

GEOCHEMICAL STUDY OF THE TIGRIS RIVER SEDIMENTS IN THE SURROUNDING AREA OF BAGHDAD MEDICAL CITY

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ABSTRACT: Heavy metals contamination of water and soil represents a major environmental threat that is to be monitored on a regular schedule in order to avoid its negative consequences. This study is dedicated to evaluating the water and the soil state in the perimeter of Baghdad Medical City's complex that is located adjacent to the great Tigris River. Water and soil samples were collected from three stations on both sides and middle of the river; upstream, downstream and at the complex's wastewater discharge point to the river. Chemical and atomic absorption spectrophotometer tests have shown that the concentrations of Cd, Pb, and Ni in water and soil are within the permissible WHO limits for all upstream samples, but they increase significantly beyond the complex's wastewater discharge location. Also, Chemical indicators have shown a similar trend for all tested samples in a clear announcement for the possible direct threat to the surrounding environment and residents/benefits, with its main spot at the medical complex, in order to initiate sudden remediation acts.

Keywords: Baghdad Medical City, Geochemistry, Heavy Metals, Water and Soil Analysis.

1. INTRODUCTION

The rivers are considered as an important source to provide potable water for human in the world. Water contamination happens by external matter like chemicals, industrial, biological, or sewage water in case of high quantities which can cause harm to live organisms [1]. However, the sewage waste consisting of many forms of pollution caused by humans, such as organic, non-organic components, radiation, and oil materials as well as biological pollution is thrown directly to the river [2].

Obviously, hospitals generate many types of wastes contains heavy metals in their wastewater. These Heavy Metals may threaten aquatic ecosystem, especially when the wastewater enters the water bodies (i.e. rivers) without treatments [3].

Tigris River is considered one of the important rivers in the world. It springs from the south-East of Turkey. The entire length of the Tigris River from up to the downstream is 1970 km, while the square of its basin is 166755 km² inside the Iraqi region [4].

Most of the geological nature of the Tigris River consists of sedimentary rocks except a small area that has igneous and metamorphic rocks like the ones found in the north and the northeast of the country. In some areas, Tigris River is surrounded by sedimentary of a Quaternary period where the river passes from the southern part of Balad City. These sediments are gravel, sand, and mud covering large areas in the middle and southern area in Iraq [5].

The area of interest is located within the flooding sedimentary plain of the river in the stable shelf of the Arabian Plate. The Tigris River represents the western part of the stable shelf, within the Mesopotamian zone, which it mainly passes the Tigris subzone [6].

The studied section (includes Tigris River) in Baghdad district, extends between Al-Sarafiya Bridge (St. No. 1) and Al-Shuhada Bridge (St. No. 3) passing through Bab Al-Muadham Bridge (St. No. 2) where Baghdad medical city hospitals are located, which it the problem of interest. The river speed is very slow in this area because the mean of the earth surface slope is (0.1 m/km) towards the south, so there is an increase in the sediments on the river sides, especially in the low-velocity intervals [7].

Heavy metals; Cadmium (Cd), Nickle (Ni), and Lead (Pb) are the target of this research due to their effects on the human because of they persist, even in low concentrations, for the long duration until entering into the food chain through Human consumption. The main source of Cd, Ni, and Pb in the environment are mainly derived from anthropogenic activity, which involves vehicles, industry, waste, and wastewater [8].

The objectives of this research are to determine the physical and geochemical characteristics of the water body and substrate, and the effects of the medical wastes when entering without treatments. The results of this paper will highlight and explain the magnitude of contamination in Tigris River due to the anthropogenic activity represented by Baghdad Medical City.

2. MATERIALS AND METHODS:

2.1 Area of Interest

Nine samples of water and six of soil were collected from the Tigris River before the raining season during September / 2016. For the combination of these samples, the Baghdad Medical City surrounding area was chosen. Those samples were taken in depths of approximately 20-30 cm beneath water surface at 7 – 9 AM.

