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RESEARCH ARTICLE

ASSESSMENT OF WATER QUALITY OF HILLA RIVER FOR DRINKING WATER PURPOSE BY CANADIAN INDEX (CCME WQI)

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ABSTRACT

The present work describes the application of Canadian Water Quality Index (CCME WQI) was applied using six located along with Al-Hilla River water quality parameter (pH, turbidity, electric conductivity, total alkalinity, total hardness, Ca, Mg, Cl). Physic-chemical parameters were monitored for along Euphrates river were monthly monitored during the study to compute the WQI in order to assess the suitability of the river water for drinking and human consumption the calculation of WQI for Winter, Spring, Summer, and Autumn seasons from August ,2013 to August, 2014, Based on the results obtained from the index, the water quality of River ranged between 60-65 which indicate that river has the marginal quality due to effect of Al-Hilla various urban pollutant sources.

INTRODUCTION

Al Hilla river is the main source for all drinking water treatment plants in Babylon governorate middle of Iraq including the large and package treatment units. Al Hilla River is used as disposal site for a portion of untreated sanitary sewage which is discharged to it through the highly polluted lateral creeks. Therefore, the water of this river is of variable quality due to natural and man-made reasons and, subsequently, needs to be assessed as a source of domestic water supply. The problem of drinking water contamination, water conservation and water quality management become very important in the recent years. [Sinha. *et al*., 1995].

The quality of water required to maintain ecosystem health is largely a function of natural background conditions. Some aquatic ecosystems are able to resist large changes in water quality without any detectable effects on ecosystem composition and function, whereas other ecosystems are sensitive to small changes in the physical and chemical makeup of the water body and this can lead to degradation of ecosystem services and loss of biological diversity. (Scheffer*et al*.,2001).
Typically, water quality is determined by comparing the physical and chemical characteristics of a water sample with water quality guidelines or standards. Drinking water quality guidelines and standards are designed to enable the provision of clean and safe water for human consumption, thereby protecting human health. These are usually based on scientifically assessed acceptable levels of toxicity to either humans or aquatic organisms (Wickham *et al*., 2005), (Dodds *et al*.,2004),(Robertson *et al*.,2006).

One of the simplest methods to assess water quality conditions is by using water quality indices (Salim *et al*., 2009). It is a tool that provides meaningful summaries of water quality data that are useful to technical and non -technical individuals interested in water quality results. It is important to note that the CCME WQI is not a substitute for detailed analysis of water quality data and should not be used as a sole tool for management of water bodies. It was simply developed to provide a broad overview of environmental performance (Khan*et al*., 2004).

The quality of water is the degree of its portability and is determined by the amount and level of physiochemical, and microbial parameters and metals (which included suspended and dissolved substances in the water). Determining water quality parameters is important to identify the quality, conditions and pollution level of surface waters. Related data must be processed and the results should be presented to specialists. One of the simplest methods to assess water quality conditions is by using water quality indices (Horton, 1965) was the first person who used the concept of water quality (Alobaidy*et al*., 2010).

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Numerous water quality indices have been formulated all over the world which can easy judge out the overall water quality within a particular area promptly and efficiently such as CCME WQI, BC WQI, NSF WQI, O WQI (Bharti*et al*., 2011).
Many researchers have used this method worldwide to assess the quality of water in various fields such as rivers and surface waters (Abdul-Razak *et al*., 2009), (Pradyusa *et al*., 2009), aquifers and underground water (Vaishnav*et al*., 2011), (Supantha*et al*., 2011). In Iraq, CCME WQI used by some studies evalution different aquatic system such as Euphrates river (Alhashimi*et al*., 2012), Qalyasam stream (Khwakaram*et al*., 2012), tigris river (Alobaidy *et al*., 2010), (Al- janabi *et al*., 2012), (Hassan *et al*., 2013), drainage of waste water (Al-yassiry*et al*., 2014) and Hilla river (Al-shammary*et al*., 2014). This study aimed to compute water quality index of raw water of Al-Hilla River in Babylon governorate for drinking purpose by using Canadian water quality index CCME WQI.

MATERIALS AND METHODS

Study area

Iraq is a country with relatively abundant renewable and non-renewable water resources. Nevertheless, during the past 30 years, Iraq has shifted from being water secure to a water-stressed country. The water resources in Iraq are composed of surface water, groundwater, rain and snow fall, marshlands, lakes and reservoirs, and drainage water (Abdul Halim*et al*., 2012).

