International Journal of Agriculture, Environment and Bioresearch

Vol. 07, No. 05; 2022

ISSN: 2456-8643

DISTRIBUTION OF HEAVY METALS IN RESIDUAL SEDIMENTS FROM TIGRIS AND EUPHRATES AND SHATT AI- ARAB RIVER

Shahinaz R.A Al-Shawi[1], Hamzah A. Kadhim[1] and Hamid T. Al-Saad[2*]
[1]Collage of Science, University of Basrah, Basrah, Iraq
[2]Collage of Marian Sciences, University of Basrah, Basrah, Iraq

https://doi.org/10.35410/IJAEB.2022.5775

ABSTRACT

Sediment samples were taken from six location in Tigris, Euphrates and Shatt AI-Arab River during 2021- 2022, sample were extracted to determine the heavy metals (Cd, Cu, Fe, Pb, Mn, Ni and Zn) in Residual sediment of these samples by using the inductively coupled plasma atomic emission spectrometer (ICP). The analysis was also determined percentage of total organic carbon and grain size. The results of the concentrations in the Residual phase as follows (Fe> Mn> Cu > Pb> Zn> Ni >Cd) was (811.71, 90.49, 72.47, 67.34, 64.44, 38.52,25.54) dry weight. The results showed that the concentrations of the Metals were high, except for nickel and cadmium, which were relatively few, as for of total organic carbon concentrations high value (TOC %) It was (7.2 µg/g) at the six station during winter while the lowest value was (2.0µg/g) at the first station during summer. The grain size analysis was mainly silt and clay are the most predominate in the study area. Geo Accumulation Index (I-geo) for heavy elements in the sediments was also determined, and it showed that the yearly rate of the concentrations of the metals varied between the lowest value (-6.895) of Iron and the maximum value (6.826) for cadmium. Additionally, it was determined the enrichment coefficient (EF) for the heavy elements in the sediments, where the annual rate of the metals ranged between the lowest value (3.26) for manganese and the highest value (10488.14) for cadmium, and was accounted the Contamination factor (CF)for the heavy metals in the sediments, where the annual average of the metals ranged between the lowest value (0.012) for Iron and the highest value (170.26) for cadmium. These results showed that organic matter pollution was mainly from direct discharge of domestic wastewater into Tigris, Euphrates, and Shatt al-Arab river.

Keywords: Heavy Metals, Sediment, Geo Accumulation Index, Enrichment Coefficient, Contamination Factor, Tigris, Euphrates, Shatt Al-arab.

1. INTRODUCTION

The properties of heavy elements in sediments can provide useful information about pollutants, including sources, transformation, and migration. Sediment character set with statistical analysis can provide more detailed information about the origins of heavy elements (Yusoff et al.,2015).Cities' environments are significant in applied environmental studies because a large portion of the population resides there and because most of them are constructed next to or close to water sources. However, due to population growth, technological advancements, waste accumulation, and high pollution levels, cities' environments have been destroyed. Urban environment pollution is one of the most hazardous environmental issues for people and other living forms today (Blomberg,2012).The toxicity of heavy metals is determined by their

Vol. 07, No. 05; 2022

ISSN: 2456-8643

chemical form and elemental composition, since most of these compounds are soluble in animal tissues and can cross biological membranes. As a result, sediments serve as a reservoir for elements that can be extracted (Zaoui and Benselhoub, 2020). As the global economy expanded, heavy metal sediment pollution increased, hurting the ecology (Jia et al., 2018). Heavy metals build in coastal sediments through land-based effluents. (Makri et al., 2020).

The Shatt al-Arab River, which has a length of 192 kilometers and 800 meters when at its mouth, defines the southern boundary between Iran and Iraq until it empties into the Persian Gulf. It is 145,190 square kilometers in size. , directly in the Shatt al-Arab region at the mouths of the Tigris and Euphrates rivers. With the exception of the regions in the Tigris and Euphrates basin (UN- ESCWA and BGR2013) The eastern portion of the area is bordered by the Tigris and Shatt al-Arab rivers, while the Euphrates River separates the territory into its northern and southern half. The study area is located at latitude 31°N and longitude 47° .

2.MATERIAL AND METHODS

Six sediments sampling sites were selected. For four seasons (fall, winter, spring, summer), where sediment samples were collected using plastic bags in order to measure heavy metals with full information recorded on each sample, which included Information: sampling site - date as shown fig (1). The sediment samples were mixed well after removing the solid parts, then dried at a temperature of (60-70) C for 48 hours, after that they were ground with mortar and sieved with a sieve with a hole diameter of (63mesh) and kept in special polyethylene that were clearly marked. After that, heavy metal ions were extracted in the sediment samples after the samples were digested with acids, and the measured elements included (cadmium, copper, iron, lead, manganese, nickel, zinc) and it was measured using a device (ICP-OES) (Inductively coupled plasma atomic emission spectroscopic).

the sediments samples is washed with distilled water several times, and the washing water is disposed of after each time by centrifugation process to remove traces of the remaining heavy elements from the exchanged part. after that, 5 ml of concentrated nitric acid is added to the sample and left on a hot plate until near dryness, and the sample is left until it cools, then we add (5 ml) a mixture of concentrated hydrofluoric acid (HF) and concentrated chloric acid (HCIO4) in a ratio of 1 1: To extract heavy metals and leave it on a hot plate until near dryness, then add (30ml) of 0.5N hydrochloric acid (HCl) and leave the sample on a hot plate to not complete the digestion process of the precipitate, until the sample size becomes less than (25ml) after that we complete the volume to 50ml It is kept in plastic bottles and the information is recorded on it until measurement using an Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-OES) (Sturgeon et al 1982).