Three stations were selected in this study; the first station located 500 m before Baghdad Medical City complexes (St. No. 1) as control Fig. 1. While the second station represents the medical wastewater discharge into the river (St. No. 2). The third station (St. No. 3) placed 500 m after the second station which is shown in Table 1. Moreover, the soil samples were collected from the same places of water samples excluding the sampling in the middle of the river due to that not possible to reach to the bottom of the river. Samples are prepared after collection according to [9] then analyzed in Atomic Absorption Spectrophotometer (Model: AA 7000 - BG.IBN - H.C.S.L.) in The Central Service Laboratory in College of Iben-Al-Haitham / Baghdad University.

2.2 Samples; collection and preparation

Soil samples were collected from the same locations of the water samples. In Baghdad Medical City surrounding area, the samples are collected 30 – 50 cm under water surface in the shallow sides, while in the middle of the river, the soil could not be sampled. Samples collected from 4 to 5 spots at each location in approximately 10 m². The samples are mixed carefully in a plastic container and then went on to the laboratory. It should be mentioned that the hole samples cannot be analyzed separately because there is no financial allocation for this research.

Physical and chemical analysis of water samples were analyzed for the parameters: pH, Temperature, total dissolved solids (TDS), electrical conductivity (EC) , total hardness (T.H.), calcium, magnesium, sodium, potassium, chloride ,in addition to the heavy metals Pb, Cd, and Ni, as listed in Table 2. As well as, soil samples were analyzed for the same heavy metals (Pb, Cd, and Ni), while the other parameters restricted to Na, K, EC, and TDS as shown in Table 3.

3. Results:

3.1 Cd concentration:

In water samples, values of Cd in the surrounding area of Baghdad Medical City ranged from 0.002 to 0.003 ppm, while the average was 0.0026 ppm, Tables 2. The maximum value was

0.003 ppm in W2L in the station 2 which the reading is in the opposite side from the main discharge of the hospitals Fig. 2A, while the lowest was in the same station next to the discharge area. This apparent conflict may be attributable to the wastewater energy when exiting from the discharge pipes to the river.



Fig. 1: The location of study, illustrates stations No. 1, 2, and 3 sites in the Baghdad Medical Complexes surrounding area, Baghdad, Iraq.

Table 1: Geographic Location of selected water, as well as, soil samples.

N o.	Sample No.	Latitude	Longitude	Station
1.	W1R	33 21 77.0	44 21 94.0	Al-Sarafiya Bridge Station No. 1
2.	S1R	33 21 77.0	44 21 94.0	
3.	W1M	33 21 71.0	44 21 95.0	
4.	W1L	33 21 65.0	44 21 96.0	
5.	S1L	33 21 65.0	44 21 96.0	
6.	W2R	33 20 34.0	44 23 28.6	Bab Al-Muadam Bridge Station No. 2
7.	S2R	33 20 34.0	44 23 28.6	
8.	W2M	33 20 31.0	44 23 25.0	
9.	W2L	33 20 28.0	44 23 21.0	
10.	S2L	33 20 28.0	44 23 21.0	Al-Shuhada Bridge Station No. 3
11.	W3R	33 20 57.9	44 22 85.7	
12.	S3R	33 20 57.9	44 22 85.7	
13.	W3M	33 20 54.6	44 22 90.0	
14.	W3L	33 20 50.0	44 22 87.0	
15.	S3L	33 20 50.0	44 22 87.0	

The values of soil samples are ranged from 0.0021 to 0.0014 ppm with an average of 0.0017 ppm. The highest value was 0.0019 ppm at the station 2 which is the cause of contamination due to hospital sewage water, Fig. 2B. The minimum values were in control station 1, and station 3 (0.0014 ppm), which is about 500 m from the contamination source, Table 3. The increase in the Cd values may be enhanced by the industrial waste that throws in meanwhile in the

river somewhere before the hospitals [10]. In spite of this increase in values was less than the maximally permissible addition [11], but the accumulation may be harmful during the time with highly anthropogenic activities.

