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ASSESSMENT OF HOSPITAL WASTEWATER QUALITY AND MANAGEMENT IN BAB-AL MUADHAM REGION AT BAGHDAD

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Abstract: The Tigris River is the most important source of water in Iraq; however, it suffers from the impact of pollutants that disposal directly into it. In this study, the Water Quality Index (WQI) of 7 of the chemical properties (Cl-, NO3, SO4, COD, BOD5, Ca, Mg) in the Tigris River, Baghdad, Iraq was analyzed to measure the impact of liquid waste discharge in the city of medicine on the river from January to October 2020. Three points were selected as the sample location, the first point was 700 meters before the discharge point, the second point was the discharge point, and the third point was 400 meters after the discharge point. The findings revealed that the concentration of all the measured components at the region where the sanitary discharge point site2 was situated was much higher than that of the location before the sanitary discharge point site1. For example, in January Cl- the concentration at site1 was (350 mg/l) relative to site2 the concentration at (1200 mg/l). In comparison, the concentration of the constituents in the area after the sanitary discharge point site 3 was lower than that of the sanitary discharge point area site2. In addition, Cl- concentration at site3 was (750 mg/l) lower than site2 (1200 mg/l) but still higher than site1 (350 mg/l). The lower concentration at site3 suggests that the water body of the river is being diluted; however, this is not a solution as the causes of pollutants of the river are various. Most of the findings have shown that the permissible cap for the Iraqi standards and the World Health Organization (WHO) for the river maintenance system has been surpassed.

Keywords: *Tigris River, Wastewater, Medical city, liquid wastes*

1. Introduction

In recent years, increasing attentiveness has been paid to surface waters, wastewaters, and groundwater because of the increased pollutants in it [1]. Wastewater is defined as all water whose quality has been low by anthropogenic influence. This includes liquid waste discharged from the hospital, agricultural, industries, commercial sectors, and domestic homes [2]. The availability of sufficient water in terms of quantity and quality is the main to human existence [3]. The hospitals' wastewater (HWW) is one of the most dangerous which pose dangerous pollutants consider the problem a significant economic and environmental should not be overlooked or neglected. The most serious pollution affecting the water environment is solid and liquid hospital pollutants, and that causes danger to humans, animals, and plants [4]. Hospital wastewater also contains many infectious and dangerous vehicles that result from patient care, as it does not have water treatment units, which drives it to drain its heavy water into the main sewage network, and when it reaches the Tigris River [5]. In Iraq, the Tigris River is the largest and is the main source of drinking water in Baghdad [6]. Any pollution in the water of the Tigris

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River will cause pollution in the waters of the Euphrates because it is connected to it by Tharthar Lake and affects any water source associated with it [7]. Many researchers studied the effect of hospital wastewater on rivers. In a study carried out by Warqa'a N. Ma'alah (2016) [8], the monthly evaluation of the possible effects of wastewater subtracted from Baghdad Medical City hospital has been carried out on Tigris waters Physio-chemical characteristics. These results exceed Iraqi and WHO standards and allowable limits on surface water protection. In a study carried out by Mohamed and Rajab (2017) [5], were studied Three Hospitals from the Medical City in the city of Baghdad, which are the surgery Specialist Hospital, the protection of children, and Baghdad Teaching Hospital. The health liquid waste subtracted from the hospital's wastewater network has displayed an increase in the concentrations of different pollutants which are hurled in the main drainage station in the river. A study carried out by Razzak and Sulaymon (2009) [6], included the distribution of pollutant physicochemical characteristics in the Tigris river between Al-Jumhuria bridge and Al-A'imma bridge. which include four sewage pumping stations without treatment discharged to the river. The results have shown that the concentrations of pollutants were increased at the discharge points in the river. A study carried out by Zahraa (2016) [9], assessed the Water Quality Index based on the Weighted Arithmetic Index to the water quality (WQ) of the Tigris River for drinking purposes. The Water Quality Index was studied based on the concentration of physio-chemical parameters. The calculation of the Water Quality Index showed that the (WQ) of the Tigris river can be classified as very poor and unsuitable conditions in winter and summer respectively. A study carried out by Al-Najar et al. (2017) [10], stated to describe the medical wastewater in Gaza. wastewater from hospitals is disposed to the public network then to central wastewater treatment plants. partly treated effluent is sneak to the groundwater and the some discharged to the sea. The Surgery department registered the highest wastewater pollution. A study carried out by Salih et al. (2018) [11], devoted to evaluating the soil and the water state in the Baghdad Medical City`s complex that is located neighboring to the great Tigris River. Soil and water samples were collected from three stations from the middle of the river and on both sides, at the complex`s wastewater discharge point to the river, downstream and upstream. The chemical indicators showed a clear rise in pollutants, which indicates a great danger to the surrounding environment and humans.

