Journal of Pollution Effects & Control

OPEN ACCESS Freely available online

Research Article

Estimation and Evaluation of the Pollution in the Sediments by Heavy Metals of Bab Suleiman River in the Abo Al-Khaseeb District in Basra-Iraq

Mustafa F. Hameed[1]*, Wissam A. Abdullah[1], Riyadh A. Abdul Hameed[1], Hameed F. Hameed[2]

[1]*Ministry of Education - Basrah Education Directorate, Basrah, Iraq*

[2]*Ministry of oil, Iraqi Drilling Company, Basrah, Iraq*

ABSTRACT

The research dealt with the estimation and evaluation of toxic sediments by heavy metals in the of Bab Suleiman river in Abi Al-Khaseeb district in Basra Governorate – Iraq. The study included four sites along the river. The sediments were digested according to the Milestone method using microwave Technique. For the purpose of concentration level of heavy metals, atomic absorption spectrometry (AAS) was used for four elements (lead, Cadmium, Chromium, Copper) and their direct impact on human health was studied. In general, the results showed that the concentrations of metals were Pb > Cd > Cr > Cu. The contamination factor (CF) was determined for each heavy metal and it was found that the sediments of the P1 and P3 sites were moderately contaminated with lead, and that all the sediments of Bab Suleiman river were polluted with cadmium. Contamination was determined in the sediments of the Bab Suleiman river through statistical analysis of the concentrations of heavy metals and it was found that the site P1 is polluted with all these elements, where the value of the PLI is greater than one, and it was showed that the quality of sediments is slightly polluted in the sediments of the sites P1 and P3 according to the PN index compared to the sediments of sites P2 and P4 which has careful sediments and is likely to become contaminated in the event that the causes of pollution continue, and this is a dangerous healthy indication for the local population near the river because the river water is used for washing and cooking, as well as the fish in which it is considered a food source.

Keywords: Pollution, Aby-AlKhaseeb, Basrah, Heavy Metal, Lead, Cadmium,

INTRODUCTION

Toxic heavy metal is any metal with a relatively high density and shows potential toxicity according to the declaration of the World

Health Organization [1]. Toxic effect on the environment and animal, plant and humans [2]. There are international health concerns related to environmental pollution with these heavy metals. Where these elements showed great exposure to humans clearly due to their wide use in many industrial and agricultural facilities and household purposes [3].

Heavy metals are deposited into land or water either through natural Factors such as soil corrosion, natural corrosion of the earth's Surface, as well as through human actions such as Industry, industrial effluents, and sewage [4]. Most abundant elements in Sewage are Pb, Cd and Cr, which have health risks to humans and the environment [5]. Sediments have real indicators of pollution in aquatic environments when they are polluted with different kinds of toxic and dangerous compounds, as well as heavy metals. It is deposited in the sediments through many different paths, for example, the disposal of liquid waste, and water carrying chemicals arising from many industrial and agricultural efficacy, and atmospheric sedimentation [6].

And due to the lack of plans to treat sewage water in Iraq, as well as human effluents, which are often discharged directly to rivers so this case, lead to a wide increase in the concentration of pollutants in rivers, and consequently these elements stick to the sediment particles and are finally deposited in them [7-9] These minerals are of great importance for the performance of many vital mission in humans and plants when they are in little concentrations, and quickly turn harmful when they become high concentrations are

***Correspondence to**: Mustafa F. Hameed, Ministry of Education - Basrah Education Directorate, Basrah, Iraq E-mail: Mustafafadil837@gmail.com

Received: October 02, 2021;Accepted: November 25, 2021;Published: December 02, 2021

Citation: Hameed MF, Abdullah WA, Abdul Hameed RA, Hameed HF (2021) Estimation and Evaluation of the Pollution in the Sediments by Heavy Metals of Bab Suleiman River in the Abo Al-Khaseeb District in Basra-Iraq. J Pollut Eff Cont 9:277. doi: 10.35248/2375-4397.20.9.277.

higher than what is stipulated in the recommendations of the World Health Organization or the Food and Health Organization, for example, they can affect the CNS and thus lead to psychosis, and disintegration of blood components and may lead to mutations to the lungs, liver, kidneys and the emergence of possible diseases, conditions and the accumulation of these minerals for a long period of time in the body may slow down the degenerative processes of physical, muscle and nervous that mimic some Mental illness [10].

