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Evaluation of Irrigation Water Quality Index for Tigris River and Pollution Levels of Heavy Metals in Baghdad.

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ABSTRACT

This research was contented to use Irrigation Water Quality Index to classify Tigris River for city of Baghdad and pollution by heavy metals. Four sites were chosen along the Tigris River in Baghdad,(Taji, Gherai'at, Doura and Jisr Diyala). Water samples were taken from October 2017 to June 2018,one sample per month. The result of Irrigation Water Quality Index for Gherai'at, Taji and Doura showed that highest values were(77.63,77.43and77.36)respectively, and the lowest valueswere (72.58, 72.03and 64.87)respectively. However, it's were Low restriction (S2) while Jisr Diyala site was a highest value is 47.97 and the lowest value 38.31, however it were between Moderate restriction (S3) and High restriction (N1). Also the results showed that heavy metal pollution by Lead (Pb^{2+}) and Zinc (Zn^{2+})were within the maximum limits, it were highest values 3.310and 0.92mg.L^{-1} respectively, on the other hand Cadmium (Cd^{2+}) and Nickel (Ni^{2+}) werelowest values 0.127 and 0.211mg.L^{-1}have the advantage in terms of the permissible limits set by WHO.

Keyword: IWQI, WHO, Pollution, Heavy Metals, Evaluate.

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INTRODUCTION

Water is essentials for life on the Earth,considered the most important element that must be preserved. The Tigris River is the artery of life in Baghdad,Which divides it into two parts.Connected parts through bridges distributed along the river.Tigris River is the main source for the irrigation of orchards which are scattered on both sides. Know-days, the river is undergoing a problem which is hard to be solved, among the problems are, pollution by wastewater resulted from household wastes, factory water wastes, using chemical substances such as: pests and herbicides and agriculture fertilizers (1).Several environmental violations have been recorded with the Iraqi Ministry of Environment which issome areas discharge sewage and household wastes into rainwater networks directly without treatment. The sewage system in the city of Baghdad is divided into two, system a separated system and a combined system that distributed on both sides of Baghdad Karkh and Rusafa(2).Heavy metals are non-degradable and cause damage to various organisms even though they are low concentrations (3). Heavy metals enter the food chain through absorption by the plant and then into the animal and human (4). The utilization of degraded quality waters in irrigation has been the main cause for the deterioration of the quality of soils and the agricultural yields grown on such soils (5). The quality of the irrigation water has to be evaluated to avoid, or at least, to minimize impacts on agriculture (6). There are several methods in assessing the quality of irrigation water, but the Irrigation Water Quality Index IWQI is the best and their results are much better than other methods,especially when there low evidence along being low in weightmoreover low-value and high-weight evidence(5). Irrigation Water Quality Index (IWQI) is an expression used for identifying water quality, in a certain location and time, an the basis of many water quality standers (7). It is a numerical term used to convert a large number of data into one number, which represents the level of water quality (8). The concepts of this index represent the water quality, it was first proposed byHorton(9).

So far, many researches and projects have been conducted to measure surface water quality index. Shihab and Al-Rawi (10) and Al-Hussain (11) they all used water quality index (WQI) as a management tool for water quality of Tigris River within Mosul city for different uses. Numaan (12) established irrigation WQI for Tigris River between Al-Sharqat and Alboajeel in Iraq.Rasul and Waqed (7) use theEvaluation of Irrigation Water Quality Index (IWQI) for Al-Dammam Confined Aquifer in the West and Southwest of Karbala City, Iraq.Saloom and Oleiwi (13) have used IWQI to EvaluateIraq's main water quality. The purpose of present study isof Evaluate of Irrigation Water Quality Index for Tigris River and Pollution Levels of Heavy Metals Pb^{2+}, Cd^{2+}, Zn^{2+} and Ni^{2+} in four sites(Taji, Gherai'at, Doura and Jisr Diyala) in Baghdad.

MATERIAL AND METHODS

Study area:

The study area is located in central Iraq, Baghdad, from north to south of Baghdad in table (1) of the four sites as shown in Figure (1).

