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ASSESSMENT OF WATER QUALITY IN EUPHRATES RIVER IN BABYLON REGION BY USING CCME INDEX

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ABSTRACT
The Canadian Council of Ministries of the Environment (CCME) Water quality index used in this study to classification water quality in the Euphratesin Babylon region. Values of CCME WQI calculated in this study was 37, 36.5, 36 and 33 in stations 1,2,3 and 4 respectively,and indicates that water quality for the protection of aquatic life can be rated as poor. Lower values of CCME WQIs in Euphrates River have been attributed to a high level of TDS, BOD, Pb, total coliform and fecal coliform in sampling stations.This clearly indicates that the water must be treated to remove the physical impurities and microbial contaminants.

KEYWORDS: Aquatic life, Coliform bacteria, Chemical properties, Euphrates River, CCME

INTRODUCTION

Euphrates River it is one of chief irrigation systems in Iraq, especially in its middle sites. Al-Hilla River branch out from the Euphrates River, after crossing the Al-Hindiya barrage[1]. Water pollution for Al-Hilla River in Middle Euphrates region of Iraq come about in both rural and urban areas. In rural areas, drinking water from natural sources such as rivers and streams is usually polluted by organic substances from upstream users who use water for agricultural activities[2]. The Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) is a significant item in water quality assessment. CCME WQI has consisted of three essential variables which are scope, frequency, and amplitude. These variables were represented as a single dimensionless score to represent the whole conditions of water quality [3, 4]. CCME is distinguished from other indicators of water quality with many advantages, including flexibility in benchmark selection and tolerance in missing data [5, 4].The CCME WQI is an objective indicator based on the comparison between the water quality values measured with the guidelines for the production of a final score, which ranges from 0 to 100 where 0 represents the worst quality and 100 represents the best. The CCME makes the practitioners are free to select suitable parameters and guidelines for their objective. Therefore, accommodating the site-specific and treatment considerations associated with assessing the source of drinking water. Also, it provides detailed information regarding index calculation and application[6,7,8]. Usually, water quality data were summarized in technical reports that are very valuable to individuals who understand the technical content. However, this information is not always useful to non-technical individuals. The CCME WQI was developed with the intent of providing a tool for simplifying the reporting of water quality data [6].

MATERIALS & METHODS

Study Area

Four locations were selected along Al-Hilla River (Figure 1).

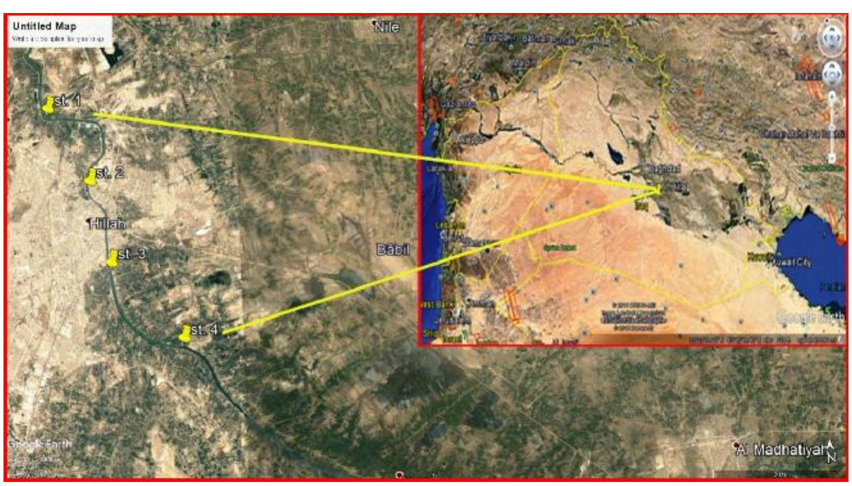

FIGURE 1: Al-Hilla River at Hilla city with the sampling stations

Samples of water from selected stations were taken twice each season from August 2016 until June 2017.Water sample for physical, chemical analysis collected in polyethylene containers with a volume of 5 litters under the water surface about 20-40 cm after punning the container with water sample twice before filling, then kept at 15°C in the refrigerator[9,10].Water samples for biological analysis were collected in closed glass bottles, washed with distilled water and sterile by placing those in the oven for 4hr at 200°c, then kept in the Cool box till carrying to a laboratory for examination [11, 12].

