Evaluation the Pollution of Sediments of the Shatt Al - Hillah with Heavy Metals by Using the Pollution Indices

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Abstract

The level of pollutant of heavy metals (Hg, Co, Pb V, Cr, Ni, Sr, Zr, Mo, Cu, Rb, Zn, As,Th, U) , in the sediment samples on the banks of the Shatt al-Hillah River The study was conducted in the Department of Earth Science at the collge of Science, University of Babylon, 14 samples of sediments ware collected from the banks of the river of Shatt Al-Hillah. The average concentration of the heavy metal in the sediment of the river bank in descending order: Sr (360.6 ppm) ,Cr (285.9 ppm), Ni (203.2 ppm), Co (169.9 ppm), Zr (166.3 ppm),. V (116.4ppm) , Zn (91.6 ppm), Cu (48.8 ppm), Rb (41.9 ppm), Pb (18.1 ppm),As(11.1 ppm), Hg(5.7ppm),Th (4.2 ppm),Mo(3.7 ppm), U(2ppm,. The geoaccumulation index (Igeo) for Hg of five sampling station along the river was greater than 3.0, which indicate cotamination of sedimentation with a high degree of pollution. The Igeo for Ni in11 sampling station and CO in 12 sites were greater than 1.0, indicated moderatly level of polluted sediment.The value of the pollution load index (PLI) for the total sampling stations ranged from 0.7 -1.4.

1-Introduction

1-1 Sediments in aquatic environments.

Heavy elements - Heavy elements exist in nature, where they go through the geochemical cycles to the environment. The high concentrations of heavy elements in the aquatic environment are dangerous to living organisms due to the ability of these organisms to accumulate these elements in their bodies and concentration which may cause imbalance in their vital functions[1]. The transmission of these elements through the food chains of humans, causing him many health damage. Heavy elements are defined as those that are five times the density of water 5 mg / cm 3 cubic and have negative effects on the environment because of excessive use and affect the health of humans, animals and plants[2]. The increase in concentrations of toxic heavy metals in sediments may lead to increased level of these components in the aquatic organisms. This increase is cumulatively cumulative and hence the introduction of food through the human chain of food, thus causing health problems. As a result of various industrial and agricultural activities, These elements in the environment are the result of various activities and practices, including the waste disposal or sedimentation from the atmosphere, or excessive use of fertilizer and pesticides[3].

1-2- Aims of study: The main objective of this research is to demonstrate the rate of concentrations of heavy elements in sediments in the Shatt al-Hillah. This study can be considered attempt to evaluate   the degree of contamination of the sediment of shat Al hilla river   by the heavy elements harmful to the by using different indices like geoaccumulation index and pollution load index .

1-3Location and area description:

The studied area is the Babylon Governorate, it's located within the Mesopotamian plain, middle of Iraq, 100km away from Baghdad in the south, between Longitude ($44^0$50'36.62" & $44^0$44'11.10" E) and Latitude ($32^0$13'46.05" & $32^0$27'46.72 N), covering an area of about 5119 km.
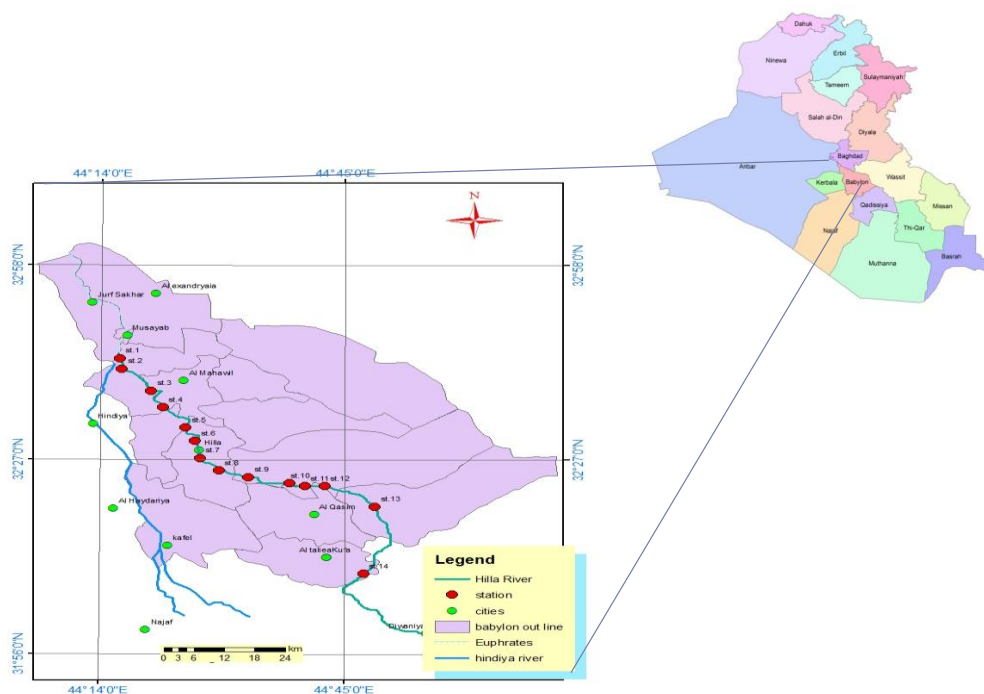