And repeated contact for a longer period with these metals or similar may lead to harms in nucleic acids, gene mutations, restricting the work of hormones and thus inhibiting the work The work of vital functions, and ultimately lead to the appearance of tumors in the body [11]. Also, heavy metals can be transferred to humans through absorption through the skin as well as through direct contact with the soil [12]. When heavy metals arrive to inside human body, they gain a proton through the acidic medium of the stomach. And it turns into different oxidation states as it can easily bind with vital molecules inside the body to form stable bonds. The heavy metals interact with are the thio-groups of the amino acids such as cysteine and methionine. Cadmium shows potent inhibition of human thioredoxin reductases and glutathione reductase by binding to cysteine [13]. Heavy metals also affect proteins and this was first noted when it was shown that cadmium and lead actively react to formation chemically denatured proteins. [14]. Heavy metal also works on protein deposition, as protein deposition was observed when exposed to arsenic, depending on the concentration [15].

The current study is on identifying heavy metals in unspecified locations of the Bab Suleiman Sediments River, and to determine the level and degree of pollution for these sediments through reliable statistical analyzes.

MATERIALS AND METHODS

Collection and preparation the sediments

Sediment were collected from four sites from the Bab Suleiman River, with one sample for each site (P1: the confluence of the river with the Shatt Al-Arab, P2: near the Jaikur bridge, P3: near the Bab Suleiman bridge, P4: near the Bab Tawil bridge) and as shown in the (Figure 1), on August 17, 2021, samples were taken from a level of 35-50 cm below the surface of the water and was kept in plastic containers and dried for 10 days under the shade and then ground by a mechanical grinding machine and then sifted well to become a powder Very fine and stored in clean plastic containers at a temperature of 4 ° C.

Digestion of samples

The four samples were digested by using the microwave device manufactured in the laboratory according to the Milestone method, where 7 ml of HNO3 con. was added to the sediment and digested for 10 minutes in microwave, then 2 ml of H2O2 was added and heated again by the microwave for 15 minutes, the samples were left to cool and then distilled water was added and full volume was added to 20 ml, filtered and kept at 4 °C [16]. Heavy metals are estimated: Pb, Cd, Cu and Cr by Atomic Absorption spectrometry (AAS) at the marine sciences centre at the University of Basra.

Determination of contamination factor (CF)

Based The pollution factor (CF) was used to determine the level of heavy metal pollution in each of the study sites of the Bab Suleiman river using the following equation [17]:

CF=Cs/Cb

Figure 1: Map of sediment sample collection from Bab Suleiman River.

Where Cs is the heavy metal concentration in the sediment, Cb is the natural background concentration of heavy metal. CF was proposed as an indicator classified into four classes to monitor the contamination of sediments with one heavy metal during a period of time [18]. As shown in (Table 1).

Pollution load index (PLI)

The pollution load index (PLI) is used to determine and evaluate the quality of sediments (PLI). The pollution index was calculated for each of the study sites in the Bab Suleiman River according to the following equation [19]:

$CF_n \backslash n....CF_3 \times CF_2 \times \ PLI=CF_1$

Where CF1 is the concentration of the first metal, CF2 is the concentration of the second metal, CF3 is the concentration of the third metal, CF_n is the concentration of the n metal, and n is the total number of studied heavy metals in the sample. If the value of PLI=0 indicates that the sediment is good and there is no effect of heavy metals on it, if the value of PLI = 1, it indicates that the sediment is contaminated [20].

Pollution nemerow index (P_N)

P_N was used as an integrated indicator to assess pollution in sediments with heavy metals, according to the following equation [21]:

$$P_N=\sqrt{(\overline{CF^2} + CFmax^2)}\backslash 2$$

Where $\overline{CF}$ is the average of the polluting factors for the heavy metals that have been studied and CF max is the maximum limit for the metal polluting factor in the sample. The sediment quality was classified into five ranges indicated as in (Table 2) [22]:

RESULTS AND DISCUSSION

The study was carried out at four sites, where site P1 represents the end point and confluence of Bab Suleiman river with the Shatt Al-Arab, site P2 is located Jaikur bridge, site P3 is located near Bab Suleiman Bridge and site P4 is located near Bab Tawil bridge. The results indicate that the sediments contained heavy elements in different concentrations, as shown in (Table 3), their concentrations in units of mg/Kg for each site [23].

According to the above table, it was found that the concentration of lead reached its peak at the first site at the confluence of the river with the Shatt Al-Arab, where it reached 24.11 mg/Kg. A recent study in the year 2020 showed that the Shatt Al-Arab sediments are contaminated with lead, with the highest value in one of its sites reaching 63.5 mg/Kg [24].