Methods

Total dissolved solids and pH were measured in the field with a portable multimeter HANNA Model (HI 9811-5), while all other parameters included Dissolved oxygen, BOD5, Nitrate, Chloride, Sulphate, Phosphate, Zinc, and Leadwere determined in thelaboratory following the standard protocols [13]. Microbial examinations, which included total coliform (TC) and fecal coliform (FC) conducted according to methods were mentioned [11, 12].

The CCME WQI

Canadian Water Quality Index(CWQI), it comprises of three factors and is well documented [6]. Factor 1: *F*1 (Scope) Scope assesses the extent of water quality guideline non-compliance over the time period of interest, which means the number of parameters whose objective limits are not met. It has been adopted directly from the British Columbia Water Quality Index:

$$F1=\left(\frac{number\ of\ failed\ variables}{total\ number\ of\ variables}\right)\times 100 \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where the variables indicate those water quality parameters whose objective values (threshold limits) are specified and observed values at the sampling sites are available for the index calculation.

Factor 2: *F*2 (Frequency) The frequency (*i.e*. How many occasions the tested or observed value was off the acceptable limits) with which the objectives are not met, which represents the percentage of individual tests that do not meet the objectives (“failed tests”):

$$F2=\left(\frac{Number\ of\ failed\ tests}{Total\ number\ of\ variables}\right)\times 100 \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Factor 3: *F*3 (Amplitude) The total by which the objectives are not met (amplitude) that represents the amount by which the failed test values do not meet their objectives, and is calculated in three steps. The numeral of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective is named an “excursion” and is expressed as follows.

Step 1- Calculation of Excursion

When the test value must not exceed the objective:

$$excursion_i=\left(\frac{\text{Failed Test Value } i}{\text{Objective } j}\right)-1$$

For the cases in which the test value must not fall below the objective:

$$excursion_i=\left(\frac{\text{Objective } j}{\text{Failed Test Value } i}\right)-1$$

Step 2- Calculation of Normalized Sum of Excursions

The collective amount, by which the individual tests are out of compliance, is calculated summing the excursions of individual tests from their objectives and then dividing the sum by the total number of tests. This variable, referred to as the normalized sum of excursions (*nse*) is calculated as:

$$nse=\frac{\sum_{i=1}^{n} \text{excursion}i}{Number\ of\ tests}$$

Step3- Calculation of F3

*F*3 is then calculated by an asymptotic function that scales the normalized sum of the excursions from objectives (nse) to yield a value between 0 and 100.

$$F_3=\left(\frac{nse}{0.01nse+0.01}\right)$$

The CWQI is finally calculated as:

$$CWQI = 100-\left[\frac{\sqrt{F1^2+F2^2+F3^2}}{1.732}\right]$$

The factor of 1.732 has been introduced to scale the index from 0 to 100. Since the individual index factors can range as high as 100, it means that the vector length can reach a maximum of 173.2 as shown below:

$$\sqrt{100^2+100^2+100^2}=\sqrt{30000}=1.732$$

The above design produces a value between 0 and 100 and gives a numerical value to the state of water quality. Note a zero (0) value indicates very poor water quality, whereas a value close to 100 indicates excellent water quality. The assignment of CCME WQI values to different categories is somewhat subjective manner and also demands expert judgment and public’s expectations of water quality. The water quality is ranked in the following 5 categories Table 1.

TABLE 1: CCME WQI categorization schema [1]

Rank	WQI Value	Description
Excellent	95-100	Water quality is protected with a virtual absence of threat or impairment
Good	80-94	Water quality is protected with only a minor degree of threat or impairment
Fair	65-79	Water quality is usually protected, but occasionally threatened or impaired
Marginal	45-64	Water quality is frequently threatened or impaired
Poor	0-44	Water quality is almost always threatened or impaired

RESULTS & DISCUSSION

The results of the physical-chemical, microbiological and some heavy metals analysis of water in the study stations such as (pH, TDS, DO, BOD, SO_4, PO_4, NO_3, Cl^-, Zn, Pb, T.C, and F.C) are represented in tables 2, 3, 4 and 5.The pH values ranged from 6.9 to 8.8 mg/1, while the TDS concentrations varied between 420- 560 mg/L. Dissolved oxygen fluctuated between 4.5- 7.9 mg/L, while the BOD values varied between 1.1-5.2 mg/L.The $SO4^2$ concentrations ranged between 119.8 -362.9 mg/L, while the NO_3 values in present study ranged between 2 - 15.5 mg/L. The concentration of reactive phosphate ranging from Zero to 0.125 mg/L. The Cl^- concentrations varied between 84.973 - 122.984 mg/L.Zinc concentrations varied between ND- 0.813 mg/L.The lead concentration in river water varied from ND to 0.52 mg/L. Total coliform in this study ranged between 11 x 10^2 to 24 x 10^5 CFU/l00 mL. Fecal coliform varied between 4.5 x 10^1 to 24 x 10^5 CFU/l00 mL.