The amount of total organic carbon**) TOC** %) in the sediments was measured according to the incineration method used by (Ball, 1964). The grain size analysis of the sediments of the study area was carried out using the pipette method, as described by (Folk, 1974).

Fig (1) Sample locations

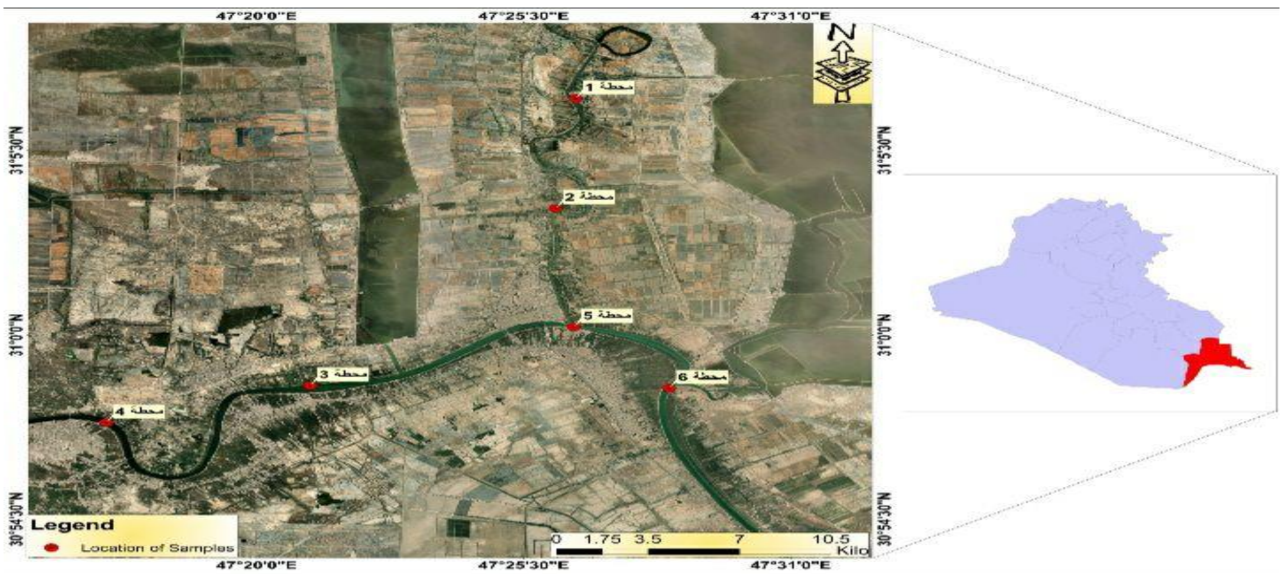
3. RESULT AND DISCUSSION

The results showed that the concentrations of the Metals were high, except for nickel and cadmium, which were relatively few, the concentration arranged as fellow (Fe> Mn> Cu> Pb> Zn>Ni >Cd). Heavy metals have become a major concern from a human public health perspective, as long bioaccumulation in humans can become dangerous due to the long biological half-life of these metals and the difficulty of their elimination from the organism (Majid ,2012).

Cadmium (Cd)

According to the study's findings, the concentration of cadmium in the residual phase of the sediments samples was lowest(7.70 µg/g) during the summer at the first station and greatest(24.51 µg/g) during the winter at the sixth station as shown table(1). The study's findings also demonstrated that there was a rise in cadmium content, particularly in the sixth station where fossil fuel products are used for transportation since they have significant levels of heavy metals as(Cd) (Zhuang etal,2021).

Table (1): Concentration of cadmium(µg/g) in the residual phase.



ISSN: 2456-8643

Locations	autumn				winter				spring				summer			
	cd	Range	Mean	±SD	cd	Range	Mean	±SD	cd	Range	Mean	±SD	cd	Range	Mean	±SD
1	10.26 10.40 10.74	10.26-10.74	10.46	0.246	16.26 16.43 16.72	16.26-16.72	16.47	0.232	12.23 12.43 12.64	12.23-12.64	12.43	0.205	8.82 9.27 9.48	8.82-9.48	9.19	0.337
2	11.87 12.24 12.54	11.87-12.54	12.21	0.335	17.63 17.87 17.95	17.63-17.95	17.81	0.166	12.94 13.26 13.46	12.94-13.46	13.22	0.262	10.21 10.45 10.68	10.21-10.68	10.44	0.235
3	13.79 14.10 14.28	13.79-14.28	14.05	0.247	19.42 19.67 19.86	19.42-19.86	19.65	0.220	13.82 14.22 14.52	13.82-14.52	14.18	0.351	11.26 11.68 11.89	11.26-11.89	11.61	0.320
4	14.82 15.14 15.29	14.82-15.29	15.08	0.238	22.26 22.56 22.72	22.26-22.72	22.51	0.233	15.27 15.43 15.74	15.27-15.74	15.48	0.240	12.52 12.63 12.83	12.52-12.63	12.66	0.157
5	15.85 16.20 16.39	15.85-16.39	16.14	0.273	23.22 23.43 23.78	23.22-23.78	23.47	0.282	18.21 18.34 18.56	18.21-18.56	18.37	0.176	13.98 14.12 14.23	13.98-14.23	14.11	0.125
6	16.21 16.45 16.68	16.21-16.68	16.44	0.235	25.27 25.54 25.81	25.27-25.81	25.54	0.27	18.32 18.51 18.78	18.32-18.78	18.53	0.231	15.48 15.60 15.81	15.48.15 .81	15.63	0.167

Copper (Cu)

According to the study's findings, the concentration of copper in the residual phase of the sediments samples was lowest(16.60 µg/g) during the summer at the first station and greatest(45.91 µg/g) during the winter at the sixth station as shown table(2). Due to the difference in clay concentration and dominant type across the stations, copper was present in greater concentrations in the sixth station. Numerous tests showed that copper was present, not from human inputs but from a mineral source(Hamuna ,2021).