Euphrates River is one of two major rivers flowing through Iraq. It originates in Turkey, runs through Syria, entering Iraq from the western border and discharge in Shat Al-Arab. It travels a distance of 2,700 kilometers before flowing into the Gulf. The river water is used for drinking, irrigation, etc. Unfortunately, the seasonal distribution of the availability of water does not coincide with the irrigation requirements of the basin. In an average year, the river reaches its peak flow in April and May as the winter mountain precipitation melts (Al-Saleh *et al*., 2014), (Al-Saqqar *et al*., 2013).

All drinking water treatment plants that considered in this research is located in north, south and mid of Al-Hilla river in Babylon provinces (Fig.1). These six water treatment plants included, Al-Hilla Al-Jadeed water treatment plant, Al-Taiyaraa Al-Kadeem WTP, Al-Hashimiyia WTP, Al-Husain WTP, Al-Musayab Al-Jadeed WTP, AL-Sadaa WTP.

Calculation of the CCME WQI

Fig 1 Distributions of six water treatment plants in Babylon provinous.

The CCME WQI model consists of three measures of variance from selected water quality objectives (scope, frequency, amplitude). These three measures of variance combine to produce a value between 0 and 100 (with 1 being the poorest and 100 indicating the best water quality) that represents the overall water quality. Within this range, designations have been set to classify water quality as poor, marginal, fair, good or excellent. These same designations were adopted for the indices developed here, The detailed formulation of the WQI, as described is as follows CCME, 2010).

$$F1 = \frac{\text{Number of variables}}{\text{total number of variables}} * 100$$

The measure for scope is F1(*Scope*). This represents the extent of water quality guidelinenon-compliance over the time period of interest.

$$F2 = \frac{\text{Number of failed tests}}{\text{Total number of tests}} * 100$$

The measure for frequency is F2 (*Frequency*). This represents the percentage of individual tests that do not meet objectives (failed tests).
-Amplitude, F3
The measure for amplitude is F3. This represents the amount by which failed tests do not meet their objectives. This is calculated in three steps:

Step 1- Calculation of Excursion

Excursion is the number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective.When the test value must not exceed the objective:

$$Excursion = \left[\frac{\text{Failed test value}}{\text{Objective}}\right] - 1$$

Step 2- Calculation of Normalized Sum of Excursions

The normalized sum of excursions, *nse*, is the collective amount by which individual tests are out of compliance. This is calculated by summing the excursions of individual tests from their objectives and dividing by the total number of tests (both those meeting objectives and those not meeting objectives).

$$nes = \frac{-\sum_{i=1}^{n} excursion}{2a}$$

Step3- Calculation of F3

F3 (*Amplitude*,)is calculated by an asymptotic function that scales the normalized sum of the excursions from objectives to yield a range from 0 to 100.

$$CWQI = 100 - \frac{\sqrt{\text{F1}^2 + \text{F2}^2 + \text{F3}^2}}{1.732}$$

$$F3 = \frac{\text{nes}}{0.1\text{nes} + 0.01}$$

RESULTS AND DISCUSSION

The physicochemical parameters with their WHO and IQS standards are listed in table (1), (2) Water quality classification based on CCME WQI values

The index has been primarily developed to reflect changes in the physicochemical quality of surface waters. However, they may be used as indicators of ecological change. The results of Overall CCME WQI calculation have been listed with their corresponding water quality status in table 3. These results indicate that water qualityvalues of CCME WQIs (range from 60 to 65) for drinking uses can be rated as marginal as showed (Fig.2).

Table 1 Standard Values of water quality according to international agency

CCME	WHO	Iraq standard	Parameter
8.5	6.5-8.5	6.5-8.5	pH (mg/l)
500	500	1000	TDS (mg/l)
-	100	50	Calcium (mg/l)
-	100	-	Total Alkalinity (mg/l)
1.37	0.2	-	Ammonia(mg/l)
48.2	50	50	Nitrate (mg/l)
-	3	3	Nitrite (mg/l)
5	5	5	Turbidity(NTU)
0.05	0.05	0.05	Chromium (mg/l)
0.3	0.3	0.3	Iron (mg/l)
0.01	0.01	0.01	Lead (mg/l)

Table 2 CCME WQI categorization schema (CCME, 2010)