The Cd in the hospitals mainly comes from the usage of batteries, dyes, stabilizers for polyvinyl chloride in electronic. Cd is also present as dirt in some products, including phosphate fertilizers, cleansing agent and the compounds of refined petroleum.

As well as the acidity of soil increase the geochemical mobility of Cd [12].

Table 2: Physical and Geochemical Properties for the Water Samples in Studied Area, in addition to heavy Metals, Cd, Pb, and Ni.

No.	Parameter	W1R	W1M	W1L	W2R	W2M	W2L	W3R	W3M	W3L
1.	PH	9.02	8.71	8.44	9.14	8.8	8.52	9.43	8.91	8.62
2.	Temp. (C°)	29	28	30	30	29	29	32	30	31
3.	TDS (ppm)	450	455	450	470	455	465	460	455	460
4.	EC µs/cm	681	644	644	686	695	682	686	669	694
5.	T.H (ppm)	0.351	0.402	0.373	0.445	0.456	0.49	0.478	0.426	0.457
6.	Ca (ppm)	4.247	3.4541	3.3411	3.6655	3.9418	2.6107	3.2811	4.1052	3.1033
7.	Mg (ppm)	3.9362	3.823	3.5094	4.0272	3.8772	3.4465	3.8937	3.8915	3.555
8.	Na (ppm)	249.00	245.00	245.00	251.00	248.00	254.00	256.00	248.00	246.00
9.	K (ppm)	13.00	11.00	20.00	12.00	12.00	17.00	14.00	10.00	10.00
10.	Cl (ppm)	0.1795	0.1825	0.1832	0.2855	0.2594	0.2185	0.2565	0.1987	0.1951
11.	Cd (ppm)	0.0024	0.0027	0.0028	0.002	0.0027	0.003	0.0022	0.0027	0.0029
12.	Pb (ppm)	0.0294	0.0371	0.0371	0.0294	0.0333	0.0371	0.0333	0.0294	0.0333
13.	Ni (ppm)	0.001	0.00	0.0009	0.0085	0.0048	0.0039	0.001	0.001	0.0019

*W means Water Sample.

Table 3: Physical and Geochemical Properties for the Soil Samples in Studied Area in addition to heavy metals, Cd, Pb, and Ni.

No.	Parameter	S1R	S1L	S2R	S2L	S3R	S3L
1.	TDS (ppm)	8760	8780	8710	8700	8260	8710
2.	EC (ms)	279.6	280	244	148.4	405.9	272.4
3.	Na (ppm)	32	21	13	25	12	12
4.	K (ppm)	111	58	64	48	110	58
5.	Cd (ppm)	0.0016	0.0017	0.0019	0.0021	0.0014	0.0017
6.	Pb (ppm)	0.0324	0.0092	0.0402	0.017	0.0518	0.0054
7.	Ni (ppm)	0.122	0.0972	0.0867	0.141	0.182	0.1115

*S means Soil Sample.

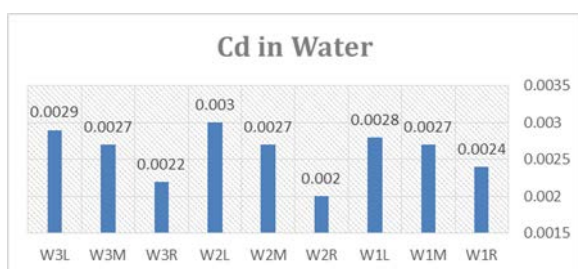


Fig. 2A: the concentrations of Cd in the water samples.

3.2 Pb Concentration:

The values of Pb as shown in Table 2 in water were relatively high in all stations, with mean value of 0.0332 ppm [13]. The highest value (0.0371 ppm) was in the station-1 in the suggested control area in the middle of the river, Fig. 3A. Whereas the lowest (0.0294 ppm) was in the same station but in the side of the medical complexes. The represented Pb high values may indicate the extensive contamination in the surrounding area of Baghdad Medical City, which mainly belongs to the fuel exhaust by automobile. The other sources of Pb are

the batteries, solders, bearings, cable covers, drainage system, dyes, and fillings. This concentration may be deposited to the soil due to precipitation.