Table (2): Concentration of copper(µg /g) in the residual phase.

Locations	autumn				winter				spring				summer			
	Cu	Range	Mean	±SD	cu	Range	Mean	±SD	cu	Range	Mean	±SD	cu	Range	Mean	±SD
1	33.46 33.75 33.86	33.46-33.86	33.69	0.206	54.86 55.12 55.29	54.86-55.29	55.09	0.216	34.52 34.76 34.85	34.52-34.85	34.71	0.170	26.26 26.40 26.74	26.26-26.74	26.46	0.246
2	36.55 36.72 36.86	36.55-36.86	36.71	0.155	58.45 58.73 58.86	58.45-58.86	58.68	0.209	37.52 37.74 37.87	37.52-37.87	37.71	0.176	29.21 29.45 29.68	29.21-29.68	29.44	0.235
3	39.52 39.75 39.93	39.52-39.93	39.73	0.205	62.26 62.51 62.72	62.26-62.72	62.49	0.230	40.39 40.78 40.91	40.39-40.91	40.69	0.270	32.26 32.41 32.74	32.26-32.74	32.47	0.245
4	42.82 43.27 43.48	42.82-43.48	43.19	0.337	66.36 66.50 66.79	66.36-66.79	66.55	0.219	43.94 44.20 44.42	43.94-44.42	44.18	0.240	35.32 35.59 35.72	35.32-35.72	35.54	0.204
5	47.26 47.41 47.74	47.26-47.74	47.47	0.245	70.32 70.64 70.92	70.32-70.92	70.62	0.300	47.91 48.14 48.28	47.91-48.28	48.11	0.186	42.51 42.64 42.83	42.51-42.83	42.66	0.160
6	51.62 51.81 52.14	51.62-52.14	51.85	0.263	72.23 72.43 72.76	72.23-72.76	72.47	0.267	53.67 53.83 53.98	53.67-53.98	53.82	0.155	46.23 46.30 46.56	46.23-46.56	46.36	0.173

Iron (Fe)

According to the study's findings, the concentration of iron in the residual phase of the sediments samples was lowest(625.71 µg/g) during the summer at the first station and greatest(784.86 µg/g) during the winter at the sixth station as shown table(3). This is due to the high natural concentration of iron in the earth's crust, as well as the sustainability processes of fishing boats, as well as human activities, especially the accumulation of iron waste, as well as iron oxides that enter the river that is loaded with them (Baddar et al,2021).

Vol. 07, No. 05; 2022

ISSN: 2456-8643

Table (3): Concentration of iron(µg /g) in the residual phase.

Locations	autumn				winter				spring				summer			
	Fe	Range	Mean	±SD	Fe	Range	Mean	±SD	Fe	Range	Mean	±SD	Fe	Range	Mean	±SD
1	636.25 636.44 636.62	636.25-636.62	636.43	0.185	679.71 679.82 679.98	679.71-679.98	679.83	0.135	672.27 672.52 672.74	672.27-672.74	672.51	0.235	632.23 632.56 632.96	632.23-632.96	632.58	0.365
2	638.98 639.12 639.23	638.98-639.23	639.11	0.125	687.22 687.39 687.68	687.22-687.68	687.43	0.232	679.95 680.15 680.38	679.95-680.38	680.16	0.215	633.36 633.78 633.98	633.36-633.98	633.70	0.316
3	648.48 648.60 648.81	648.48-648.81	648.63	0.167	765.62 765.83 765.98	765.62-765.98	765.81	0.180	725.38 725.65 725.84	725.38-725.84	725.62	0.231	645.26 645.41 645.74	645.26-645.74	645.47	0.245
4	657.36 657.74 657.86	657.36-657.86	657.65	0.261	775.46 775.72 775.86	775.46-775.86	775.68	0.202	757.21 757.39 757.58	757.21-757.58	757.39	0.185	655.27 655.42 655.78	655.27-655.78	655.49	0.262
5	675.75 675.90 675.86	675.75-675.86	675.95	0.077	789.55 789.62 789.85	789.55-789.85	789.67	0.156	782.72 782.93 782.23	782.72-782.23	782.96	0.359	669.55 669.72 669.86	669.55-669.86	669.71	0.155
6	677.86 678.25 678.21	677.86-678.21	678.19	0.214	811.52 811.75 811.88	811.52-811.88	811.71	0.182	779.82 780.15 780.33	779.82-780.33	780.1	0.258	670.25 670.44 670.62	670.25-670.62	670.43	0.185

Lead (pb)

According to the study's findings, the concentration of lead in the exchangeable phase of the sediments samples was lowest(18.50 µg/g) during the summer at the first station and greatest(40.63 µg/g) during the winter at the sixth station as shown table(4). This is because of nearby transportation activity, which results in lead particles being released into the air as a result of the combustion of gasoline by moving vehicles. This activity traps a foggy suspension, which then spreads to other areas of the environment and increases pollution levels (Bantan etal,2020).

Table (4): Concentration of lead(µg/g) in the residual phase.