WQI Value	Rank
95-100	Excellent
80-94	Good
65-79	Fair
45-64	Marginal
0-44	Poor

Table 5 CCME for 4 seasons in Al- Hilla River

Season	Summer	Autman	Winter	Spring
CCME	62.94	57.97	63.26	45.77

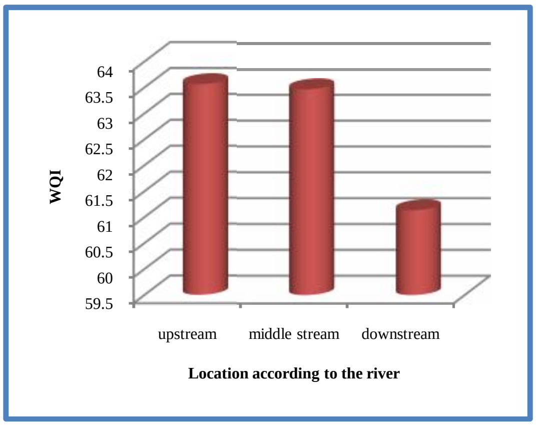

Figure 2 Variation of CCME as different location in Al- Hilla River

The water quality indices that were found for raw for four different seasons have been represented graphically in Fig. (3) The results showed that for raw water none of the samples are coming neither under good nor poor (the highest value is 63.26

Table 3 Results of overall CCME WQI calculation with corresponding water quality status

	WQI	F1	F2	F3	Water quality status
Location	Up stream	50	42.3	13.27	marginal
	Middle stream	50	36.5	13.27	marginal
	Down stream	50	36.5	12.28	marginal
Season	Summer	50	37.5	14	marginal
	Autman	50	50	16.96	marginal
	Winter	50	37.5	11.5	marginal
	Spring	50	50	61.65	marginal

This finding disagree with (Al-Saleh *et al.*, 2014) which indicate that Euphrates river water quality within Babylon province is generally categorized as "Good" and suitable for drinking uses and human consumption in the period from 2007 to 2013 without any treatment for the whole studied period This may reflect the Discharge of pollutants to a water resource system from domestic sewers, storm water discharges, industrial wastes discharges, agricultural runoff and other sources, Fig (2) Shows the three location at Al-Hilla river (upstream, middle stream , downstream)the WQI for these location is (63.56, 63.48, 61.41) respectively show table (4) below, as notice that higher value in the upstream of river and lowest value in downstream river, in this may reflect the discharge of pollutants to a water resource system from domestic sewage, industrial wastes water, agricultural runoff and other sources, all of which may be untreated.

This finding dis agree with (Alhashim *et al.*, 2012) that the Euphrates river water is generally "good" range (26-50) at the upstream and is either "poor" range (51-75) or "very poor" range (76-100) at the mid and downstream of river. This may reflect the effect of pollution from urban wastes and anthropogenic activities The water quality index that was found for four different seasons have been listed in table (5).

during summer while, the lowest value 57. 97 during autumn).The values of WQI showed the higher percent of unsuitable category was found in summer season as compared with the other seasons.

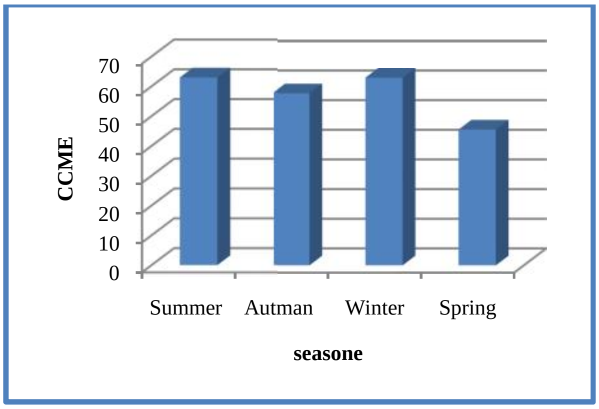

Figure 3 variation of CCME for 4 seasons in Al- Hilla River

CONCLUSION

Water quality index (WQI) of the present study for Al- Hilla River was calculated from important various physiochemical parameters in order to evaluate the suitability of water for

Table 4 CCME as different location in Al- Hilla River

Location according to the river	Up stream	Middle stream	Down stream
CCME (WQI)	63.56	63.48	61.41

drinking purposes. This quality is impacted by physico-chemical parameters (Turb, Temp, pH, EC, Alk, T.H, Ca, Mg, and Cl). The calculated CCME WQI provides an easy way of understanding the overall water quality and water management. The temporal variation of WQI trend was generally "marginal" of river upstream, midstream and downstream stations throughout the study period (WQI 63.56, 63.48, 61.41) respectively. It was also observed that the pollution load was relatively high during summer and winter season when compared to the spring and autumn seasons, the worst water quality for treated water according to the CCME WQI method classification was in summer season.

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