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Geochemical Evaluation of Heavy Metals (Cd, Cr, Fe, and Mn) in Sediment of Shatt Al-Basrah, Iraq

Abstract- *In this study, the sediment of Shatt Al-Basrah canal, was evaluated to illustrate the distribution of 4 heavy metals Cd, Cr, Fe and Mn in sediments collected from 5 sites. The assessment of heavy metals was conducted using three indices; the geo-accumulation index (I-geo), the enrichment factor (E.F.) and Pollution Index (PI). According to I-geo, the sediments collected from all sampling locations were unpolluted by Cd, Cr and Fe, where their values are less than 0 (<0), except Mn ranged between 0.98 to 1.37, the Igeo values for Mn show that sediments of Shatt Al-Basrah are unpolluted to moderately polluted for all sampling locations. Based on The enrichment factor, the sediment of Shatt Al-Basrah canal are classified as followed; significant enrichment for Cd, moderate enrichment to significant enrichment for Cr and deficiency to minimal enrichment for Mn. PI, which is based on individual metal Concentrations, shows that all sampling sites have no pollution effect for Cd, Cr and Mn, except Fe, which cause Slightly pollution affect in all site.*

Keywords- *Heavy Metal, accumulation, indices, sediment.*

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1. Introduction

In the last few years, the attention in the problems that are associated with pollution of the environment as a result of the extensive assortment of chemical pollutants (such as heavy metals) has increased [1]. High concentrations of heavy metals from anthropogenic and geological sources are being released into the aquatic ecosystem [2]. Heavy metals are considered one of the most critical contaminants in the environment due to their persistence, toxicity and bioaccumulation problems [3]. The continuous discharge of huge volumes of domestic and industrial waste into the aquatic system has led to increase the levels of heavy metals in the river, which finally accumulate in sediment. High concentrations of metals can be very toxic, since the metals can resist degradation, and could possibly settle for a long period in the ecosystem. On the other hand, Heavy metals in the rivers also can be participated by a natural event such as weathering of the rock with the dissolution of metals in water [4]. The associations of heavy metals with sediments are not stable endless or under dynamic situations of the environment. If the equilibrium is disturbed, heavy metals may be released and return to the water column by a variety of remobilization methods. In the aquatic system, therefore, sediments can show a two role, both as a possible source and as a carrier of pollution [5]. Sediment, as a part of the aquatic environment, can deliver a record of depositional history and is taking into account a sink for metals released into an aquatic ecosystem due to

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the longer lifetime of heavy metals in sediment. They can also considered as point sources of pollution throughout anthropogenic activities [6]. The present study aimed to assess the sediment quality for Shatt Al-Basrah canal by using ecological indices depending on the concentration of heavy metals and investigating the distribution pattern of the pollutant in this canal.

2. Material and Methods

Shatt Al-Basrah canal is a non-natural canal extent from Al-Hammar marshes into Khor Al-Zubair in Al- Basrah and finally to the Arabian Gulf and its length is about 38 Km. this canal was built to carry irrigation drainage from the middle and southern area of Iraq [6-8]. The canal able to drain water at about 325 m3/sec during the flood and 1050 m3/sec through ebb tides to Khor Al-Zubair [9].

Five locations were chosen for collecting the sedimentary samples during 2014 -2015 at Shatt al Basrah (figure1); Van Veen grabs sampler was used for collecting the samples. In the laboratory, the sediment was dried (105 Cº) by using the oven until it loses its moist content. The dried samples were sieved by 200 µm mesh sieve. To measure the heavy metals (HMs) concentration (Cd, Cr, Fe, Mn) the Atomic Absorption Spectrophotometry device (model AAS 6300, Shimadzu) was used according to the Standard Methods [10]. The measured concentrations for the studied metals were compared against sediment quality guidelines ISQG for sediment [11].

Figure 1: Sampling sites

Table 1: The Mean values of HMs in selected sites (mg/kg)

Sites	Cd	Cr	Fe	Mn
1	0.0166	0.9207	98.806	2.8829
2	0.0114	0.9004	109.724	2.8521
3	0.0162	0.8292	82.387	2.2424
4	0.0163	0.8851	76.452	2.2661
5	0.0183	1.0734	100.204	2.9302

3. Results and Discussion

Table 1 illustrate the mean concentration of heavy metals (HMs) that are found in Shatt Al-Basrah canal during the current study.