TABLE 2: Water quality variables and objectives or guidelines used to calculate Water Quality Index in station 1

Data	pH	TDS mg/l	DO mg/l	BOD mg/l	Cl mg/l	SO4 Mg/l	NO3 mg/l	PO4 mg/l	Pb mg/l	Zn mg/l	T.C CFU/ 100ml	F.C CFU/ 100ml
August 2016	7.7	510	5.5	**3.1**	86.973	325.691	7.435	MD	**0.415**	0.813	**600000**	**600000**
October 2016	7.5	540	5.58	**4.1**	106.28	325.691	6.868	0.0035	**0.333**	0.619	**1400000**	**110000**
November 2016	6.9	540	6.6	**2.3**	105.08	158.333	9.117	0.019	**0.141**	0.089	**2400000**	**2400000**
January 2017	7.5	530	8.5	**2.5**	122.12	216.535	2.24	0.0025	**0.522**	0.091	**68000**	**20000**
February 2017	7.6	450	7.8	1.4	99.4	150.394	3.07	0.025	**0.099**	0.113	**6800**	**6800**
March 2017	7.6	430	7	1.25	100.82	189.066	3.052	0.0107	**0.805**	0.036	**4000**	**4000**
April 2017	8.7	420	6	1.3	132.18	210.248	2.319	0.0144	**0.234**	0.048	**4000**	**400**
June 2017	8.1	410	5.1	0.7	97.62	159.145	2.251	0.06	**0.461**	0.612	**1400000**	**140000**
Objectives	6.5-9	1000	5	2	250	500	45	0.1	0.01	5	200	200
CCME WQI value					37							

Values in Bold do not comply with the corresponding objective; objectives have been taken from [14, 15, 16, and 17].

TABLE 3: Water quality variables and objectives or guidelines used to calculate Water Quality Index in station 2

Data	pH	TDS mg/l	DO mg/l	BOD mg/l	Cl mg/l	SO4 Mg/l	NO3 mg/l	PO4 mg/l	Pb mg/l	Zn mg/l	T.C CFU/ 100ml	F.C CFU/ 100ml
August 2016	7.4	530	**4.9**	**2.2**	84.473	259.61	12.47	0.0365	**0.272**	0.781	**400000**	**400000**
October 2016	7.9	530	6	**5.2**	101.96	200	7.723	ND	**0.252**	0.099	**1700000**	**140000**
November 2016	7.1	543	6.1	**3.7**	102.95	362.951	8.612	0.00468	**0.328**	0.647	**1400000**	**1400000**
January 2017	8	560	8.1	**3.63**	122.47	268.504	2.239	0.0229	**0.363**	ND	**1100**	**1100**
February 2017	8.2	460	7.3	1.8	101.175	175.591	2.788	0.02	ND	ND	**11000**	**6800**
March 2017	8	440	6.2	1.8	101.53	179.966	2.946	0.02	ND	0.021	**1800**	**1800**
April 2017	8.6	520	5.7	0.9	127.8	215.507	2.169	0.014	**0.097**	0.049	**1100**	45
June 2017	8.3	430	**3.5**	0.8	93.72	119.829	2.337	0.045	**0.178**	0.231	**14000**	**14000**
Objectives	**6.5-9**	**1000**	**5**	**2**	**250**	**500**	**45**	**0.1**	**0.01**	**5**	**200**	**200**
CCME WQI value						36.5						

Values in Bold do not comply with the corresponding objective

TABLE 4: Water quality variables and objectives or guidelines used to calculate Water Quality Index in station 3