Table 1: sampling geographical location

No.	Location	Geographical location	
		latitudes	longitudes
1	Taji	33° 40.522	44°33.889
2	Gherai'at	33° 42.878	44°34.373
3	Doura	33° 28.365	44°37.555
4	Jisr Diyala	33° 23.343	44°45.649

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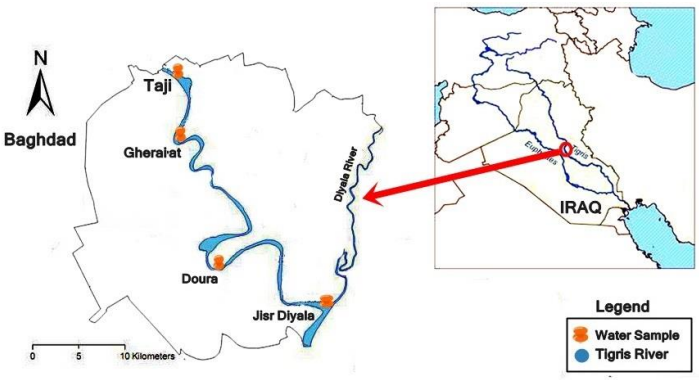

Figure 1: Sampling sites, Baghdad, Iraq

Water samples:

Water samples were collected from these four sites in Baghdad for the period ofOctober2017 to June 2018. Water samples were taken from the center and banks of the Tigris River, it were collected in 500 mL plastic bottles.

Chemical water analysis:

$$SAR = \frac{Na^{1+}}{\sqrt{(Ca^{2+} + Mg^{2+})/2}}$$

Water samples were taken to the laboratory for chemical analysis,after filtering the impurities by using whatman filter paper (No.42).Measurements included Electrical Conductivity (EC), pH andtheconcentrations ofCl^{1-}, CO_3^{2-}, and HCO_3^{1-}, they were determined due toRichards(14). Concentration of Ca^{2+} and Mg^{2+} were determined due toBlack (15). The concentrations of Pb^{2+}, Cd^{2+}, Zn^{2+} and Ni^{2+} were determined using AAS(Atomic AbsorptionSpectrophotometer)due toJones(16) andConcentration of Na^{1+} and K^{1+}using (Flam photometer)due toRichards(14). Values of SAR were calculated using the equationsuggested byRichard(14):

Irrigation Water Quality Index (IWQI):

Irrigation water has been classified according to its suitability for irrigation, as shown in Table (2).After the implementation of a computer program to evaluate of Irrigation water Quality Index (IQWI) designed in Java Script by Saloom and Oleiwi(13)Figure 2.

Table 2: Irrigation Water Quality Index Classified (3)

No.	IWQI	Water use restrictions	class
1	>80	No restriction	S1
2	80 – 60	Low restriction	S2
3	60 – 45	Moderate restriction	S3
4	45 – 30	High restriction	N1
5	30<	Severe restriction	N2

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Figure2:IWQI interface designed in Java Script(13)

Figure3: Contamination of the waters of the Diyala River, one of the tributaries of the Tigris River, the site of Jisrdiyala, Rustamiyah

RESULT AND DISCUSSION

Evaluation of Irrigation Water Quality Index:

The results showed that highest values of IWQI were recorded in April 2018 (77.63, 77.43, 77.36 and 47.97) in the site of Gherai'at,Taji, Doura and Jisr Diyalarespectively due to the increase in river water level that lead to a decrease in water salinity and concentration of pollutants, and the lowest valueswere recorded in June2018 (38.31, 64.87, 72.03 and 72.58) in the site of Jisr Diyala, Doura,Taji and Gherai'atrespectively,due to thereduction inriver water level of the Tigris River after the activation of Ilisu dam in Turkey, along with the high temperature of the summer and evaporation rate,led to a high salinity in the Tigris River moreover the concentration of pollutants,as shown in figure 4. Also, result showed that Irrigation Water Quality Index for Taji, Gherai'at and Doura were within the Low restriction (S2), As a result of the water pollution of the Tigris with cadmium (figure 6), the water quality index has been reduced. The site of Jisr Diyala was betweenModerate restriction (S3) and High restriction (N1)because the water of the Tigris River in Jisr Diyalahas a problem of pollution with heavy metals Cd and Ni (figure 6, 8).