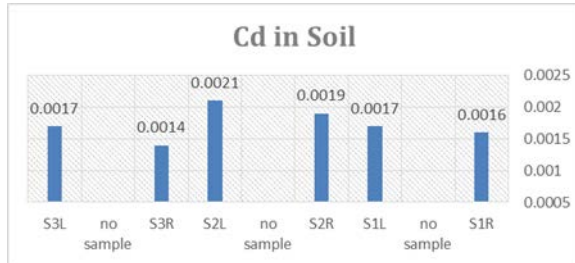


Fig. 2B: the concentrations of Cd in the soil samples.

As well as, the soil samples ranged from 0.0054 to 0.0518 ppm, while the average of those values was 0.026 ppm. As shown in Table 3, the lower values located in the stations 1 and 3, which represent the distance from the source of contamination in the opposite side of hospitals, Fig. 3B. In the next side of the hospitals, Pb concentrations were high, especially after the wastewater discharge area. In-depth, more than 30 cm below the substrate, the concentration of Pb (and of course other metals) may be higher than these values [8]. This fact due to the continuous leaching of river currents to the surface of sediments, especially the river have multiple meandering in this area, which makes the erosion in places is higher than the others, Fig. 1.

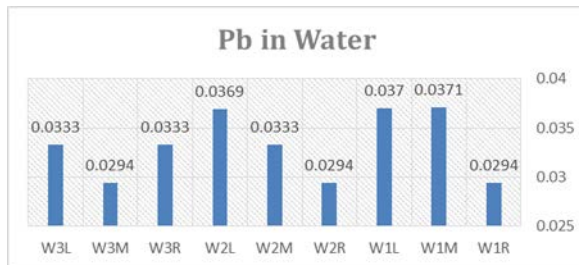


Fig. 3A: the concentrations of Pb in the water samples.

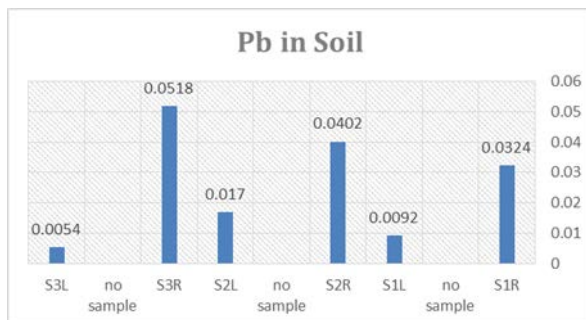


Fig. 3B: the concentrations of Pb in the soil samples.

3.3 Ni concentration:

In water, Ni concentrations were as high as can find in the input of the wastewater discharge area in the next side (0.0085 ppm), and decrease gradually to the middle and then to the opposite side from the river, Fig. 4A. Again, the Ni concentration starts to decrease toward the next station. The values as shown in Table 3 ranged between 0 – 0.0085 ppm, and the average was 0.0026 ppm. However, Ni comes to water from the discharge of wastewater from the hospital complexes. Then Ni adsorbs in the end up to the sediments. Ni is widely used in hospitals, for example in stainless Steels, nickel alloys, and other nickel-containing alloys are used extensively in the medical field. Included in the scope of medical applications are surgical implants, medical tools, healthcare equipment and fixtures, as well as dental tools and implants. Body modification Cosmetic such as body piercing can also be considered as a medical application.

Fig. 4B shows relatively high concentrations in all station sites of study. The values ranged 0.0867 to 0.182 ppm, while the average was 0.1234 ppm. Although all the Ni concentration were below maximum permissible values as shown in Table 3, the concentration is accumulative over time.

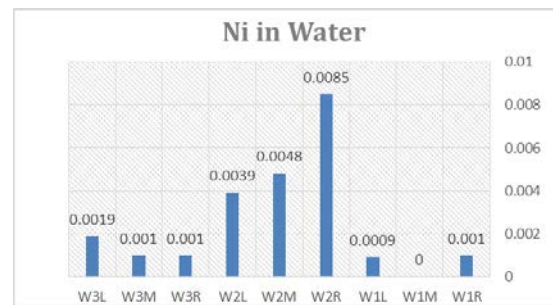


Fig. 4A: the concentrations of Ni in the water samples.