Locations	autumn				winter				spring				summer			
	Pb	Range	Mean	±SD	Pb	Range	Mean	±SD	pb	Range	Mean	±SD	pb	Range	Mean	±SD
1	23.83 24.20 24.42	23.83-24.42	24.15	0.255	43.23 43.34 43.56	43.23-43.56	43.37	0.168	24.87 25.14 25.38	24.87-25.38	25.13	0.255	20.37 20.74 20.85	20.37-20.85	20.65	0.251
2	38.21 38.36 38.56	38.21-38.56	38.37	0.157	46.94 47.23 47.55	46.94-47.55	47.24	0.305	39.52 39.63 39.83	39.52-39.83	39.66	0.157	26.46 26.75 26.86	26.46-26.86	26.69	0.206
3	50.27 50.42 50.78	50.27-50.78	50.49	0.262	54.91 55.23 55.91	54.91-55.91	55.25	0.350	52.26 52.45 52.69	52.26-52.69	52.46	0.215	35.22 35.37 35.58	35.22-35.58	35.39	0.180
4	51.52 51.70 51.86	51.52-51.86	51.69	0.170	55.87 56.21 56.46	54.87-56.46	56.18	0.296	54.25 54.64 54.83	54.25-54.83	54.57	0.295	38.55 38.72 38.86	38.55-38.86	38.71	0.155
5	51.95 52.37 52.58	51.95-52.58	52.3	0.320	63.85 64.14 64.36	63.85-64.36	64.11	0.255	55.95 56.37 56.68	55.95-56.68	56.33	0.366	50.22 50.47 50.65	50.22-50.65	50.44	0.215
6	62.89 63.30 63.61	62.89-63.61	63.26	0.361	67.21 67.31 67.52	67.21-67.52	67.34	0.158	64.93 65.36 65.75	64.93-65.75	65.34	0.410	60.52 60.63 60.83	60.52-60.83	60.66	0.157

Manganese (Mn)

According to the study's findings, the concentration of manganese in the residual phase of the sediments samples was lowest(40.51 µg/g) during the summer at the first station and greatest(88.17 µg/g) during the winter at the sixth station as shown table(5). This is because human activity has increased, notably in recent years in agriculture, which can contribute to environmental pollution through the use of pesticides (Taban et al .,2022).

Table (5): Concentration of manganese(µg /g) in the residual phase.

Locations	autumn				winter				spring				summer			
	Mn	Range	Mean	±SD	Mn	Range	Mean	±SD	mn	Range	Mean	±SD	mn	Range	Mean	±SD
1	44.81 45.21 45.42	44.81-45.42	45.14	0.309	67.25 67.51 67.72	67.25-67.72	67.49	0.235	48.85 49.11 49.32	48.85-49.32	49.09	0.235	40.94 41.30 41.58	40.94-41.50	41.27	0.320
2	50.69 50.81 51.13	50.69-51.13	50.87	0.22	70.22 70.34 70.56	70.22-70.56	70.37	0.172	52.73 52.93 53.22	52.73-53.22	52.96	0.246	47.95 48.10 48.28	47.95-48.28	48..11	0.165
3	57.75 57.94 58.18	57.75-58.18	57.95	0.215	77.46 77.74 77.93	77.46-77.93	77.71	0.236	58.75 58.96 59.29	58.75-59.29	58.95	0.340	50.52 50.73 50.92	50.52-50.92	50.72	0.200
4	61.95 62.10 62.28	61.95-62.28	62.11	0.165	80.36 80.65 80.87	80.36-80.87	80.62	0.255	63.79 64.12 64.36	63.79-64.36	64.09	0.286	54.94 55.30 55.58	54.94-55.58	55.27	0.320
5	71.62 71.78 72.25	71.62-72.25	71.83	0.238	88.28 88.58 88.79	88.28-88.79	88.55	0.256	72.61 72.86 73.28	72.61-73.28	72.91	0.338	65.26 65.51 65.71	65.26-65.71	65.49	0.225
6	74.22 74.31 74.57	74.22-74.57	74.36	0.181	90.23 90.39 90.85	90.23-90.85	90.49	0.321	77.22 77.33 77.58	77.22-77.58	77.37	0.184	71.22 71.47 71.65	71.22-71.65	71.44	0.215

Nickel(Ni)

According to the study's findings, the concentration of Nickel in the residual phase of the sediments samples was lowest(7.46 µg/g) during the summer at the first station and greatest(16.40 µg/g) during the winter at the sixth station as shown table(6). The use of pesticides and fertilizers, irrigation and sewage operations, industrial waste, as well as spills and leaks of liquid materials from loading trucks, are some of the factors that contribute to the contamination of sediments with sewage and agricultural waste, was causes Increased nickel (Majed et al,2021).

Table (6): Concentration of nickel (µg /g) in the residual phase.

Locations	autumn				winter				Spring				summer			
	Ni	Range	Mean	±SD	Ni	Range	Mean	±SD	Ni	Range	Mean	±SD	Ni	Range	Mean	±SD
1	13.92 14.12 14.23	13.92-14.23	14.09	0.157	29.73 29.93 30.21	29.73-30.21	29.95	0.241	15.26 15.41 15.68	15.26-15.68	15.45	0.212	11.27 11.42 11.78	11.27-11.78	11.49	0.262
2	16.22 16.47 16.65	16.22-16.65	16.44	0.215	30.95 31.25 31.49	30.95-31.49	31.23	0.270	16.75 17.15 17.32	16.75-17.32	17.07	0.292	12.94 13.30 13.58	12.94-13.58	13.27	0.320
3	16.94 17.30 17.58	16.94-17.58	17.27	0.320	32.28 32.52 32.86	32.28-32.86	32.55	0.291	18.23 18.33 18.52	18.23-18.52	18.36	0.147	15.36 15.55 15.75	15.36-15.75	15.55	0.195
4	20.26 20.50 20.72	20.26-20.72	20.49	0.230	33.43 33.62 33.84	33.43-33.84	33.63	0.205	22.31 22.43 22.56	22.31-22.56	22.43	0.125	18.22 18.31 18.57	18.22-18.57	18.36	0.181
5	25.52 25.73 25.92	25.52-25.92	25.72	0.200	35.26 35.51 35.78	35.26-35.78	35.51	0.260	26.19 26.35 26.85	26.19-26.85	26.36	0.215	23.22 23.47 23.57	23.22-23.57	23.44	0.215
6	26.72 26.90 26.18	26.72-26.18	26.93	0.231	38.24 38.56 38.78	38.24-38.78	38.52	0.271	27.75 27.93 28.12	27.75-28.12	27.93	0.185	24.94 25.30 25.58	24.94-25.58	25.27	0.320