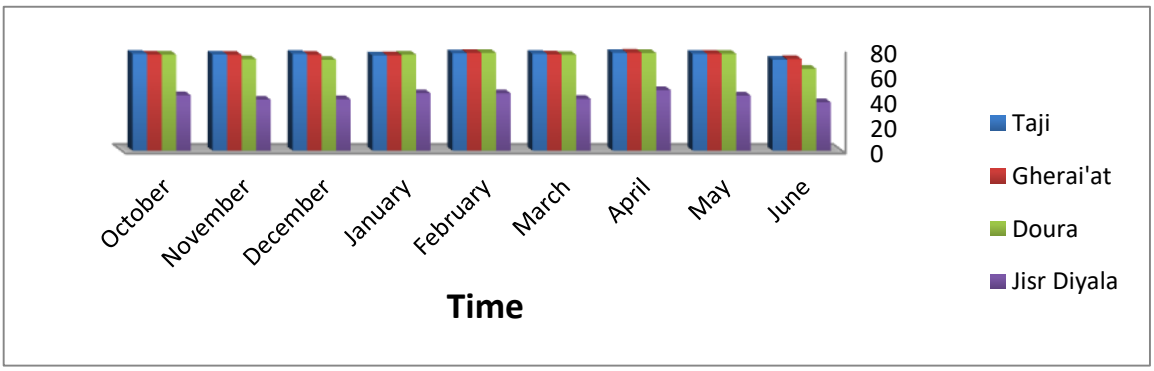

Figure 4: Irrigation Water Quality Index of Tigris River in Baghdad

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Concentration of chemical parameters and heavy metals in irrigation water:

In four sites, results showed that highest mean values of pH were 7.07 in Gherai'at and Doura, as shown in table(4,5),and the obvious lowest was recorded inJisr Diyala6.80 as shown in table(6). Also, it was from table (6) that the highest mean value ofEC was 1.24dS.m^{-1} inJisr Diyala. Table (3) shows that the lowest value was recorded inTaji 1.10dS.m^{-1} as shown in table(3). Table (6) shows that the highest mean values of SAR were recorded in Jisr Diyala 0.58meq.$L^{-1/2}$(Table 6)andlowest was recorded inTaji 0.46meq.$L^{-1/2}$. However, the mean values of pH, EC and SAR in irrigation werewithin therecommended level, used for irrigating agriculture yields(5).

Table 3: Results of chemical analysis of Tigris River water in Baghdad, Taji

Time	Parameter									
	Ca^{2+} $meqL^{-1}$	Mg^{2+}meq L^{-1}	Na^{1+}meq L^{-1}	$K^{1+}$$meqL^{-1}$	$Cl^{1-}$$meqL^{-1}$	CO_3^{2-} $meqL^{-1}$	$HCO_3^{2-}$$meqL^{-1}$	EC dSm^{-1}	pH	SAR meq.$L^{-1/2}$
October	5.81	3.60	1.01	0.29	8.82	Nil	0.81	1.00	7.00	0.46
November	5.75	3.56	0.87	0.32	7.14	Nil	0.83	1.09	7.02	0.40
December	5.77	3.60	0.97	0.22	7.97	Nil	0.80	1.01	7.06	0.44
January	6.09	3.72	1.07	0.33	7.87	Nil	0.73	1.20	7.01	0.48
February	4.92	3.12	0.91	0.45	6.20	Nil	0.70	0.94	7.00	0.45
March	5.10	3.33	1.08	0.30	7.89	Nil	0.80	1.00	7.03	0.52
April	4.78	3.07	0.81	0.40	6.24	Nil	0.81	0.90	7.01	0.41
May	5.13	3.40	1.00	0.38	7.70	Nil	0.81	1.01	7.30	0.48
June	6.31	4.17	1.23	0.21	9.91	Nil	1.05	1.71	7.02	0.54
Mean	5.52	3.51	0.99	0.32	7.75	Nil	0.82	1.10	7.05	0.46