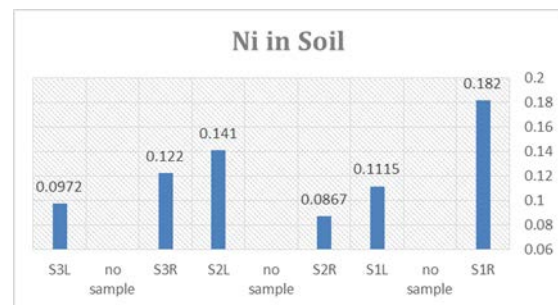


Fig. 4B: the concentrations of Ni in the soil samples.

4. DISCUSSION

Water contamination is unsafe for health, so it is the need to consider the water quality of rivers as this is a very significant problem related to the environment and living organism. This study was directed in order to evaluate the heavy metal contamination of water and soil in the surrounding area of Baghdad Medical City.

For this study, 9 samples of water were composed of the surface water of the river, next to the medical city side, in the opposite side, and in the middle. So, the soil samples were also collected from the shoreline of the Tigris River in the same sides mentioned above. Samples were submitted to the atomic analysis and also for chemical factors as obtained in the tables 2 and 3.

This study revealed that the concentration of all sites was relatively below the maximum permissible values which indicated by WHO [14]. Nevertheless, the values of the element were almost higher after the Baghdad Medical Complexes. This increase in values affected by the leaching of the river currents, therefore, the results become higher in the area of sedimentation than the erosion sides. The increase in the opposite side may be due to the wastewater of Al-Kadhimia discharge pipes, which it considers a huge area in Baghdad city.

The low values may be gradually increased in the near future if the wastewater of the medical complexes before the input to the river was not treated. Otherwise, the sediments in the depth may have more concentration than the surface values [15]. This need for more detailed studies and strenuous efforts to keep the environments in the safe side.

On the other hand, the chemical properties of the water samples in respect of PH, EC, and TDS were higher than the WHO standards, Table 3. WHO normal ranges for pH are 6.5 - 8.5, and as presented in Fig. 5, the studied values ranged 8.44 – 9.43 PH, while the average was 8.84[16].

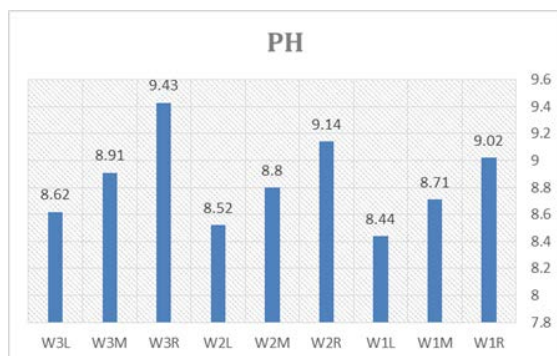


Fig. 5: the values of PH in the water samples.

The EC ($\mu\text{s}/\text{cm}$) in WHO ranges 400 – 600 $\mu\text{s}/\text{cm}$, [17], while the studied samples values

ranged 644 – 695 $\mu\text{s}/\text{cm}$ is shown in Fig. 6A in water. Whereas in soil EC values were within the normal range of WHO except in the station 3 after the wastewater discharge area, Fig. 6B. The data ranged in 148.4 - 405.9 $\mu\text{s}/\text{cm}$, while the maximum value was 405.9 $\mu\text{s}/\text{cm}$ in station 3 in the opposite side of the medical complexes.