Figure (1) Map showing the Shatt al Hilla river catchment, the largest towns, and the station of sediment samples.

2- Physiography:

The Republic of Iraq divided into five broad physiography regions. each region has its specific geological hydrological and climatological condition and consequently specific soil condition as well. The study area located within the lower Mesopotamian plan is the southern part of an extensive geosyncline which at basin is wide and has a base of about 3 km below the surface filled with sediments from the older shelf sediments, river sediments form the upper part of these sediments[5].

3-Geologic setting

The study area is within the sedimentary plain in the unstable pavement area in relation to the tectonic division of Iraq [6]. This range, also called the Mesopotamian zone, is located within the geosyncline basin between the Zagros Mountains in the north-east and the stable Arab plateau in the south-west [7]. The area of research generally covers modern Quaternary sediments with the Pleistocene and Holocene sediments of the Flood Plain Deposit of the Euphrates [8]. There are also fill deposits. These deposits are caused by floods and are generally made up of thin layers of fine sand, and mud. [9] and Aeolian deposition are found in the eastern parts of the province. Dry marsh deposits are found in different areas of the study areas [10]. Sediments, which are the result of human activity, Remains of ancient canals

and small archaeological tails representing ancient population settlements have long been characterised by natural phenomena as well as important geomorphological phenomena in the flatlands of the sedimentary plain [11].

4-Topography and geomorphology of the region

Babylon Governorate is located within the Sedimentary Plain, which is characterised by flatness, and low general slope. The slope is about 22 cm per kilometre and there are secondary slopes [10], where the land descends from the northern and western sides towards the eastern and southeastern parts. Some dunes are found in some areas, such as south of Hilla. These dunes have fixed bases, but their peaks are moving. Winds form shapes according to their direction [12].

5- Hydrology of the area

The province of Babel is characterised by the abundance of its streams that extend to its most agricultural areas. The Euphrates River and the branching streams are considered the main water resource of the study area. When the Euphrates River enters the province of Babylon, it is close to the Tigris River, The Euphrates River is about 7 meters high [12] This phenomenon has been exploited as the stream of the rivers of Yusufiya, Latifiya and Musayyib were opened to take their water from the Euphrates River. The river then branches south of Musayyib into two branches: Shatt al-Hindiy in the west and Shatt al-Hillah in the east. The Hindiya Barrage was established to raise water for the streams in front of it.Shatt al-Hillah is an important water resource in the province, where it passes through large areas, and it is divided into several rivers that feed and irrigate large agricultural lands [12].

6- Shat al Hilla river

As for the geographical location of Shatt al-Hillah, it is located in the center of Babylon province. It has a length of about 104 km within the province of Babyilon and the rate of width of a section in most of its parts is about 50 meters and irrigates an area of 2,365,000 dunums of agricultural land and passes through a number of districts, and the center of the province of Hilla and the Hashemiya, Shomali and even the province of Qadisiyah, where it branches into three branches are Dagara, Al huriya and Diwaniyah. Al Hilla is a city located in central Iraq on the banks of the Shatt al-Hillah River, which branches from the Euphrates river at the edge of Hindya, about 100 kilometers south of Baghdad. This city is the center of the province of Babylon and the largest cities of the province is also close to the historic city of Babylon and also close to the cities of Bursibba and Kish, which is a dense agricultural area Palm trees [13].