Zinc (Zn)

According to the study's findings, the concentration of Zinc in the exchangeable phase of the sediments samples was lowest(9.42 µg/g) during the summer at the first station and greatest(32.63 µg/g) during the winter at the sixth station as shown table(7). The study's findings revealed that transportation and fuel combustion, as well as the effects of human activity, increased the concentration of zinc in the stations, particularly the sixth station. Other findings included an increase in the proportion of clay granules in other stations, which aid in the element's absorption. The rise may be caused by the area's high concentration of silt and sand sediments, closeness to a wastewater treatment facility that receives its water untreated, proximity to landfill regions, as well as other factors (Huang ,2020).

ISSN: 2456-8643

Table (7): Concentration of zinc (µg /g) in the residual phase.

Locations	autumn				winter				spring				summer			
	zn	Range	Mean	±SD	zn	Range	Mean	±SD	zn	Range	Mean	±SD	zn	Range	Mean	±SD
1	32.75 32.92 33.17	32.75-33.17	32.94	0.211	46.23 46.38 46.62	46.23-46.62	46.41	0.196	33.45 33.61 33.82	33.45-33.82	33.62	0.185	22.23 22.31 22.55	22.23-22.55	22.36	0.166
2	35.59 35.82 36.25	35.59-36.25	35.88	0.335	54.29 54.55 54.73	54.29-54.73	54.52	0.221	36.74 36.90 37.14	36.74-37.14	36.92	0.201	25.26 25.41 25.74	25.26-25.74	25.47	0.245
3	35.98 36.29 36.52	35.98-36.52	36.26	0.270	56.22 56.42 56.76	56.22-56.76	56.46	0.273	38.85 39.19 39.28	38.85-39.28	39.10	0.226	28.22 28.47 28.65	28.22-28.65	28.44	0.215
4	37.85 38.09 38.25	37.85-38.25	38.06	0.201	58.21 58.55 58.82	58.21-58.82	58.52	0.305	39.75 40.26 40.43	39.75-40.43	40.14	0.353	34.21 34.33 34.57	34.21-34.57	34.37	0.183
5	40.36 40.55 40.75	40.36-40.75	40.55	0.195	59.96 60.24 60.58	59.96-60.58	60.26	0.310	43.24 43.49 43.85	43.24-43.85	43.52	0.306	36.26 36.51 36.71	36.26-36.71	36.49	0.225
6	45.23 45.30 45.56	45.23-45.56	45.36	0.173	64.23 64.42 64.68	64.23-64.68	64.44	0.225	46.91 47.39 47.55	46.91-47.55	47.27	0.328	40.25 40.72 40.95	40.25-40.95	40.64	0.365

The results of the grain size analysis of the sediment samples also showed that the sediments of the study area have a clay or silty clay character where was the clay rate is (44.31%), while the silt rate is (39.77%) and the sand rate is (15.91%)as shown table (8). The Shatt al-Arab region's surface sediments are recent deposits made up primarily of silt and clay with some sand(AI-Ali,2010).

Table (8): grain size analysis of sediment samples

Locations	Clay%	Silt%	Sand%	Texture
1	44.26	46.28	9.46	Silty clay
2	44.38	40.1	15.52	Silty clay
3	46.04	38.32	15.64	clay
4	48.42	32.02	19.56	clay
5	42.36	42.12	15.52	Silty clay
6	40.4	39.79	19.81	clay
Mean	44.31	39.77	15.91	

As for the total organic carbon of the sediment samples, it was found that there are seasonal and local changes in the values of organic carbon. The results of the study showed that the lowest value was in the first station in the summer (2.0) and the highest value in the sixth station in the winter (5.06) as shown table (9).The findings of the present study revealed that the region had a high proportion of organic materials since there were plants and animals there as well as because of the local environment. According to the findings of the current study, the greatest values were obtained during the winter due to the high percentage of rainfall as well as the presence of dead aquatic plants in the area (Zaoui and Benselhoub,2020).

ISSN: 2456-8643

Table (9): TOC% values for stations in the study area

Depth (cm)	Autumn	winter	spring	summer
1	2.5	2.9	2.2	2.0
2	3.0	3.5	2.6	2.2
3	3.7	4.6	3.1	2.8
4	4.5	5.8	4.2	3.9
5	5.8	6.4	5.3	5.0
6	6.9	7.2	6.2	5.8
Mean	4.40	5.06	3.93	3.61

The results of the study showed the evidence of the geochemical accumulation of heavy elements in the study area, according to the classification of (Muller, 1979) As shown tables(10), The sediments of each of the Tigris and Euphrates and the confluence of the Shatt al-Arab were unpolluted to highly polluted, as cadmium exceeded the maximum levels of pollution degrees (<5). As for lead, which gave a non-polluting to medium pollution degree in the remaining phase of some study areas, this is due to the use of pesticides and fertilizers in agricultural lands, as well as sewage and human and health waste as. Thus, the result of the geochemical accumulation factor took the following order:

Cd > Pb > Cu > Zn > Ni > Mn > Fe

Table (10): The geochemical accumulation coefficient (I-geo) of Heavy metals

Stations	season	I-geo Cd	I-geo Cu	I-geo Fe	I-geo Pb	I-geo Mn	I-geo Ni	I-geo Zn
Stations 1	autumn	5.538	-1.418	-6.881	0.678	-5.058	-3.18	-1.88
	winter	6.193	-0.708	-6.795	1.389	-4.506	-2.12	-1.39
	spring	5.787	-1.277	-6.802	0.722	-4.965	-3.05	-1.83
	summer	5.351	-1.766	-6.895	0.333	-5.210	-3.47	-2.47
Stations 2	autumn	5.761	-1.296	-6.874	0.799	-4.321	-2.94	-1.78
	winter	6.306	-0.617	-6.770	1.480	-4.442	-2.05	-1.15
	spring	5.876	-1.254	-6.795	0.839	-4.836	-2.94	-1.73
	summer	5.536	-1.612	-6.888	0.485	-4.965	-3.47	-2.25
Stations 3	autumn	5.964	-1.181	-6.854	0.918	-4.717	-2.86	-1.73
	winter	6.448	-0.526	-6.615	1.570	-4.293	-2.00	-1.08
	spring	5.977	-1.145	-6.702	0.948	-4.680	-2.83	-1.64
	summer	5.689	-1.473	-6.861	0.622	-4.921	-3.05	-2.12
Stations 4	autumn	6.066	-1.061	-6.834	1.035	-4.608	-2.64	-1.68
	winter	6.644	-0.436	-6.601	1.659	-4.237	-1.94	-1.05
	spring	6.439	-1.029	-6.643	1.070	-4.573	-2.55	-1.59
	summer	5.814	-1.343	-6.839	0.757	-4.795	-2.83	-1.83
Stations 5	autumn	6.164	-0.924	-6.834	1.176	-4.411	-2.32	-1.59
	winter	6.704	-0.351	-6.573	1.748	-4.083	-1.83	-1.00
	spring	6.351	-0.905	-6.587	1.195	-4.380	-2.32	-1.47
	summer	5.970	-1.077	-6.748	1.021	-4.539	-2.47	-1.73
Stations 6	autumn	6.194	-0.971	-6.795	1.298	-4.351	-2.25	-1.43
	winter	6.826	-0.312	-6.532	1.786	-4.058	-1.73	-0.91
	spring	6.363	-0.741	-6.587	1.356	-4.293	-2.18	-1.35
	summer	6.118	-0.957	-6.816	1.137	-4.411	-2.32	-1.59

The results of the enrichment coefficient for heavy metals in the study area were shown according to the classification (Huheey, 1983) As shown tables(12). We observe that the lead and cadmium elements were more richer than the other elements as a result of the pollution sources represented by the burning of car fuel and the burning of wastes created by government buildings, hospitals, power plants, and other sources. The sediments of the study area range from moderate to very severe and the result of the arrangement was taken as follows: $EF^{Cd} > EF^{pb} > EF^{Cu} > EF^{Zn} > EF^{Ni} > EF^{Mn}$

Table (12): Enrichment factor (EF) of Heavy metals

Stations	season	EF-Cd	EF-Cu	EF-Pb	EF-Mn	EF-Ni	EF-Zn
Stations 1	autumn	5478.47	44.11	135.52	3.54	13.17	32.34
	winter	8075.54	67.52	227.84	4.96	26.22	42.66
	spring	6160.99	43.01	133.45	3.64	13.67	31.24
	summer	4842.60	34.85	116.58	3.26	10.81	22.09
Stations 2	autumn	6368.23	47.86	214.41	3.97	15.31	35.08
	winter	836.03	71.13	245.42	5.11	27.04	49.56
	spring	6478.86	46.20	208.24	3.89	14.93	33.92
	summer	5491.55	38.71	150.42	3.03	12.46	25.12
Stations 3	autumn	7220.34	51.04	278.00	4.46	15.84	34.93
	winter	8553.03	67.99	257.66	5.07	25.30	46.07
	spring	6513.96	46.73	208.20	4.06	15.06	33.67
	summer	5995.63	41.92	195.42	3.92	14.33	27.53
Stations 4	autumn	7371.88	54.72	280.70	4.72	18.54	36.17
	winter	8716.28	71.49	258.70	5.19	25.81	47.15
	spring	6812.87	48.60	257.32	4.23	17.62	33.12
	summer	6437.93	45.18	210.91	4.21	16.67	32.77
Stations 5	autumn	7959.16	58.52	276.33	5.31	22.64	37.49
	winter	9915.50	74.52	289.94	5.60	26.76	47.69
	spring	7820.74	51.20	256.94	4.65	20.03	34.73
	summer	7022.94	53.08	268.98	4.88	20.83	34.05
Stations 6	autumn	8080.33	63.71	333.13	5.48	23.63	41.80
	winter	10488.14	74.40	296.28	5.61	28.24	49.61
	spring	7917.78	57.49	299.13	4.95	21.31	37.87
	summer	7771.13	57.62	323.14	5.32	22.43	37.88

The results of the heavy metal Contamination factor in the study area showed according to the classification (Hakanson, 1980) as shown table(13) .Copper, iron, manganese, nickel and zinc appeared in the study sites as having low pollution, while lead appeared in the study sites as medium pollution, while cadmium in the study sites was highly polluted This is consistent with the study (AI-Saad et al,. 2022).. Several factors contributed to the increase in the concentration of heavy metals in the sediments, including the increase in transport vehicles and the burning of gasoline and the increase in the release of pollutants from government facilities such as hospitals, electric power plants, oil and gas companies, paper mills, etc., as well as the use of fertilizers in agricultural areas. Thus, the result of the pollution coefficient took the following order:

$CF^{cd} > CF^{pb} > CF^{Mn} > CF^{Cu} > CF^{Zn} > CF^{Ni} > CF^{Fe}$

Table (13): Contamination factor (CF) of Heavy metals

Stations	season	CF-Cd	CF-Cu	CF-Fe	CF-Pb	CF-Mn	CF-Ni	CF-Zn
Stations 1	autumn	69.73	0.56	0.012	1.72	0.045	0.16	0.41
	winter	109.8	0.91	0.013	3.09	0.067	0.35	0.58
	spring	82.86	0.57	0.013	1.79	0.049	0.18	0.42
	summer	61.26	0.44	0.012	1.47	0.041	0.13	0.27
Stations 2	autumn	81.4	0.61	0.012	2.74	0.050	0.19	0.44
	winter	118.73	0.97	0.013	3.37	0.070	0.37	0.68
	spring	88.13	0.62	0.013	2.83	0.052	0.20	0.46
	summer	69.60	0.49	0.012	1.90	0.048	0.15	0.31
Stations 3	autumn	93.66	0.66	0.012	3.60	0.057	0.20	0.45
	winter	131.00	1.04	0.015	3.94	0.077	0.38	0.70
	spring	94.53	0.67	0.014	3.74	0.058	0.21	0.48
	summer	77.41	0.54	0.012	2.52	0.050	0.18	0.35
Stations 4	autumn	103.2	0.71	0.013	3.69	0.062	0.20	0.47
	winter	150.06	1.10	0.015	2.63	0.080	0.38	0.73
	spring	100.53	0.73	0.015	3.89	0.064	0.21	0.50
	summer	84.4	0.59	0.013	2.76	0.055	0.18	0.42
Stations 5	autumn	107.6	0.79	0.013	3.73	0.071	0.30	0.50
	winter	156.46	1.17	0.015	2.72	0.088	0.42	0.75
	spring	122.46	0.80	0.015	4.02	0.072	0.31	0.54
	summer	94.06	0.71	0.013	3.60	0.065	0.27	0.45
Stations 6	autumn	109.6	0.86	0.013	4.51	0.074	0.32	0.56
	winter	170.26	1.20	0.015	2.90	0.090	0.45	0.80
	spring	123.53	0.89	0.015	4.66	0.077	0.33	0.59
	summer	104.20	0.77	0.013	4.33	0.073	0.30	0.50

If we compare our data with the previous study, we see that our data lies in some of this study as shown table (14). Where the sediments of the study area of the Tigris, Euphrates and Shatt al-

ISSN: 2456-8643

Arab receive large quantities of minerals resulting from industrial waste resulting from human activity and other sources such as sewage.

Table(14): Heavy metals concentrations in sediments sampling (µg /g) in the present study as compared with the other previous studies.

Studied Area	Cd	Cu	Fe	Pb	Ni	MN	Zn	Reference
Shatt Al-Arab River – Shatt Al-Basra	5.81	30.15	4170.33	40.13	53.80	-	-	(Al-Qarooni,2011)
Euphrates River	11.22	14.14	661.70	0.59	0.37	-	67.66	(Hassan et al, 2010)
Euphrates River	0.30	30.40	2034	11.17	-	-	24.05	(Al-Khafaji et al, 2011)
The swamp of Chbayish	2.32	2.25	-	5.1	81.25	-	109.47	(Mashkhool,2012)
Shatt Al-Arab River	-	26.69	1911.03	83.78	-	-	75.56	(Al-shmery,2013)
Shatt Al-Hilla River	-	21..8-8.21	629.0-1228.9	27.06-18.5	1114.5-140.5	-	-	(Al-Robai, 2013)
Shatt Al-Arab River	13.08	44.11	20485.79	104.97	234.64	-	106.21	(AL-Hajaj, 2015)
Shatt Al-Arab River	693.245-1159.254	-	-	-	40.942-134.375	-	-	(Al-Mahana,2015)
Shatt Al-Arab River	6.49-15.98	18.47-31.99	770.15-20158.26	61.25-19.73	47.50.42.85		44.79-65.89	(Al-Shamsi ,2017)
Abu Al-Kasaib River- Iraq	0.0001-0.009	0.1118-3731	1118-3731	0.015-0.256	-	-	-	(Al- Tamimi,2021)
Shatt Al-Basra	-7.22-16.52	2.99-0.4	1080-660	-25.02-58.94	-2.49-76.07	-	-2.45-36.47	(Al-Shammari ,2022)
Tigris – Euphrates – Shatt Al-Arab	25.54-9.19	51.85-26.46	811.52-632.58	67.34-20.65	38.52-11.49	90.49-41.27	64.44-22.36	Study present

REFERENCES

Al-Ali, S.H. (2010). Geochemical and mineralogical study of the fluvial deposits at Abul-Kasib area, south east of Iraq. Mesopotamian. Journal. Marian. Science., 25(2): 154-165.

Al-Hassan, S.I. (2014). Bacterial contamination caused by wastewater discharge from some hospitals in Basrah city south of Iraq. Journal of the college of arts, University of Basrah, 70: 1-16.

Al-Hejuje,M.M.(2015). Application of water quality and pollution indice to evaluate the water and sediments status in the middle part of shatt Al-Arab River. Ph.D.Thesis,Biology Department , collage of science. University of Basra, 239pp.

Al-Khafaji, B.Y. , Mohammed, A.B., and Maqtoof, A.A., (2011). "Distribution Of Some Heavy Metals In Water , Sediments and Fish Cyprinus carpio in Euphrates River Near Al-Nassiriya City Center South Iraq". Baghdad Sci. J. , 8(1): 552-560.

Al-Mahana, D. S. (2015)."Distribution and sources of total Hydrocarbons , NAlKane and Poly Cyclic Aromatic compounds in sediment cores of Shatt AlArab coast , Khor Al-Zubair and UmQaser". M.Sc. thesis . University of Basrah, college of science , Geology department.

Al-Robai, H.A.H.,(2013). "Determination some Heavy metals in Sediments of Shatt Al-Hilla River by Using Modified Single Chemical Fractionation Technique ". J . Babylon University/pure and Applied Sci.,21(8) : 2811-2818.

ISSN: 2456-8643

AI-Saad, H.T., Kadhim, A.H. and AI-Hejuje, M.M.(2022). "Heavy Elements in Soil of West Qurna-1 Oil Field in Basrah Governorate, Southern Iraq.