Table 4: Results of chemical analysis of Tigris River water in Baghdad, Gherai'at

Time	Parameter									
	Ca^{2+} $meqL^{-1}$	Mg^{2+}meq L^{-1}	Na^{1+}meq L^{-1}	$K^{1+}$$meqL^{-1}$	$Cl^{1-}$$meqL^{-1}$	CO_3^{2-} $meqL^{-1}$	$HCO_3^{2-}$$meqL^{-1}$	EC dSm^{-1}	pH	SAR meq.$L^{-1/2}$
October	5.91	3.30	1.72	0.51	9.03	Nil	0.88	1.10	7.01	0.80
November	5.83	3.30	1.60	0.65	7.77	Nil	0.85	1.12	7.00	0.75
December	5.71	3.43	1.62	0.52	8.46	Nil	0.83	1.12	7.04	0.76
January	6.01	3.18	1.07	0.44	9.11	Nil	0.82	1.18	7.09	0.49
February	4.88	3.08	0.87	0.60	6.63	Nil	0.68	0.90	7.06	0.44
March	5.41	3.29	1.31	0.45	8.88	Nil	0.85	1.08	7.01	0.63
April	4.10	3.00	0.80	0.51	6.56	Nil	0.70	0.87	7.00	0.42
May	5.21	3.31	1.23	0.40	7.89	Nil	0.84	1.01	7.17	0.60
June	6.10	4.53	1.77	0.32	10.76	Nil	0.90	1.62	7.27	0.76
Mean	5.46	3.38	1.33	0.49	8.34	Nil	0.82	1.11	7.07	0.63

Table 5: Results of chemical analysis of Tigris River water in Baghdad,Doura

Time	Parameter									
	Ca^{2+} $meqL^{-1}$	Mg^{2+}meq L^{-1}	Na^{1+}meq L^{-1}	$K^{1+}$$meqL^{-1}$	$Cl^{1-}$$meqL^{-1}$	CO_3^{2-} $meqL^{-1}$	HCO_3^{2-} $meqL^{-1}$	EC dSm^{-1}	pH	SAR meq.$L^{-1/2}$
October	6.52	4.51	1.21	0.30	10.11	Nil	0.80	1.10	7.03	0.52
November	5.88	4.00	1.47	0.44	9.13	Nil	0.85	1.10	7.11	0.66
December	6.42	4.31	1.30	0.35	9.64	Nil	0.81	1.20	6.91	0.56
January	5.80	3.89	1.12	0.41	10.10	Nil	0.87	1.10	7.20	0.51
February	5.01	4.24	1.01	0.51	8.14	Nil	0.64	0.94	7.20	0.47
March	5.55	3.97	1.23	0.40	10.01	Nil	0.83	1.13	7.00	0.56
April	4.81	3.16	0.92	0.54	7.11	Nil	0.73	0.91	7.02	0.46
May	5.42	3.91	1.28	0.51	9.12	Nil	0.87	1.00	7.09	0.59

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June	7.50	5.19	1.80	0.33	10.65	Nil	0.97	1.73	7.05	0.71
Mean	5.88	4.13	1.26	0.42	9.34	Nil	0.82	1.13	7.07	0.56

Table 6: Results of chemical analysis of Tigris River water in Baghdad,Jisr Diyala