The study aims to determine the level of contamination (Cl-, NO_3, SO_4, COD, BOD_5, Ca, Mg) caused by the discharge of the hospital wastewater in Bab-Al Muadham is a region in Baghdad to Tigris River.

2. Methodology

2.1. Study area

The Medical City in Baghdad is one of the largest health establishments in the capital Baghdad, and it is one of the largest modern hospitals not only in Iraq but also in the Middle East, where it includes a large number of hospitals. Located between Bab Al-Muadham Bridge to the east and Al-Sarafia Bridge to the west. All hospitals and buildings of the complex overlook the side south to ensure that the facades of hospitals and buildings are exposed to sunlight from sunrise to sunset [12]. Hospitals located within a city and medical centers dispose of wastewater directly to Tigris River without treatment, once to twice daily (7 a.m. to 9 a.m. and 6 p.m. to 8 p.m.).

2.2. Samples Collection

Three sites were selected to collect samples from Tigris River near the Medical City, the first is located 700 meters before the wastewater discharged site and the second represents the waste discharged site, and the third is located 400 meters after the discharged site as shown in Fig.1. The sample is taken at a depth (5-15 cm)

from the surface of the water approximately, Samples were collected between (7 and 8) am during the operation of the pump, and for each site, one sample was taken for each month, and the water draining into the river in during the study continued the period from January to October 2020, and because of coronavirus conditions (COVID-19) and the difficulties of accessing the sites, the study was halted for five months.

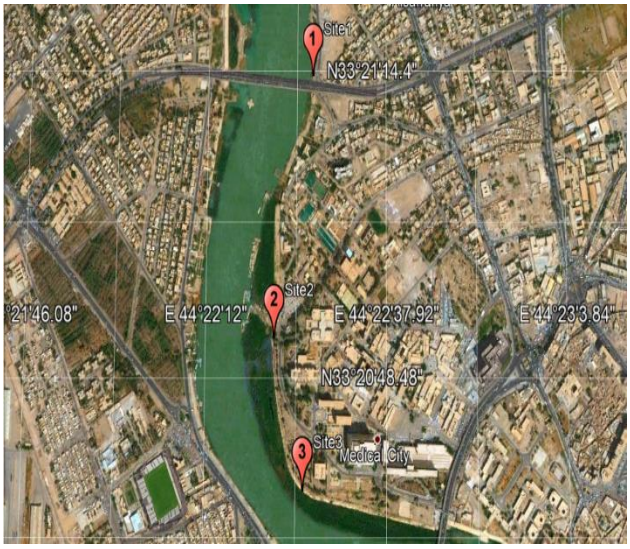

Figure1. Sampling site from the Tigris River: Map from (Google Earth Pro)

2.3. Samples analysis

The collected samples were analyzed for the chemical properties' concentrations (Cl-, NO_3, SO_4, COD, BOD_5) In the laboratory of the Environmental Department, College of Engineering, Al-Mustansiriya University, in the methods shown in Table 1 for January, while (Ca, Mg) and the remaining months were examined in the u-science scientific laboratory in Diwaniyah by Atomic Absorption Spectrophotometer. They were conducted according to the Standard Methods for the Examination of Water and Wastewater. American Public Health Association, American Water Works Association, Water Environment Federation,2017.

Table 1. chemical parameters were examined during the study and the methods.

NO.	Parameters	References
1	Chloride	[13]
2	Nitrates	[14]
3	Sulfates	[15]
4	Chemical Oxygen Demand	[16]
5	Biochemical oxygen demand.	[17]

2.4. Water quality indices

Water Quality Index (WQI) selected according to data availability in this study Table 2 displays the estimates and evaluations of the chosen index. In this analysis, the WQI is calculated by using the weighted arithmetic index method for the concentrations of chemical properties. Many of the parameters evaluated relate to the final value of the WQI. The standard values for the present analysis, Table 3, are taken from the Iraqi stream standard by the criteria of the Iraqi legislation of water sources preservation system number 25 dated 1967.