Al-Shmery, A.Y.H.,(2013)." Estimation of some Heavy Metals in clams , sediments and water from Shatt Al-Arab and treatment by porcellanite rocks". M.Sc. Thesis , Chemistry depart. , College Of Education For Pure Science , Unive. Basrah , 100 pp.

Al-Shammari , A.H.(2022). Assessment of heavy metals contamination in the larch sediments of the Shatt al-Basrah RiverAnd diagnose the fossils in it.

AL-Shamsi,Z.S.R.(2017). Heavy Metals in sediments core Along The Shatt AL-Arab Esturay.M.SC.thesis.university of Basrah, collage of science, Biology department.

Al-Tamimi ,M.H.(2021). Assessment of environmental pollution by heavy metals and hydrocarbons In the water and sediments of Abu Al-Khasib River in Basra Governorate - south Iraq.

Al-Qarooni , I. H. M.(2011). "Estimation of some heavy metals concentrations in water , sediment and bioaccumulation in some invertebrates of Shatt Al-Arab River and Shatt Al-Basrah canal , southern Iraq ". Ph.D. Thesis , Biology Dep. , College of Education, Univ. Basrah . 243 pp.

Baddar, I.D., Zeinah Elhaj ,Peck Erin and Xu Xiaoyu ,(2021). "Temporal deposition of copper and zinc in the sediments of metal removal constructed wetlands". 16(8): e0255527.

Bantan, R.A.; Al-Dubai, T.A.; Al-Zubieri, A.G, (2020)." Geo-Environmental assessment of heavy metals in the bottom sediments of the Southern Corniche of Jeddah, Saudi Arabia". Mar. Pollut. Bull161, 111721.

Folk, R.L. (1974). "Petrology of sedimentary rocks. Hemphill Publishing Company", Austin, Texas, 183pp.

Hakanson, L. (1980). An Ecological Risk Index for Aquatic Pollution Control a Sedimentological Approaches, Water Research, 14(8), 975-1001.

Hamuna, B. and Wanimbo, E.(2021). "Heavy Metal Contamination in Sediments and Its Potential Ecological Risks in Youtefa Bay, PapuaProvince, Indonesia". Journal of Ecological Engineering, 22(8), 209–222.

Hassan, F.M., Saleh, M.M., and Salman, J.M., (2010). "A study of physicochemical parameters and nine heavy metals in the Euphrates River , Iraq." E- Journal of Chemistry ,7(3):685-692.

Hlavay, J.; Prohaska, T.; Weisz , M.; Wenzel, W.W. and Stingeder , G.I. (2004). Determination of trace elements bound to soils and sediment fractions. Pure Appl. Chem. 76 (2): 415 – 442.

Huang Z., Liu C., Zhao X., Dong J., Zheng B.(2020)." Risk assessment of heavy metals in the surface sediment at the drinking water source of the Xiangjiang River in South China. Environ". Sci. Eur., 32, 23.

Huheey, J. E. 1983. Inorganic chemistry : Principles of structure and reactivity. Harper and Row Publishers, New York, 912.

Jia Z, Li S, Wang L,(2018)."Assessment of soil heavy metals for ecoenvironment and human health in a rapidly urbanization area of the upper Yangtze Basin". Scientific Reports, 8 (1), 3256.

Majed. N. Real · M. I. H. Redwan · A .Azam. H. M. (2021)." How dynamic is the heavy metals pollution in the Buriganga River of Bangladesh". A spatiotemporal assessment based on environmental - International Journal of Environmental Science and Technology https://doi.org/10.1007/s13762-021- 03434-8.

Makri, P., Stathopoulou, E., Hermides, D., Kontakiotis, G., Zarkogiannis, S. D., Skilodimou, H. D., ... and Scoullos, M. (2020). The Environmental Impact of a Complex Hydrogeological System on Hydrocarbon-Pollutants' Natural Attenuation: The Case of the Coastal Aquifers in Eleusis, West Attica, Greece. Journal of Marine Science and Engineering, *8*(12), 1018.

Mannaa. A.A, Khan A. A, Haredy. R. Al-Zubieri, A.G,(2021). "Contamination Evaluation of Heavy Metals in a Sediment Core from the AlSalam Lagoon", Jeddah Coast, , Journal. Marian. Science. Engineering., 9, 899.

Sturgeon, R.E., Desaulincrs, J.A., Berman, S.S. and Russell, D.S. (1982). Determination of trace metals in estuarine sediment by graphite furnace atomic absorption spectrophotometry Anal. Chem. Acta. , 134: 288-291.

Taban ,E.A, AI-Saad ,H.T,AI- Hejuje ,M.M.(2022). The concentration of some organ chlorine pesticides in the surface sediments of the Shatt AI-Arab River.

UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe), 2013, Inventory of Shared Water Resources in Western Beirut. Chapter 5 - Shatt Al Arab, Karkheh and Karun Rivers.

Yusoff, A., Zulkifli, S. Z., Ismail, A. and Mohamed, C. A. (2015)." Vertical trend of trace metals deposition in sediment core off Tanjung Pelepas harbour, Malaysia" Procedia Environmental Sciences 30: 7pp.

Zaoui, L and Benselhoub, A. (2020)." Geo-environmental assessment of soil pollution with heavy metals in El Tarf region (Ne Algeria)", Studia Universitatis "Vasile Goldiş", Seria Ştiinţele Vieţii Vol. 30, issue 2, , pp. 96 – 105.

Zhuang W. and Zhou, F.(2021). "Distribution, source and pollution assessment of heavy metals in the surface sediments of the Yangtze River Estuary and its adjacent East China Sea". Mar. Pollut. Bull., 164, 112002.