected some properties including temperature and acidity. [3]. In recent years, the growth of human activities such as agriculture, mining, aquaculture, maritime transport and urban expansion has led to the degradation of aquatic ecosystems, ultimately affecting living and non-living organisms[6,5,4]. Heavy metals are pollutants that cause many environmental risks due to their high toxicity, bioaccumulation, biomagnification, and non-biodegradability

[8,7]. Therefore, they can accumulate in all components of the living and non-living environment, so the accumulation of these elements in soil and water can cause a serious threat to the environment and human health [9,10]. The concentrations of heavy elements in sediments are a good and common indicator of the pollution and health status of water bodies. Moreover, sediments can act as a reservoir for these elements and, therefore, they can be re-released into the water column and, for this reason, cause environmental and health problems in aquatic ecosystems. In addition to the importance of estimating heavy elements in sediments, these pollutants should be estimated in the water column as they provide important information about the quality and quality of water in aquatic environments [12,11]. The importance of heavy elements may vary among groups of living organisms such as plants, animals and microorganisms. However, some of these elements are naturally present in the environment and are considered the basic

component of life due to their physiological and biochemical functions in biological systems. At the same time, they can have harmful effects on health if their levels exceed specified levels [13.[

The study aimed to know the effect of the quality of Shatt Al Hillah water on the properties and concentrations of some available and total heavy elements (lead, cadmium, cobalt and iron) in the sediments.

Material and Methods

Six study sites were selected to collect water samples in winter and summer seasons of 2023 and 2024 and sediment samples in 2023 from Shatt Al-Hillah, which branches off from

the Euphrates River north of Babil Governorate at Al-Hindiyah Dam, passing through the center of Al-Hillah, Al-Hashimiyah, Al-Madhatiyah, and Al-Shomli cities, ending in Al-Diwaniyah Governorate [14 .[

Table(1) Sampling sites for the study area

Station	Site Name	Longitude	Latitude
1	.Sinjar	44° 24' 1 " E	32° 31' 49" N
2	Al-Farsi	44° 25' 21 " E	32° 27' 59 " N
3	Al-Nabi Ayyub	44° 26' 39 " E	32° 25' 16" N
4	Al-Muaymirah	44° 28' 25" E	32° 23' 36" N
5	Al-Ibrahimiyah	44° 33' 27" E	32° 21' 44" N
6	Al-Hashimiyah	44° 41' 14" E	32° 18' 9" N

Water samples were collected from the study sites to conduct chemical tests for the winter and summer seasons from the study sites in clean one-liter plastic bottles made of polyethylene. Three drops of a coloring substance were added to prevent the growth of microorganisms. Then, the samples were transferred to the laboratory to conduct the required tests. The chemical properties of the Shatt water were estimated according to [15], and the concentration of heavy elements (lead,

cadmium, cobalt and iron) in the water was measured using a Japanese Schmadzu atomic absorption spectrometer (AAS) 2013. The sediments were air-dried, then ground and passed through a sieve with a diameter of 2 mm, then collected in plastic containers for the purpose of preparing them for physical and chemical tests according to [16], , and the concentrations of the studied heavy elements, available and total, in the sediments were estimated according to [18,17 [

Results and Discussion

properties of Shatt al-Hillah water and sediments

In the current study, some properties of the water and sediments of Shatt al-Hilla Table (2 and3)were estimated due to the effect of these properties on the behavior of the aquatic environment, mainly the processes of dissolution, transport and distribution of heavy elements between the water column and sediments and vice versa. Therefore, they can determine the degree of pollution in the river water [19]. The highest concentration of water properties was in the summer season compared to the winter season, and the reason for this is attributed to the seasonal differences in temperatures that help dissolve salts [20.[

Heavy elements in Shatt al-Hilla water and sediments

From Table (4 and 5), the results showed that the highest concentration of the studied elements in the Shatt water was in the summer season, where the elements took In the summer season the following order: lead 2.15> iron 1.53> cobalt 0.56> cadmium 0.0175(mg.L-1). The reason for their increase in the summer may be attributed to the difference in acidity and the high temperatures in the summer, which help dissolve the salts, and the rainfall in the winter, which reduces the elements [21]. It was noted that the concentrations of elements decreased in site (1) for the winter and summer seasons as a result of the decrease in pollutants that are randomly thrown into the river, the distance of the area from the city, and the decrease in population concentrations compared to site (2), which suffers from high concentrations of lead and iron due to the abundance of solid and liquid pollutants from the city that are randomly thrown, as well as the discharge of sewage into the river and the presence of markets on the river bank, which contributed to the increase in heavy elements in it, and this was confirmed by [23,22], The increase of human population has lead to an increase in liquid and solid discharges into rivers and their surroundings, thus increasing the inputs of pollutants from heavy elements and deteriorating the quality of river water [24]. As for the available heavy elements in the sediments, they took the following order: cobalt 1.17> iron 0.98> lead 0.32> cadmium 0.020 (mg.L-1).The difference in the concentrations of the elements studied in the sediments between the six stations and their biological availability is not only affected by human sources of pollution, but also depends on the mineral composition and sedimentary environment of the sediments [25]. The highest concentration of cadmium, cobalt and iron was at site (4). This increase is attributed to natural sources, weathering and also human activity, including the discharge of sewage water into Shatt al-Hilla without treatment, and the disposal of household waste, chemical fertilizer and pesticide residues. The decrease in their concentration at other stations may be due to dilution and adsorption of the element [26]. The total heavy elements took the following order: iron 6978.37 > lead 76.05 > cobalt 50.62 > cadmium 1.07 (mg.kg-1). These results show the high level of the total heavy elements studied in the sediments compared to the water in Table 4. In general, heavy elements do not remain dissolved for a long time in the water because they will be bound to suspended colloids or accumulate on the sediments or absorbed by aquatic plants, so their concentration in the sediments is high [27]. River water is one of the aquatic environments most vulnerable to pollution with heavy elements, including lead, due to