I. Calculation of Pollution Indices

a. The geo-accumulation index (I-geo)

Is a common measure to assess the pollution of heavy metal in sediments, which was initially defined by [12] to find out heavy metals contamination in sediments, by comparing current concentrations with pre-industrial levels, this index was calculated as follows:

$$I-geo = log_2\,(C_n/1.5\ B_n)$$

Where Cn is the measured value of the observed metal in the sediment samples and Bn represent the geochemical background content of the same metal. The constant value of 1.5 is led to reducing the effect of potential deviations in the background values, which might be familiar to anthropogenic influences. In this study, the average of world surface rock given by [13] was used as the geochemical background value. The following classification is given for I-geo as reported by [14] Table 2.

Table 2: I-geo categories

I-geo Value	Rank
<0	practically unpolluted
0-1	unpolluted - moderately polluted
1-2	moderately polluted
2-3	moderately - strongly polluted
3-4	strongly polluted
4-5	strongly - extremely polluted
> 5	extremely polluted

The results of Table 3 showed that I-geo values of Cd ranged from -4.64 to -4.06, from -7.16 to -6.64 for Cr, from -9.96 to- 8.96 for Fe and from 0.98 to 1.37 for Mn. All sites have Igeo for Cd, Cr and Fe less than 0 (<0), According to the classification of Muller's, which indicate that's all sediments sites were unpolluted. The Igeo for Mn ranged between 0.98 to 1.37, the Igeo values for Mn point out that Shatt Al-Basrah sediments are unpolluted to moderately polluting with Mn for all sampling sites.

Table 3: Geo-accumulation Index (I-geo) of HMs in Shatt Al-Basrah sediments

Sites	Metals			
	Mn	**Fe**	**Cr**	**Cd**
Site 1	1.35	-9.96	-6.79	-4.06
Site 2	1.17	-8.96	-6.97	-4.64
Site 3	0.98	-9.96	-7.16	-4.32
Site 4	1	-9.96	-6.96	-4.32
Site 5	1.37	-8.96	-6.64	-4.06
All samples	1.22	-9.20	-6.79	-4.32

b. The enrichment factor (E.F.)

Is a useful tool to reveal the condition and grade of ecological pollution [15]. The calculations of E.F. compare each value of parameter with the background level, either from a global or regional average composition, or from a local site, using older deposits formed under similar conditions, but without the impact of anthropogenic [16-17]. The mathematical calculation of EF was done by using the method suggested by [18] as follows:

$$EF = \frac{(M/Fe)sample}{(M/Fe)background}$$

Where EF is the enrichment factor, (M/Fe) sample is the metal ratio, and Fe concentration of the sample and (M/Fe) background is the metals ratio and Fe concentration of a background [18]. Based on the enrichment factor (EF), five categories of contamination are reported, as shown in table 4 [19].

Table 4: EF categories

EF Value	Rank
<2	deficiency - minimal enrichment
2-5	moderate enrichment
5-20	significant enrichment
20-40	very high enrichment
>40	Extremely high enrichment

The results of the present study showed that EF of Cd ranged from 16.67 at site 2 to 33.3 at site 4 (Table 5). However, the results also indicated that the sediments of Shatt Al-Basrah are categorised as very high enrichment for Cd, except site 2 that has EF value more than 5 and less than 20 and Shatt Al-Basrah sediments are categorized as significant enrichment for Cd. The EF values for Cr in Shatt Al-Basrah sediments ranged from 4.21 at site 2 to 6.32 at site 4. Most sampling sites have EF more than 5 and less than 20 suggesting that Shatt Al-Basrah sediments are categorized as significant enrichment for Cr, except Site 2 the EF value was more than 2 and less than 5 and Shatt Al-Basrah sediments are classified as moderate enrichment for Cr (Table 5). All sampling sites (S1, S2, S3, S4, and S5) have EF values for Mn less than 2 suggesting that Shatt Al-Basrah sediments are categorized as a deficiency - minimal enrichment for Mn (Table 5).

c. Pollution Index (PI(

Is a useful tool to evaluate water pollution of any aquatic ecosystem, where it gathers many parameters to attain at a certain value which can be compared with the standard value to assess the level of pollution [20]. Pollution index (PI) is based on the calculation of individual heavy metal and can be characterized into five classes (Table 6) [21].