Data	pH	TDS mg/l	DO mg/l	BOD mg/l	Cl mg/l	SO4 Mg/l	NO3 mg/l	PO4 mg/l	Pb mg/l	Zn mg/l	T.C CFU/ 100ml	F.C CFU/ 100ml
August 2016	7.4	520	**4.5**	**2.2**	85.973	299.675	3.704	0.0031	ND	0.217	**600000**	**600000**
October 2016	8	530	5.9	**4.8**	102.96	228.438	15.503	ND	**0.192**	0.583	**920000**	**920000**
November 2016	7.3	545	6.2	**3**	106.5	189.358	5.537	0.0347	**0.187**	0.509	**140000**	**140000**
January 2017	7.7	540	7.3	**2.83**	118.95	243.307	2.017	0.012	**0.166**	0.012	**4000**	**4000**
February 2017	8	440	7.6	1.2	104.725	180.315	2.957	0.0102	ND	ND	**6800**	**4000**
March 2017	7.7	420	6	1.4	100.465	170.465	3.209	0.0413	**0.21**	0.003	**6800**	**930**
April 2017	8.8	530	5.1	0.8	130.28	195.372	2.219	0.0232	**0.157**	0.04	**1100**	**1100**
June 2017	7.7	410	**3.3**	**1.7**	**97.32**	155.727	2.423	0.055	**0.123**	0.322	**1700**	**1700**
Objectives	**6.5-9**	**1000**	**5**	**2**	**250**	**500**	**45**	**0.1**	**0.01**	**5**	**200**	**200**
CCME WQI value						36						

Values in Bold do not comply with the corresponding objective

TABLE 5: Water quality variables and objectives or guidelines used to calculate Water Quality Index in station 4

Data	pH	TDS mg/l	DO mg/l	BOD mg/l	Cl mg/l	SO4 Mg/l	NO3 mg/l	PO4 mg/l	Pb mg/l	Zn mg/l	T.C CFU/ 100ml	F.C CFU/ 100ml
August 2016	7.2	510	5.2	**2.4**	85.983	218.374	11.211	ND	ND	0.602	**610000**	**40000**
October 2016	7.9	540	6.4	**3.2**	100.96	179.176	6.465	0.0086	**0.195**	0.255	**920000**	**68000**
November 2016	7.4	550	6	1.2	106.5	248.073	5.656	0.0398	**0.16**	0.395	**110000**	**40000**
January 2017	7.6	530	9.2	**2.7**	122.47	288.976	2.018	**0.125**	**0.103**	0.033	**1100**	**1100**
February 2017	7.8	460	7.9	1.7	99.542	140.995	3.239	0.0051	**0.019**	ND	**40000**	**1200**
March 2017	7.9	450	8.6	1.1	101.175	168.547	2.894	0.0107	**0.149**	ND	**14000**	**6800**
April 2017	8.7	520	6.5	0.5	131.35	170.579	2.269	0.0231	**0.31**	0.038	**40000**	**4000**
June 2017	8	420	**4.3**	1.3	101.53	162.564	2.77	0.0607	**0.043**	0.167	**11000**	**11000**
Objectives	**6.5-9**	**1000**	**5**	**2**	**250**	**500**	**45**	**0.1**	**0.01**	**5**	**200**	**200**
CCME WQI value						33						

Values in Bold do not comply with the corresponding objective

A total number of variables examined were 12. A total number of individual tests were 96 per table, a number of parameters whose values were above objective levels were 20.Values of CCME WQI calculated in this study was 37, 36.5, 36 and 33 inside stations 1,2,3 and 4 respectively, and indicates that water quality for the protection of aquatic life can be rated as poor Table 1. Lower values of CCME WQI in Al-Hilla River drainage have been attributed to a high level of TDS, BOD, Pb, total coliform and fecal coliform for all four sampling stations. This clearly indicates that the water must be treated to remove the physical impurities and microbial contaminants. In other studies in Iraq and using the same index showed that the water quality of the Tigris and Euphrates Rivers fluctuate between poor to marginal categories [18, 19]. There is a need to decrease soil erosion by watershed management techniques, which will cut down the turbidity and TDS in the waters that threaten the aquatic life.

CONCLUSION

The evolution of the water in Al- Hilla River using CCME WQI showed that the water qualities of this river in all stations are considered poor. These results indicate deterioration in the quality of this water and its inability to support aquatic life. Therefore must be

- Restriction of the human, industrial and agricultural discharges to the river.
- The strict laws should be activated to prevent hazardous pollutants to be higher than standard levels in rivers.
- Continuous monitoring of discharge sewage water into the river. There is the need for constant monitoring and education for the local population about the need for environmental protection and the ill effects of indiscriminate and illegal activities so as to curb any unanticipated disaster.

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