the flow of household, industrial, agricultural and sewage waste. There are still societal customs that make the river a garbage dump, thus increasing the level of water pollution. Pollution with heavy elements that enters the river water environment will dissolve in the water and accumulate on the sediments, which are considered a cumulative reservoir of heavy elements. Over time, their concentration increases depending on environmental conditions [28.[

Table (2) Chemical properties of Shatt al-Hilla water

Station	Season	pH	EC	Ca^{+2}	Mg^{+2}	Cl$^-$	HCO3$^-$	CO3$^-$	Na$^+$	K$^+$
			dS.m^{-1}	meq L^{-1}					ppm	
1	Winter	7.32	1.11	7.00	3.60	2.20	6.10	Nil	78.00	1.20
	Summer	7.98	1.34	7.00	6.20	3.50	5.00	Nil	122.50	6.60
2	Winter	7.79	1.17	6.60	4.20	2.20	7.90	Nil	78.20	1.20
	Summer	8.25	1.72	6.87	7.00	8.46	5.50	Nil	396.10	38.60
3	Winter	7.91	1.24	5.60	5.40	2.50	5.00	Nil	79.70	1.30
	Summer	8.12	1.48	7.60	6.80	4.90	5.55	Nil	195.60	19.00
4	Winter	7.87	1.23	5.60	5.00	2.50	7.10	Nil	78.50	1.20
	Summer	8.00	1.37	7.80	6.40	4.90	6.00	Nil	161.10	18.80
5	Winter	7.91	1.30	5.80	5.40	2.50	6.80	Nil	79.80	1.50
	Summer	8.22	1.67	6.90	7.00	4.90	5.06	Nil	334.70	38.10
6	Winter	7.67	1.14	5.40	3.80	2.20	7.90	Nil	78.10	1.20
	Summer	8.21	1.65	8.80	7.00	4.90	6.02	Nil	265.50	27.70

Table (3) Some chemical and textural properties of Shatt al-Hilla sediments.

Station	pH	EC	CEC	O.M	Clay	Silt	Sand	Soil Texture
		dS.m^{-1}	Cmol.kg^{-1}	%				
1	7.31	2.11	2.10	0.60	9.37	4.00	86.63	LS
2	7.82	10.70	10.70	1.30	24.37	15.00	60.63	S C L
3	7.84	1.62	11.20	1.40	35.00	23.12	41.88	C L
4	8.23	1.45	17.60	1.50	35.00	15.00	50.00	S C
5	7.52	1.72	5.30	0.60	13.75	14.37	71.88	S L
6	7.59	4.40	5.80	0.80	18.75	11.87	69.38	SL

Table(4): Concentrations of heavy elements (Pb, Cd, Co, and Fe) mg/L-1 in Shatt al-Hilla water

Station	Season	Pb	Cd	Co	Fe
		mg/L^{-1}			
1	Winter	0.0025	Nil	0.052	0.38
	Summer	0.72	0.0019	0.11	0.74
2	Winter	0.0062	0.0007	0.090	0.99
	Summer	2.15	0.0014	0.28	1.53
3	Winter	0.018	0.0005	0.095	0.61
	Summer	1.12	0.0026	0.25	1.37
4	Winter	0.014	0.0037	0.12	0.79
	Summer	1.08	0.0175	0.48	1.11
5	Winter	0.019	0.0066	0.11	0.72
	Summer	1.80	0.0096	0.19	1.24
6	Winter	0.0060	0.0048	0.26	0.73
	Summer	1.72	0.0079	0.56	1.51

Table (5): Concentrations of the studied elements, available (mg.L-1) and total (mg.kg-1) for the sediments of Shatt al-Hillah.

Station	Pb		Cd		Co		Fe	
	available	Total	available	total	Available	Total	available	Total
1	0.008	32.59	Nil	0.24	0.21	25.06	0.61	3648.77
2	0.015	58.49	0.008	0.72	0.17	32.78	0.82	6978.37
3	0.022	62.64	Nil	0.39	0.81	18.05	0.77	4480.81
4	0.035	76.05	0.020	1.07	1.17	42.83	0.98	3830.65
5	0.16	47.98	0.008	0.61	0.81	34.86	0.21	3591.43
6	0.32	51.05	0.013	0.79	0.51	50.62	0.45	4156.85

Conclusion

We conclude from the results of the study the impact of human activities and the liquid and solid waste discharged into the waters of Shatt al-Hilla and the impact of physical and chemical properties on the concentration of heavy elements. The highest concentration of heavy elements in the water was in the summer due to high temperatures and different acidity. It was noted that the heavy elements in the sediments increased when compared with the concentrations of water of Shatt al-Hilla because the elements do not remain for a long time in the water but rather settle on colloids and sediments.

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