Table 5: Enrichment Ratio (ER) of HMs in the sediments of Shatt Al-Basrah

Sites	EF		
	Cd	**Cr**	**Mn**
1	28.3	4.74	1.5
2	16.67	4.21	1
3	31.67	5.26	1.5
4	33.3	6.32	1
5	30	5.23	1
All samples	28.3	10.53	1.5

Table 6: PI categories

PI Value	Rank
<1	No effect
1–2	slightly affected
2–3	moderately affected
3–5	strongly affected
>5	seriously affected

PI can be calculated according to the following Equation,
$$PI = \frac{\sqrt{(\frac{ci}{si})^2_{max}+(\frac{ci}{si})^2_{min}}}{2}$$
Where Ci: the concentration of each metal and Si: the metal level consistent with criteria of sediment quality [21].The results of PI (table 7) were ranked from No effect to slightly affect for all metal Cd (0.097-0.122) Cr (0.127-0.145) Fe (1.128-1.352) Mn (0.194-0.221). Most of the variables have PI value less than 1, except for Fe where values larger than 1 in all sites, which will fall in the rank of "slightly affected." So, the sampling sites have slightly affected contamination for Fe and no effect for others parameter Cd, Cr and Mn. The slightly high value of Fe concentration that raises the PI value can be retuned in the first place to anthropogenic metals loaded form industrial activity, where the studied area is characterized by the presence of industrial complex plant [22].

Table 7: Pollution Index (PI) for Sediment of Shatt Al-Basrah

sites	**PI**			
	Cd	Cr	**Fe**	**Mn**
1	0.102	0.128	1.303	0.221
2	0.097	0.134	1.352	0.218
3	0.114	0.127	1.192	0.200
4	0.116	0.133	1.128	0.194
5	0.122	0.145	1.275	0.219

4. Conclusion

In the end, the Results of the current work showed that there was contamination with iron in the sediment of Shatt Al-Basrah as indicated by the Pollution Index, and the high values for the enrichment factor were for the cadmium in all sites. More attention and considerations need to pay for theses concentrations of heavy metals to keep them at a low level or keep them even lower.

References

[1] D. Mendil, Ö.D. Uluözlü, E. Hasdemir, M. Tüzen, H. Sari, M. Suiçmez, “Determination of trace metal levels in seven fish species in lakes in Tokat, Turkey,” *Food Chem*., Vol. 90, pp. 175–179, 2005.

[2] F.Yilmaz, N. Ozdemir, A. Demirak, A.L. Tuna, “Heavy metal levels in two fish species Leuciscus cephalus and Lepomis gibbosus,” *Food Chem*., Vol. 100, pp.830–835, 2007.

[3] C.D. Chandam and K. Rolee, “Grain Size Distribution and Its Relation to the Geochemical Parameters in the Chemical and Petrochemical Complex of Vadodara District of Gujarat, India,” *International Research Journal of Environment Sciences*, Vol. 4, No. 7, pp. 7-16, 2015.

[4] N.F. Mokhtar, A.Z. Aris, S.M Praveena, “Preliminary stud of heavy metal (Zn, Pb, Cr, Ni) contaminations in Langat River Estuary, Selangor,” *Procedia Environmental Sciences*, Vol. 30, pp. 285–290, 2015.

[5] A.M. Sheela, J. Letha, S. Josep, J. Thomas, “Assessment of heavy metal contamination in coastal lake sediments associated with urbanization: Southern Kerala, India, Lakes & Reservoirs,” *Research and Management*, Vol. 17, pp. 97–112, 2012.