Table 2. The calculation and evaluation of the selected Index

Index	Parameters	Evaluation	Ref.
$WQI = \frac{\sum QiWi}{\sum Wi}$	WQI: water quality index	WQI < 50: Excellent.0 < WQI < 100: Good	[18]
$Wi = \frac{K}{Vsi}$	Qi: quality rating	100 < WQI < 200: Poor	
$K = 1/\Sigma (1/Vsi)$	Wi: relative weight	200 < WQI < 300: Very poor	
$Qi=\left(\frac{Ci}{Si}\right) * 100$	K: proportionality constant	WQI > 300: Unsuitable	
	Vsi: standard value.		
	Ci: measured value.		

Table 3. Iraqi standard for chemical properties [19]

Element	Iraqi standard (mg/L)
Cl^-	200
NO_3	10
SO_4	200
COD	100*
BOD_5	5
Ca	75*
Mg	50*

*Since there were no standards for these variables in the river standards, the COD was based on the standards of the wastewater and discharged to the water source and on the standard for drinking water for Ca, Mg.

3. Results and discussion

The Water Quality Index (WQI) was applied to the data obtained to assess the water quality by applying the equations mentioned in Table 2 using Excel. Table 4 shows the statistical analysis of the measured parameters and Fig. 2 illustrates the difference in pollution between the sites and the percentage during the study period it shows that the first site was unstable, between excellent, poor, and unsuitable, while the second and third sites were unsuitable throughout the study period.

Table 4. WQI throughout for the present study

Months	Site1	Site2	Site3
Jan.	129.1799	1340.661	173.8038
July	1149.655	6461.471	2238.367
Aug.	34.42418	7210.81	5315.693
Sep.	55.68299	5846.696	2326.078
Oct.	41.43726	6234.207	4099.57

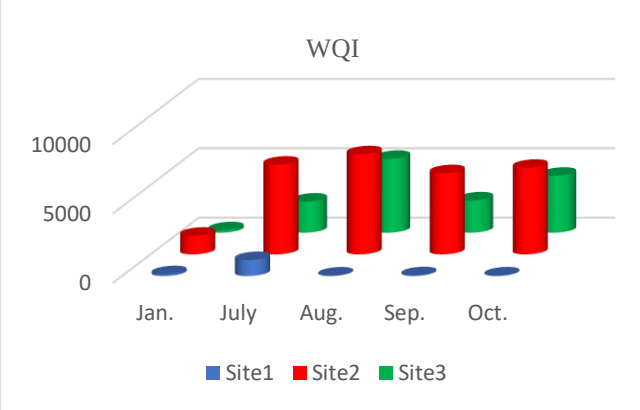

Figure 2. WQI throughout for the present study

The measured items are shown for site 1 mentioned in Table 5 the water is somewhat acceptable. Fig.3 shows the percentage of chlorides, sulfates, and nitrates, the chemical oxygen demand, biochemical oxygen demand, and the ratio of calcium and magnesium in the first site, which precedes the drainage of the medical city, as most of the parameters were within the permissible limits during the study period.

Table 5. Monthly Variations of parameters of Water Samples for site1.

Parameter*	Jan.	July	Aug.	Sep.	Oct.
CL	350	137	58.8	120	84.28
SO_4	258	282	153.75	282	231.12
NO_3	8	4.549	1.776	7.502	6.690
COD	105	150	9	17	10
BOD_5	8	90	1.8	2.6	1.6
Ca	100.8	88	78.4	91.2	89.6
Mg	35.5	43.9	25.3	32.20	35.13

* All values are measured in units (mg/l)

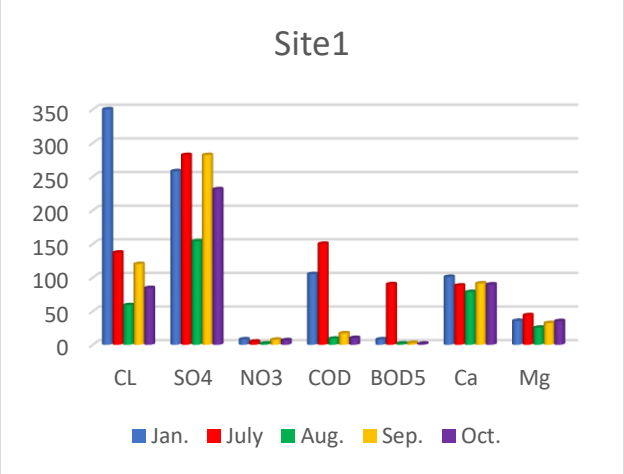

Figure 3. Monthly concentrations of the parameters measured for the site1 during the study period.