7-Methodology

Fourteen samples from the sediment banks of Shat al Hilla river were collected between December 2015 and January 2016. The samples are distributed through the fourteen station of the river (Fig. 1). All samples were dried in the oven with 60ºC, stone, plants and other impurity materials were removed from the samples, and the remaining sediment samples were powdered into 0.075 mm. 15 trace element (Pb, V, Cr, Cu, Rb, Zr, Co, Ni, Th, Mo, As, Hg, Sr, Zn, U) concentrations were determined in all samples by using X-ray fluorescence in the Geology department, colloge of science, university of Babylon, this technic the devise used in the analysis is Niton XRF analyzer.The concentrations of heavy elements in the sediments of the Shatt al-Hillah banks have been obtained and various indicators and guidelines have been applied to assess their pollution and environmental hazards. The total concentrations of heavy metals in the surface sediments of) Shatt al-Hillah were obtained and multiple indices and guidelines were applied to assess their contamination and ecological Hazared.

8-Result and discussion

The total concentration of heavy elements and the spatial distribution of these concentrations and the related information is summarized in Table 1. Based on the average concentrations, the target.

Table 1. concentration ,Average and range values of total heavy metal content (ppm) of all sampling sites.

Station No	Co	Ni	Cu	Zn	Th	Pb	MO	Zr	Sr	Rb	As	Cr	V	Hg	U
st.1	156	219	41	79	5	16	3	135	318	46	10	320	58	5	nd
st.2	85	214	35	68	3	12	3	130	422	44	13	251	217	12	nd
st.3	nd	nd	41	75	4	19	nd	136	344	47	10	262	109	nd	nd
st.4	136	184	41	75	4	13	4	130	350	41	11	nd	nd	1	nd
st.5	204	215	55	81	5	12	5	109	331	47	14	nd	nd	4	4
st.6	171	207	37	84	3	16	3	158	351	41	10	436	38	5	nd
st.7	160	212	40	75	4	12	3	149	362	40	11	215	116	8	1
st.8	145	181	39	76	5	17	1	144	356	40	9	233	nd	1	nd
st.9	208	223	28	68	4	12	4	124	361	40	11	224	239	6	nd
st.10	128	181	109	185	4	42	4	171	419	39	12	353	nd	nd	nd
st.11	302	215	46	103	4	20	7	365	334	36	13	nd	1	8	nd
st.12	138	207	43	75	5	11	4	133	379	43	nd	267	141	3	1
st.13	160	203	40	85	5	17	nd	158	352	41	9	483	126	8	2
st.14	169	183	48	84	4	18	3	145	350	43	10	95	112	6	nd
Min	85	181	28	68	3	11	1	109	318	36	9	95	1	1	1
Max	302	223	109	185	5	42	7	365	422	47	14	483	239	12	4
Average	169.9	203.2	48.8	91.6	4.2	18.1	3.7	166.3	360.6	41.9	11.1	285.9	116.4	5.7	2.2

nd :not detected

Table (2) Classification of sediments with regard to Igeo [4]

Igeo	Class	Pollution intensity
>5	6	Very strong polluted
4-5	5	Strong to very strong
3-4	4	Strongly polluted
2-3	3	Moderately to strongly
1-2	2	Moderately polluted
0-1	1	Unpolluted to mod. polluted
<0	0	Unpolluted

Table 3. Pearson correlation matrix for the sediment components.

	Co	Ni	Cu	Zn	Th	Pb	MO	Zr	Sr	Rb	As	Cr	V	Hg	U
Co	1														
Ni	0.7156	1													
Cu	-0.0382	-0.052	1												
Zn	0.07665	-0.0012	0.9544	1											
Th	0.1382	0.07303	0.0471	-0.0592	1										
Pb	-0.082	-0.2065	0.89788	0.95849	-0.0815	1									
MO	0.70619	0.53575	0.2184	0.23787	-0.1425	0.03226	1								
Zr	0.59602	0.11608	0.12018	0.31082	-0.1375	0.28095	0.49753	1							
Sr	-0.3519	0.07774	0.42494	0.42231	-0.4225	0.37991	-0.0157	-0.1532	1						
Rb	-0.5681	-0.3811	-0.1636	-0.3783	0.20713	-0.3153	-0.3476	-0.6527	-0.2038	1					
As	0.20537	0.0443	0.17352	0.19945	-0.387	0.20899	0.23021	0.21152	-0.0566	-0.0729	1				
Cr	-0.3653	-0.0573	0.06255	0.16978	-0.0404	0.24652	-0.6132	-0.2463	0.28877	0.02066	-0.3256	1			
V	-0.2478	0.03107	-0.4623	-0.4379	-0.2392	-0.4076	-0.2438	-0.3281	0.34134	0.17229	-0.2201	0.28257	1		
Hg	0.34327	0.52442	-0.422	-0.3347	-0.3204	-0.4078	0.16646	0.22899	0.11499	-0.129	0.24609	0.04231	0.53405	1	
U	0.19798	0.20522	0.05392	-0.1103	0.50216	-0.2588	0.06579	-0.2307	-0.2331	0.35443	0.06596	-0.1489	-0.1235	0.08808	1

To assess the extent to which elements are enriched in environmental samples a geochemical methods are used by comparing the concentration of the element in the sample with its concentration in the continental crust, which is called the "the clarkevalues" relative to the American geologist Clark[14]. Another method used to determine the average composition of the upper crust is by measuring the concentrations of elements in soft granules. The most common of these formulas is the average values of the shale as reported and published by by [15].