[6] T. Tomiyasu, A. Nagano, N. Yonehara, H. Sakamoto, O.K. Rifardi, H Akagi, “Mercury contamination in the Yatsushiro Sea, south-western Japan: spatial variations of mercury in sediment,” *Sci. Total. Environ*., Vol. 257, pp. 121–132, 2000.

[7] M.F. Abbas “Ecological study of zooplankton in the Shatt Al-Basrah anal, Basrah-Iraq Mesopot,” *J. Mar. Sci*., Vol. 30, No. 1, pp. 67 -80, 2015.

[8] H.K. Hussein, T. Z. Abdul Razzak, M.A. Luay, “Assessment of Water Quality Indices for Shatt Al-Basrah River in Basrah City, Iraq,” *Eng. & Tech. Journal*, Vol. 34, Part (A), No.9, pp. 1804-1822, 2016.

[9] N.N.M. Al-Khayat, “Hydrological status of the Shatt Al-Basrah canal and some of their environmental,” *J. Coll. Arts. Univ. Basrah*, Vol.43, pp. 214- 229, 2007.

[10] APHA; WWA and WEF “Standard methods for examination of water and wastewater,” 21st Edition, American Public Health Association, Washington, D.C., 2005.

[11] CCME “Canadian sediment quality guidelines for the protection of aquatic life. Canadian Council of Ministers of the Environment,” Winnipeg. Publication No., 1299, 2001.

[12] B. Maurizio, “The Importance of Enrichment Factor (EF) and Geoaccumulation Index (Igeo) to Evaluate the Soil Contamination Barbieri,” *M. J Geol Geophys*, Vol. 5, No.1, 2016.

[13] J.M. Martin, M. Meybeck, “Elemental Mass-Balance of Material Carried by Major World Rivers” *Marine Chemistry*, Vol. 7, No. 3, pp. 173 -206, 1979.

[14] O. Sana`a, “Application of Geoaccumulation Index and Enrichment Factors on the Assessment of Heavy Metal Pollution along Irbid/zarqa Highway-Jordan,” *Journal of Applied Sciences*, Vol. 15, pp. 1318-1321, 2015.

[15] H. Feng, X., Han W.G. Zhang, L.Z. Yu, “A Preliminary Study of Heavy Metal Contamination in Yangtze River In tertidal Zone Due to Urbanization,” *Marine Pollution Bulletin*, Vol. 49, No. 11-12, pp. 910-915, 2004.

[16] I. Cato, “Recent Sedimentological and Geochemical Conditions and Pollution Problems in

Two Marine Areas in Southwestern Sweden," *Striae*, Vol. 6, pp. 1-150, 1977.

[17] K. Choi, S. Kim, G. Hong, H. Chon, "Distribution of Heavy Metals in the Sediments of South Korean Harbors," *Environmental Geochemical Health*, Vol. 34, No. 1, pp. 71-82, 2012.

[18] S. Sinex, G. Helz, "Regional Geochemistry of Trace Elements in Chesapeak Bay Sediments," *Environmental Geology*, Vol. 3, No. 6, pp. 315-323, 1981.

[19] K. Mmolawa, A. Likuku, G. Gaboutloeloe, "Assessment of Heavy Metal Pollution in Soils along Roadside Areas in Botswana" *African Journal of Environmental Science and Technology*, Vol. 5, pp. 186-196, 2011.

[20] J. A. Enaam, "Evaluation of Surface Water Quality Indices for Heavy Metals of Diyala River-Iraq," *Journal of Natural Sciences Research*, Vol.3, No.8, pp. 63-69, 2013.

[21] A.H.M.J. Al-Obaidy, Zahraa Z. Al-Janabi and A.A.M. Al-Mashhady, "Distribution of Some Heavy Metals in Sediments and Water in Tigris River," *Journal of Global Ecology and Environment*, Vol. 4, No. 3, pp. 140-146, 2016.

[22] H. Hazzeman, J.L. Ley, Z. A. Ahmad, F. M. Nor, A.A. Nur, M.Y. Fatimah, S. Abu Bakar, M.P. Sarva, "Geo-accumulation index and contamination factors of heavy metals (Zn and Pb) in urban river sediment," *Environ Geochem Health*, Vol. 39, Issue 6, pp. 1259–1271, 2017.