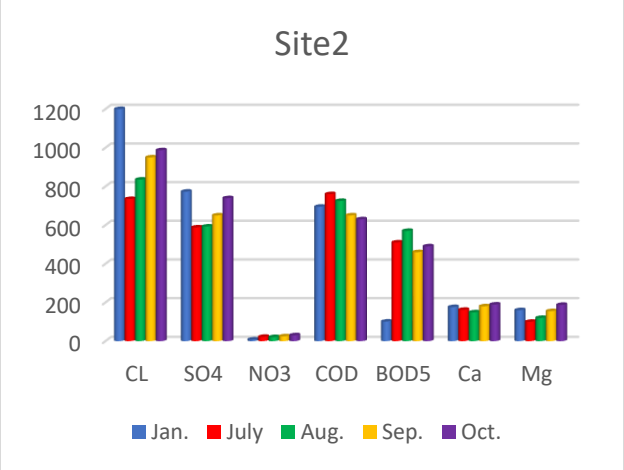

Figure 4. Monthly concentrations of the parameters measured for the site2 during the study period.

While the results of the measured elements for the second site shown in Table 6 and shown in Fig. 4 indicate the amount of pollution resulting from the sewage drainage discharged to the river, where all the parameters exceeded the permissible limits for the length of the study period and the water quality is unacceptable and very poor.

Table 6. Monthly Variations of parameters of Water Samples for site2

Parameter*	Jan.	July	Aug.	Sep.	Oct.
CL	1200	735	835.2	950	987
SO_4	773	588	592.6	650	739.25
NO_3	8.1	22.237	20.687	24.846	30.310
COD	695	760	725	650	630
BOD_5	101	510	570	460	490
Ca	176	162	148.8	180	189.2
Mg	160	100	120	155	187.4

* All values are measured in units (mg/l)

As for the third site, the measured parameters are shown in Table 7 and shown in Fig. 5 showed a slight dilution compared to the second site concentrations, but they remain outside the permissible and unacceptable limits, and this indicates the amount of pollution resulting from the wastewater discharged to the river.

Table 7. Monthly Variations of parameters of Water Samples for site3.

Parameter*	Jan.	July	Aug.	Sep.	Oct.
CL	750	450.8	558.7	650	850.8
SO_4	316	468	490.9	578	662.32
NO_3	2	10.992	14.460	22.304	28.228
COD	153	280	550	430	509
BOD_5	11	175	420	180	320
Ca	120	130	139	152	182.4
Mg	110	99.6	100	109	180.03

* All values are measured in units (mg/l)

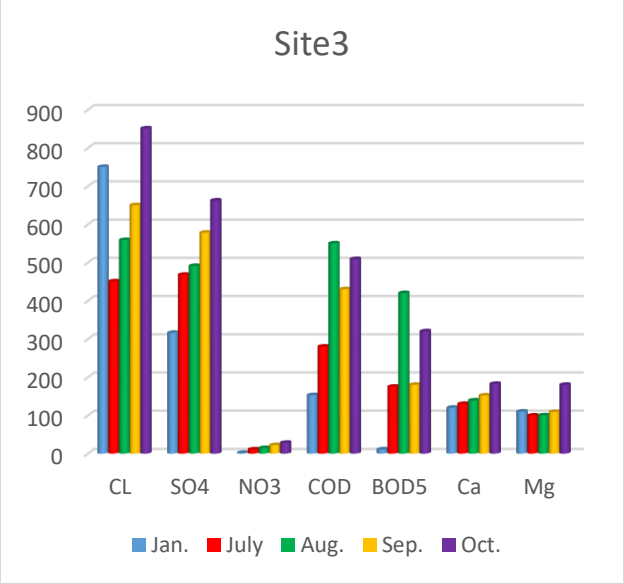

Figure 5. Monthly concentrations of the parameters measured for the site3 during the study period.

4.Conclusion

The results showed that the wastewater affects the quality of the Tigris River, as it was mostly above the natural limits of the water supplies by measuring some chemical properties for the wastewater discharged to the river from the city of Medical city hospitals. These pollutants are a source of worry for water bodies as they are the main source of water for humans, animals, and plants.

5. Recommendations

1-Monitoring wastewater treatment plants effectively monitoring.

2-Measuring pollutants are released to the river periodically to ensure the efficiency of the plant's work.

3-Using disinfectants and chemicals to treat less polluted wastewater.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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