Geoaccumulation index (Igeo). Igeo is contamination index which isWhich can be represented by the following equation : Ige o $= \text{Log2} \dfrac{Ce}{1.5GB}$ --------------------(1)

where: Ce – concentration of the element in the sample GB – geochemical background concentration According to Igeo values, there are 7 classes of the sample pollution, varying from 0 (unpolluted) to 6 (extremely polluted).

Table (2) and figure (3) presents the geo-accumulation index for the quantification of heavy metal accumulation in the study area. The I-geo grades for the study area sediments varies from metal to metal and site to site (across metals and sites). The values of all metal are zero or PLI < 0 Un polluted PLI = 1 Perfection PLI > 1 Deterioration of the environment.
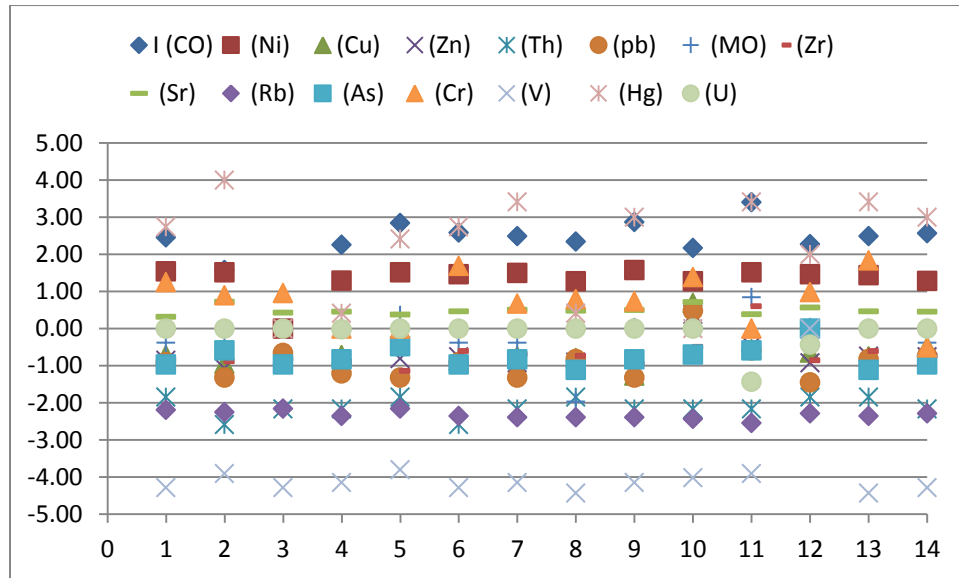

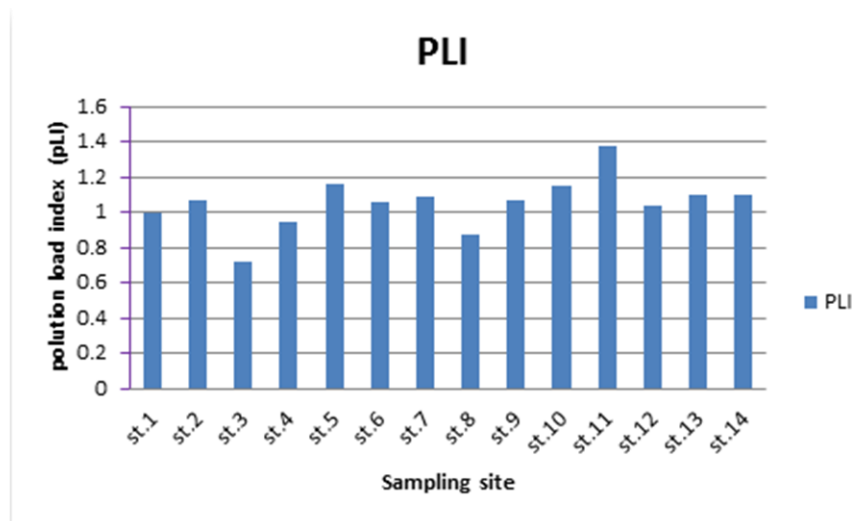**Fig. 2. Geoaccumulation index (Igeo) values of different sampling sites of shat al Hilla river**

Fig. 3: PLI vs. sampling station

Close to zero (unpolluted) expect the values for the nickel element ranged from 1 to 2 in all sites (Igeo class: 2), the values of mercury, the values reached 4 in station 3 while the values 3 were in stations (8,12,14) moderately to strongly polluted.