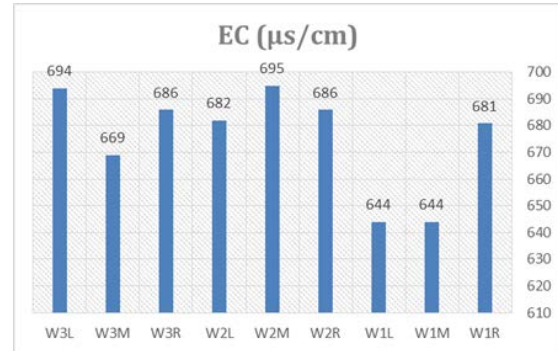


Fig. 6A: the values of EC μs in the water samples.

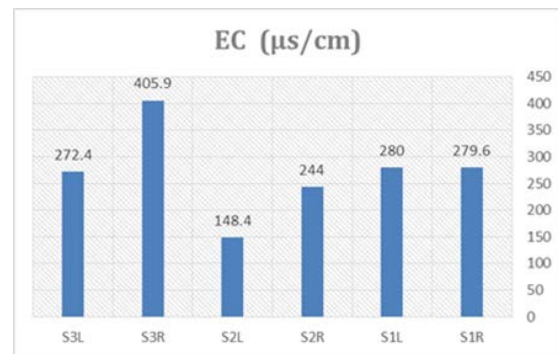


Fig. 6B: the values of EC μs in the soil samples.

Fig. 7A showed the TDS ranges 450 – 470 ppm, while the WHO ranges the normal values between 50 – 250 ppm. So, the soil values ranged in 8260 – 8780 ppm, which indicated high salinity in soil [18].

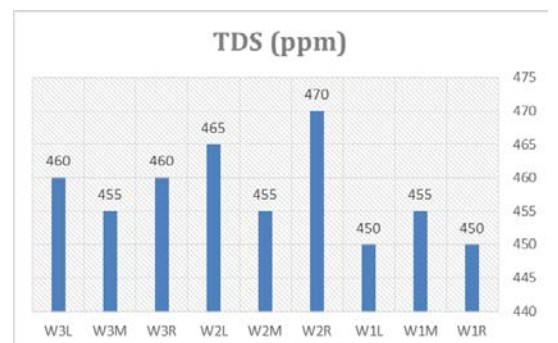


Fig. 7A: the values of TDS (ppm) in the water samples.

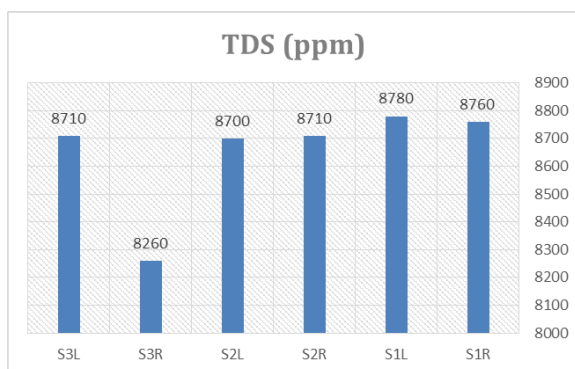


Fig. 7B: the values of TDS (ppm) in the soil samples.

All the chemical parameters (i.e. PH, EC, and TDS) were above the WHO as shown in this research. This increase in values indicates dangerous contamination in water, especially after the Baghdad Medical Complex.

5. CONCLUSIONS

The objective of this investigation was to evaluate the concentration of Cd, Pb, and Ni in the water and soil, as well as chemical parameters like pH, EC and TDS of water in the surrounding area of Baghdad Medical city. The results indicate a high influence of the medical complexes wastewater on the Tigris River quality. This influence might be accumulative in the southern parts which may threaten the human and agricultural crops. In addition, the discharge of wastewater of Al-Kadhimiya is effected the water quality, as well as the soil in the substrate.

6. RECOMMENDATIONS

Researches have to be more details for heavy metals in this site to detect the suitable solutions for this problems, in addition to southern areas may extend to Basra governorate. Those researches should study the effects of heavy metals on human and animals' health. On the other hand, wastewater has to be treated before entering the water body of the river. Finally, the concerned administrative institutions have to pay attention to increase water quality around Baghdad Medical City in respect of all contaminants including heavy metals.

7. ACKNOWLEDGMENTS

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