Time	Parameter									
	Ca^{2+} $meqL^{-1}$	Mg^{2+} meq L^{-1}	Na^{1+} meq L^{-1}	K^{1+} $meqL^{-1}$	Cl^{1-} $meqL^{-1}$	CO_3^{2-} $meqL^{-1}$	HCO_3^{2-} $meqL^{-1}$	EC dSm^{-1}	pH	SAR $meq.L^{-1/2}$
October	7.00	4.32	1.30	0.42	11.53	Nil	0.98	1.20	6.75	0.55
November	6.01	4.22	1.91	0.52	11.20	Nil	0.90	1.31	6.98	0.84
December	6.57	4.51	1.73	0.49	11.40	Nil	0.88	1.24	6.96	0.74
January	7.11	4.07	1.21	0.50	10.61	Nil	1.01	1.25	6.61	0.51
February	6.12	4.36	1.12	0.40	8.88	Nil	0.71	1.10	6.69	0.49
March	6.83	4.98	1.31	0.46	10.45	Nil	0.92	1.19	6.96	0.54
April	5.00	3.23	0.95	0.38	7.26	Nil	0.84	0.97	6.57	0.46
May	5.57	3.9	1.30	0.57	10.02	Nil	0.95	1.07	6.83	0.60
June	7.13	5.91	1.21	0.40	11.60	Nil	1.21	1.80	6.87	0.47
Mean	6.37	4.39	1.34	0.46	10.33	Nil	0.93	1.24	6.80	0.58

In this study,the highest concentration of Pb^{2+}, Cd^{2+}, Zn^{2+} and Ni^{2+}were 3.3101, 0.12,0.1921 and 0.211 $mg.L^{-1}$respectively, in Jisr Diyala at June2018 as shown in figure(5,6,7,8),due to wastewater is being dumped directly into the river without treatment (figure3). Concentration of Pb^{2+} and $Zn^{2+}$was within the maximum limits, but $Cd^{2+}$and Ni^{2+}were above the maximum limits in comparison with the WHO (17). It's obvious from figure (5,6,7,8) thatThe highest concentrations of Pb^{2+},Cd^{2+},$Zn^{2+}$and Ni^{2+}were in June2018 because of thea decrease in the level ofTigris Riverafter the activation of the Turkish Ilisu dam along with increase the summer in temperatures and the average evaporation while continuing to throw wastewater.

