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Quality assessment of drinking water by using some Environment Index in Misan Province

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ABSTRACT

The aim of the study to the assessment of drinking water by two different WQI models, Arithmetic Weighted Water Quality Index (AW-WQI), and Overall Index of Pollution (OIP-WQI). Water samples were collected from ten sampling stations during 2017-2018 and 9 physicochemical parameters were analyzed: hydrogen ion concentration (pH), Turbidity NTU, Total Suspended Solids TSS, Total Dissolved Solids TDS, Total Hardness, Chloride mg. L^{-1}, Sulphate mg. L^{-1}, Reactive Nitrate mg, Reactive Phosphate. The study showed the water quality is very poor in Station 1 and all the Stations. which was classified as unsuitable for drinking because of increasing the TDS, TSS, SO4, PO4 and total hardness for these stations as a result. While Overall Index of Pollution (OIP-WQI) The results revealed that Stations 1,4,8,9,10 were polluted, and Slightly polluted in station 2,3,5,6,7.

Key words : *Water quality, physicochemical parameters, Iraq*

Introduction

Water quality is a general descriptor of water properties in terms of physical, chemical, thermal, and/or biological characteristics. It is difcult to dene a single water quality standard to meet all uses and user needs. For example, physical, chemical, and biological parameters of water that are suitable for human consumption are different from those parameters of water suitable for irrigating a crop (Al-Saffar, 2001.) Water quality indices (WQIs) are tools to determine conditions of water quality and, like any other tool require knowledge about principles and basic concepts of water and related issues. It is a well-known method of expressing water quality that offers a stable and reproducible unit of measure that responds to changes in the principal characteristics of water (Nikbakht, 2004, Giriyappanavar and Patil, 2013). The OIP-WQI is a promising tool and efficient to study the effect of water quality. It is also a very useful tool for communicating the information on the overall quality of water to the concerned citizens and policymakers. This could help to assess and solve local and regional surface water quality-related problems (Das and Sil, 2017; Ban *et al.,* 2014). The Misan River is of essential importance for domestic, agricultural and industrial uses and its water masses are essential to satisfy the requirements of Misan provinces. Their study aimed at using ten ecological parameters in evaluating the quality of the Misan for public usage. Previous studies have demonstrated that Iraq currently faces serious water problems; not only over-exploitation and uneven in the spatial distribution of water resources, but also severe water pollution in Iraqi main rivers, which give a contribution to the scarcity of water of adequate quantity and quality (Federation, W.E. and American Public Health Association, 2005; Sargaonkar and Deshpande, 2003; Fulazzaky, 2010). Growing municipal wastewater discharges due to

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urbanization, agriculture, and industrial practices, along with the limitation of wastewater treatment facility and capacity, considered the principal drivers of water pollution. In Iraq, all wastewater discharged into rivers, and most of that is untreated (Akkoyunlu and Akiner, 2012; Rangeti *et al.,* 2015; Dede *et al.,* 2013).

Materials and Methods

In this study, water samples were collected Three replicates of water samples were collected from drinking water purification plants in Maysan Governorate 2017 -2018. Samples were preserved and examined according to the standard techniques of the American Public Health Association (Federation, W.E. and American Public Health Association, 2005). Physical and chemical parameters. For physical-chemical parameters Table 1, samples were collected in 2.5-liter polyethylene bottles by direct immersion of bottles in the water, 10-20 cm below the surface, Samples are preserved following the procedures described in APHA (2005). Before collection, bottles are washed with distilled water and marked. The samples were kept in an icebox and transported to the laboratory as soon as possible, mostly within 7-9 hrs. from the time of collection. Field instruments for in situ measurements calibrated regularly to ensure accurate results APHA (2005).

Arithmetic Weighted Index method (AW-WQI)

For calculation and formulation Arithmetic Weighted WQI, involved the following steps: In the first step, Relative weight (Wi) for various parameters is inversely proportional to the recommended standard (V standard) for the corresponding parameter (Parparov, 2006). The number obtained from applying the index is classified into five scale categories as display in Table 2 according to Tyagi *et al.* (2013).