This means that the source of lead in the Bab Suleiman River is from the Shatt Al-Arab, and it is likely that it is the result of industrial activities such as the nearby cars wash stations. The concentration of lead at (P_1) is a matter of concern as it approaches the lowest level of influence of LEL on pollution, which means that over time or during certain seasons it may rise and the river becomes very contaminated with lead, and this constitutes a dangerous health phenomenon for the residents who are near the river, as They use it for domestic washing purposes, for agriculture, and for animals as well, including fish in the river, which is a food source.

It was found through the results that the concentration of the heavy element cadmium in the sediments of the four sites also reached its peak at the first site (P_1) at the confluence of the river with the Shatt Al-Arab, where it reached 0.2664 mg/Kg and at the second site (P_2) 0.1928 mg/Kg. The more it is moved away from the Shatt Al-Arab, its concentration will gradually decrease, and its value is considered at the first location (P_1) is half of the effective threshold level (TEL).

The results in (Table 3) showed that the concentration of chromium in the four sites (P_1, P_2, P_3, P_4) also reached its peak at the first

Table 1: Indicators of sediment pollution by pollution factor.

CF Value	Contamination factor
less than 1	less pollution
between 1 and 3	Medium pollution
between 3 and 6	big pollution
greater than 6	very high pollution

Table 2: Indicators of sediment pollution depending on the value of PN.

Precipitation quality	PN value
safe deposit	PN < 0.7
Caution sediment	0.7 ≤ PN < 1.0
Slightly contaminated precipitate	1.0 ≤ PN < 2.0
Medium polluted sediment	2.0 ≤ PN < 3.0
Seriously contaminated sediment	PN > 3.0

Table 3: Concentrations of heavy metals in sediments of Bab Suleiman River.

Heavy Metal	Concentrations in mg\Kg					
	P_1	P_2	P_3	P_4	Threshold effect level (TEL)[23]	Lowest effect level (LEL)[23]
Pb	24.11	5.474	21.634	12.772	35	31
Cd	0.2664	0,1928	0.1826	0.1618	0.596	0.6
Cr	13.48	1.416	4.468	4.904	37.3	26
Cu	19.188	5.494	9.876	5.044	35.7	16

site (P_1) where it reached 13.48 mg/Kg and at the fourth site P_4 4.904 mg/Kg. It is less than the value of the lowest effective level of chromium according to the recommendations of the World Environment Protection Organization, which recommended that 26 mg/kg be the lowest concentration of chromium in the sediment [25, 26].

The results in (Table 3) showed that the concentration of copper also reached its peak at the first site (P_1), where it reached 19.188 mg/Kg, and at the third site near Bab Suleiman Bridge (P_4) 9.876 mg/Kg, the source of copper in the river as a result of throwing copper pipes, wires and tools cooking copper and others, as well as a result of industrial waste from the branches of this river, the concentration of copper in the sediments of the Bab Suleiman river was higher than the lowest effective level according to the recommendations of the World Environment Protection Organization, which recommended that the lowest concentration of copper in the sediments is 16 mg/Kg. Copper ions in the help Configure ROS which can participate in vital redox reactions, where Cu^{2+} can be reduced by the oxidizing agent glutathione or vitamin C to Cu^{1+}, and this last ion is able to catalyse the dissolution of hydrogen peroxide to form OH hydroxide through the reaction follows:

$$Cu^{1+}+H_2O_2 \rightarrow Cu^{2+}+OH\cdot+OH^-$$

Hydroxyl free radical can interact with many biomolecules in the human body. Where it was noted that it works to cause breaks in the DNA strands and oxidize the nitrogenous bases [26]. The in vivo studies also showed that copper does not oxidize copper-induced low density lipoprotein (LDL) inside the body, but it showed in vitro copper oxidation of this LDL lipoprotein [27].

The pollution factor (CF) was determined in the studied sites of the Bab Suleiman River, and it is assumed that these target sediments are free from heavy metal pollution, being a source for the population in the city of Abi Al-Khasib, CF was proposed as an indicator classified into four categories to monitor heavy metal pollution as in (Table 1), the results showed as in (Table 4) that the pollution factor was greater than 1 for lead in P_1 and P_3, which means that the pollution is moderately in the sediments of the river site near the Shatt Al-Arab, as well as near the Bab Suleiman Bridge and the sediments of the site P_2 and P_4 It has a low degree of pollution, and lead is one of the most important factors polluting the aquatic environment and living organisms, especially since the degree of pollution is medium due to the lead element. One of the symptoms of acute exposure to lead is that it leads to high blood pressure,, kidney weakness and Other diseases that lead to death [28]. Lead is considered a carcinogen and a dangerous substance, as one study suggested that lead works to damage DNA, disrupt disruption of the nucleic acid repair system and the cell tumor regulator gene, and it may work to stop transcription processes by interfering with some proteins with zinc [29].