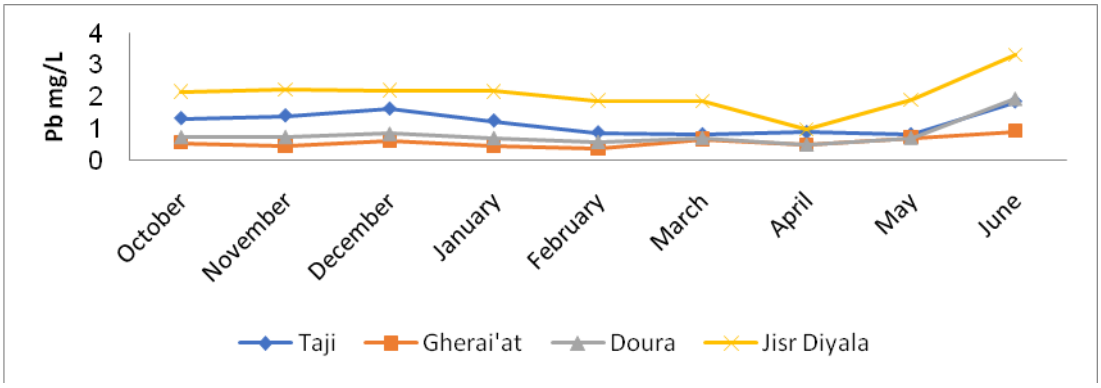

Figure 5: Concentration of lead in the Tigris River in Baghdad

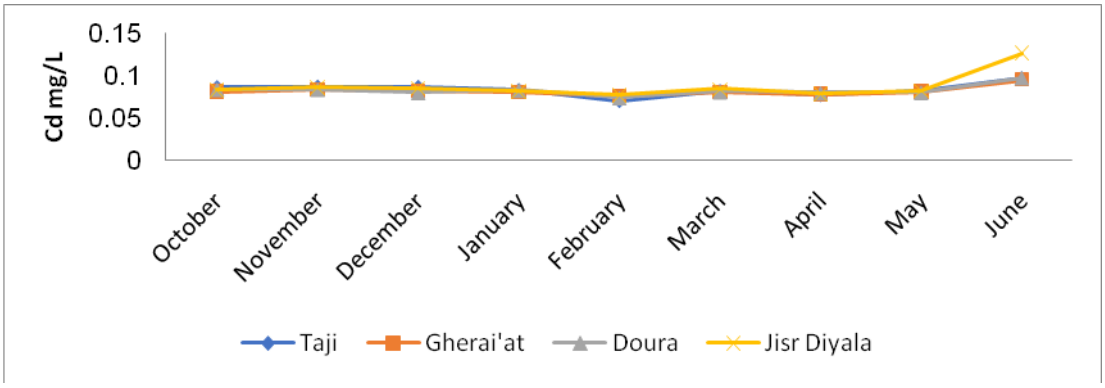

Figure 6: Concentration of Cadmium in the Tigris River in Baghdad

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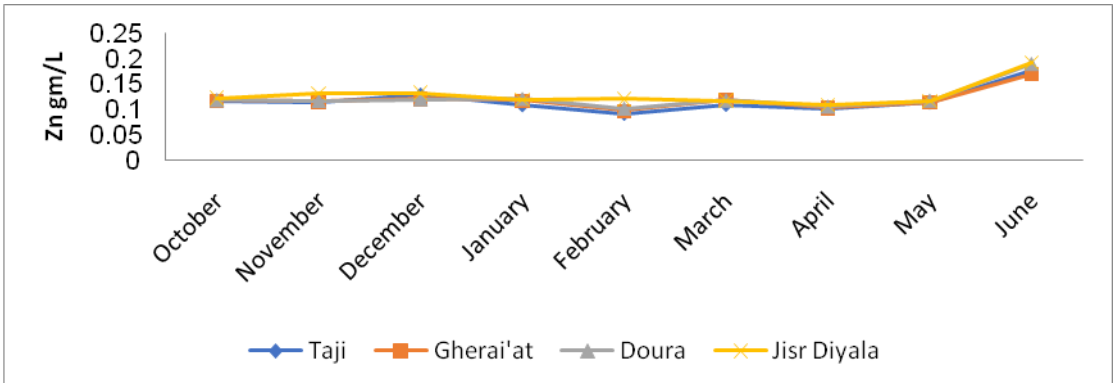

Figure 7: Concentration of Zinc in the Tigris River in Baghdad

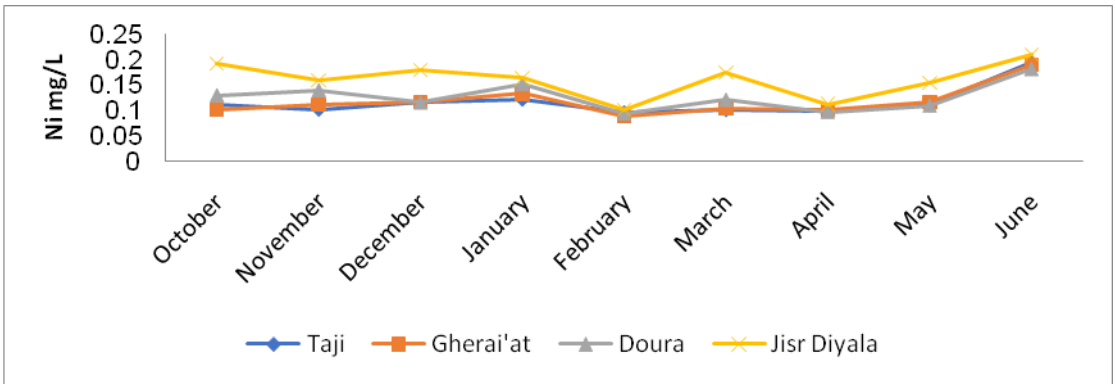

Figure 8: Concentration of Nickel in the Tigris River in Baghdad

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