Overall Index of Pollution (OIP)

OIP creates a score to evaluate the surface water quality of Indian rivers based on measurements and classification of, turbidity, total hardness, total dissolved solids, pH, and total. The model classified the river water as Excellent, Acceptable, Slightly Polluted, Polluted, and Heavily Polluted, according to Indian standards or WHO Standard as showed in Table 3.

Table 2. The illustrated the AW-WQI categories.

AW-WQI rank	Water quality	Class
0- 25	Excellent	I
26-50	Good	II
51-75	Poor	III
76-100	Very Poor	IV
>100	**Unsuitable for Drinking**	**V**

Table 3. OIP ranks water quality in 5 categories.

OIP values	Water quality	Class
0-1	Excellent	I
1-2	Acceptable	II
2-4	Slightly polluted	III
4-8	polluted	IV
8-16	Heavily polluted	V

Table 1. Standard methods for laboratory measurements

No	Factor	Device name or Tools	Reference
1	Turbidity NTU	Turbidity meter APHA (2005)	Turbidity meter APHA (2005)
2	Total Suspended Solids TSS	Temperature drying (103-105) C°	APHA (2005)
3	Total Dissolved Solids TDS (mg. L^{-1}	Portable Digital Meter	APHA (2005)
4	pH	Multi parameter analyzer device type Milwaukee	APHA (2005)
5	Total Hardness mg CaCO3L	Titration with Na2EDTA	Lind (1979)
6	Chloride mg. L^{-1}	Titration with AgNO3	ASTM (1999)
7	Sulphate mg. L^{-1}	Turbidity method and spectrophotometer at wavelength (420 nm)	APHA (2005)
8	Reactive Nitrate mg. L^{-1}	Sulphonial amide solution and Cadmium Colum method and Spectrophotometer	APHA (2005)
9	Reactive Phosphate mg. L^{-1}	Ascorbic Acid method	APHA (2005)

Result and Discussion

The great amount of water quality data without precise interpretation cannot help water quality management properly. Therefore, it is necessary to summarize water quality data to a defined numeric digit that indicates the degree of water quality. To solve this problem in this study, different WQI models were applied and their comparative results are presented. For this purpose, two different WQI models, Arithmetic Weighted Water Quality Index (AW-WQI), and Overall Index of Pollution (OIP-WQI). The testing of the water quality parameters and their characteristics is an important part of environmental monitoring and assessment quality of the water, to know the reasons which led to changes in the quality, and to help in interpreting these changes. According to the United State Environmental Protection Agency (2015), the major factors which can influence the quality of river water are: physical properties of water quality include Water Turbidity (Turb.), Total dissolved solids (TDS), Total suspended solids (TSS) and pH. Total hardness (TH), Cl^-, SO_4^-, NO_3^-, PO_4^-. The AW-WQI, is the first WQI model applied to the data collected in this study. It is a powerful and versatile technique that categories the water quality according to the suitability of water for various beneficial purposes using the most commonly measured water quality parameters (Leizou *et al.,* 2017) According to the estimated AW-WQI for drinking, irrigation, and living aquatic uses, the water quality is very poor in Station 1 and all the Stations (Table 4) Figure 1. which was classified as unsuitable for drinking because of increasing the TDS, TSS, SO_4, PO_4 and total hardness for these stations as a result of domestic and industrial effluents in Tiger River moreover, current study is backed by that Alobaidy *et al.* (2010), on Tigris River, Khan and Hazarika (2011) on Kolong River in India, Ahmad, *et al.* (2012), on Qalyasan stream in Sulaimani City Iraq, Zhao *et al.* (2013), on