It was found that all the sediments of the four sites in the Bab Suleiman River are moderately polluted with cadmium, as the pollution factor is greater than 1 in all the sediments of the sites as illustrated in (Table 4). Cadmium has many health effects, including bone damage, and itai-itai disease, which it results in a broken bone, was found to be caused by cadmium pollution in the body [30]. It was also found that cadmium has a high toxicity to the kidneys and is precipitated inside in high concentrations, so exposure to cadmium in higher concentrations can produce a defect in kidney function and disrupt its work in the future [31]. As for the elements copper and chromium, the pollution factor was found to be less than one, meaning that the pollution was little in all the sediments of the four sites.

The results showed, as in (Table 4), that the PLI value was equal to 1 in the P_1 site, which means that this site, which is near the Shatt Al-Arab, is completely polluted due to of the accumulation and deposition of heavy metals in it, that the remaining three sites are not polluted by heavy metals in general, but they are polluted with some elements such as Cd in all sites according to the index (CF). The PLI value is important for assessing and determining heavy metal pollution on sediments, as it serves as an indicator to assess the effects of pollutants in sediments compared to the standard values for each indicator [32].

The results of the Nemerow sediment quality index were shown as in (Table 5), these results are depending on the types of sediments that were placed in (Table 2), it was found that the pollution was to a small degree in the sediments of the site P_1 and P_3, with a value of $1.0 \leq P_N < 2.0$ and that the pollution in the sediments of the site P_2 and P_4 are viable and may become contaminated in the future.

Table 4: CF and PLI for heavy metals in the sediments of Bab Suleiman River.

Position	Contamination factor (CF)				PLI
	Pb	Cd	Cr	Cu	
P1	1.772	1.779	0.136	0.3198	1
P2	0.391	1.285	0.0138	0.0915	0.4453
P3	1.545	1.217	0.0438	0.1646	0.7426
P4	0.912	1.078	0.048	0.084	0.5305

Table 5: Results of the Nemerow Pollution Index (PN) for the sediments of Bab Suleiman River.

Position		CFmax	P_N Value
P_1	0.98745	1.779	1.438
P_2	0.44533	1.285	0.9616
P_3	0.7426	1.217	1.008
P_4	0.5305	1.078	0.8495

CONCLUSION

Pollution occurs in the sediments of the aquatic environment by chemical and natural products and artificial pollutants from industrial materials or human waste. These chemical pollutants have an impact on human health as they are outside the legal limits followed within the instructions of the Environmental Protection Organization. Heavy elements are among the most dangerous toxic chemical pollutants in sediments, and cause a health defect on living organisms and this appears directly or indirectly on humans. Site P1 in Bab Suleiman River, near the Shatt Al-Arab, is completely polluted according to the environmental indicators that have been studied, such as CF and PLI, and it was found that the sediment quality is slightly polluted in the sediments of P1 and P3 sites according to the PN index compared with the sediments of P2 and P4 sites that have cautious and potential sediments. To become contaminated in the near future, in addition, all the sediments of the studied sites in the river are contaminated with cadmium, as cadmium has severe health effects on humans, such as smashing and breaking bones and affecting kidney functions. Despite the importance of some heavy elements in our lives, they have a dangerous impact, due to their inability to decompose by microorganisms, as well as their survival in sediments and their spread farther from the sources of their deposition due to the tides and the decline of water in certain places. The sediments are more than in the water, which makes these sediments dangerous in saturating the waters of the Bab Suleiman River over time with these toxic elements, from which these elements enter to human body and pose a danger to the environment and humans.

ACKNOWLEDGEMENT

All the authors extend their sincere thanks to Assistant Prof. Zuhair A. Abdulnabi at the Center for Marine Sciences, as well as the Prof. Dr. Abbas D. Matter Al-Maliki, who revised the research linguistically.

AUTHORS' CONTRIBUTION

M.F.H.: Sediment collected from river and digested by MAE, H.F.H.: experiments and wrote the article. R.A.A.: designed the article. W.A.A.: Doing statistical analyses. All the authors contributed to reading and approving the article.

FUNDING: AND SPONSORSHIP

Self-funding

CONFLICTS OF INTEREST

There are no conflicts of interest.

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