10- Pollution load index

Determine the magnitude of heavy metal contamination in the sediment, the Pollution Load Index (PLI) and geo-accumulation Index (Igeo) were employed. Pollution load index (PLI) for each station were evaluated using the procedure of[16].

$$PLI = (CF1 \text{ x } CF2 \text{ x } CF3x............CFn) 1/n \text{ (1) Where: n = number of metals--------(2)}$$

CF = contamination factor CF = Metal concentration in sediment/Background values of the metal PLI is a potent tool in heavy metal pollution evaluation. According to [16]

pollution load Index PLI provides simple but comparative means for assessing a site quality, where a value of PLI < 1 denote perfection; PLI = 1 present that only baseline levels of pollutants are present and PLI > 1 would indicate deterioration of site quality [17]. and coordination of PLI against sampling sites is expressed by Fig.3 . in this study Calculation showed that (PLI) range is 0.72– 1.38 with a mean value of 1.1 indicating that the concerned heavy metals lie on the class PLI = 1 the pollutants are present within the baseline level of pollutant are present.

Statistical methods were applied to process the analytical data in terms of the distribution and correlation among the studied parameters. Pearson's correlation coefficient analysis was performed to identify the relationship among heavy metals in sediments and their possible sources. The correlation matrix for the parameters studied was shown in Table 3. sum metals were significantly correlated with each other in the surface sediments of the shatt al Hilla river there is high positive correlation with a very significant probability) was observed between Cu/pb, Pb/zn, Co/Ni,Co/Mo,Ni/Hg, and V/Hg.

11-Conclusion

Geoaccumulation index (Igeo) showed that sediments of Shat al hilla river values for Cu,Zn,Th,Mo,Pb,Zr,Sr,U,,Th, V,and As concentrations that were within the background values, sediment polluted by Hg was more widespread than the other heavy metals, which was contributed mostly by both natural and anthropogenic sources. The PLI values of all the sediment samples of the studied region that concerned heavy metals lie on the class PLI = 1 the pollutants are present within the baseline level of pollutant are present.

CONFLICT OF INTERESTS
There are no conflicts of interest.

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الخلاصة

اهتمت هذه الدراسة بتقييم مستوى تراكيز الملوثات من المعادن الثقيلة التالية (Hg، V Pb، Cr، Co، Ni، As، Rb، Sr، Zr، Mo، Cu، Zn، Th، U)، لرواسب من ضفاف شط الحلة. أجريت الدراسة في قسم علم الأرض في كلية العلوم، جامعة بابل، تم جمع ١٤ عينة من الرواسب من ضفاف نهر شط الحلة اظهرت نتائج الفحوصات ان متوسط تركيز المعادن الثقيلة في رواسب ضفاف النهر بالترتيب التنازلي(Sr (360.6 : السنترونشيوم، Cr (285.9) الكروم، النيكل Ni (203.2)، Co (169.9) الكوبلت Zr (166.3 الزركونيوم، الفناديوم (116.4) .V، Zn (91.6) الخارصين، النحاس (Cu (48.8، Rb (41.9) الروبيديوم، الرصاص(Pb (18.1، As الزرنيخ (11.1)، Hg الزئبق (5.7)، الثوريوم Th 4.2، الموليبدنوم (3.7) o، U اليورانيوم 2)(ملغرام/لتر)، وكان مؤشر التراكم (Igeo) للزئبق لخمس محطات على طول النهر أكبر من ٣.٠، والذي يشير إلى تلوث الترسبات بدرجة عالية بهذا العنصر. وكان مؤشر التراكم (Igeo) لعنصر النيكل (Ni) في ١٢ موقعاً ولعنصر الكوبلت في ١٢ موقعا أكبر من ١.٠، يشير إلى مستوى معتدل من التلوث لرسوبيات ضفاف النهر، تراوحت قيمة مؤشر حمل التلوث (PLI) لمحطات أخذ العينات الإجمالية من ٠.٧ إلى ١.٤.

الكلمات الدالة: أثر العناصر، الرواسب. نهر الحلة، بابل، التلوث.