Fig. 1. WA-WQI for ten sampling stations on Misan Province

Table 4. The calculate AW-WQI Method of WTPs

ID	Qi									AW-WQI value	AW-WQI rank	Water Quality Rating
	PH unit	TUR. NTU	TDS mg/L	TSS mg/L	TH mg/L	CL mg/L	SO_4 mg/L	NO_3 mg/L	PO_4 mg/L			
S1	40	900	64.2	80	90	120.8	156.4	3.8	16	91.9	76-100	Very Poor
S2	46	660	111.3	100	104	128	74.4	2.4	20	92.7	>100	Unsuitable for Drinking
S3	33	700	110.9	108	72.8	56.8	73.2	2.6	30	86.9	76-100	Very Poor
S4	46.7	440	88.9	320	26.6	134.8	196.8	5.2	26	201.4	>100	Unsuitable for Drinking
S5	53.3	1240	99.2	200	86	70.6	92.8	3.2	38	141.	>100	Unsuitable for Drinking
S6	80	1380	75.2	208	108	134.4	103.2	1.2	18	137.4	>100	Unsuitable for Drinking
S7	53.3	1560	86.2	356	109.4	155.6	86.8	3.8	20	155.1	>100	Unsuitable for Drinking
S8	26	1900	110	388	119	158.8	99.2	4.4	26	187.6	>100	Unsuitable for Drinking
S9	86.6	1740	112.5	588	131.6	163.6	101.6	4.2	36	188.9	>100	Unsuitable for Drinking
S10	13.33	1840	98	560	134	168	104	5.2	30	188.1	>100	Unsuitable for Drinking
Wi	0.049	0.083	0.0004	0.016	0.0008	0.0016	0.0016	0.0083	0.84	$\sum Wi = 1$		

Gorges River in China, Amneera *et al.* (2014), on Perlis River in Malaysia, Atiaa (2015), on Al-Gharraf River in Iraq, Bora and Goswami (2015), on Kolong River in India, Al-Mansori (2017), on Shat-Al-Hilla River, Leizou *et al.* (2017), on Brass River in Nigeria.

The OIP-WQI is a promising tool and efficient to study the effect of water quality changes. It is also a very useful tool for communicating the information on the overall quality of water to the concerned citizens and policymakers. This could help to assess and solve local and regional surface water quality-related problems (Shukla *et al.*, 2017).

The results revealed that Stations 1,4,8,9,10 were polluted, and Slightly polluted in stations 2,3,5,6,7 as in Table 5, Fig. 2. The reason for this fluctuation in the water quality index at these stations was the fluctuations in total hardness (sulfate and nitrate) as a result of direct domestic and industrial effluents.

Fig. 2. OIP-WQI for ten sampling stations on Misan Province

According to OIP-WQI values, river water at these stations, clearly appear unsuitability of water for human consumption. The comparatively high level of turbidity total dissolved solid hardness and sulfates indicates the water is not suitable for domestic use without elaborate treatment. can be used for boating or other recreational activities because of the good dissolved oxygen concentration, this study agrees with (Kupatadze, 2020) who study Iori river in Georgia.

Water quality deterioration has occurred in the last ten stations, consequently, the health status of the river has changed from acceptable to heavily polluted.

This comprehensive study investigates has been made to assess the water quality of Al-Gharraf River, which considered the main branch of Tigris River south of Iraq using the overall Index of Pollution (OIP), depending on 9 physicals, chemical, which measured monthly on the river during 2016-2017. Water quality deterioration has occurred in the health status of the river has changed from acceptable to heavily polluted, factor that affects the quality of the water river. In this paper concluded that the AlGharraf River was in class poor and the Al-Gharraf River water is relatively not (Al-Mayah and Rabee, 2018).

Conclusion

1. The results of the study revealed that the water stations are not suitable for use as drinking water without elaborate treatment, poor for aquatic life protection and fair for irrigation
2. The study showed that the application of OIP is a useful tool in assessing the overall quality. Therefore, water quality evaluating using the OIP tool could help to assess and solve local and regional water quality-related problem

Table 5. The calculate OIP-WQI of WTP.

ID	Individual parameter indices							OIP-WQI value	OIP -WQI scale	Water Quality Rating
	PH unit	TUR. NTU	TDS mg/L	TH mg/L	CL mg/L	SO_4 mg/L	NO_3 mg/L			
S1	1.74	2.57	1.21	3.77	10.1	7.96	1	4.05	4-8	Polluted
S2	1.74	2.22	2.33	1.95	14.7	3.83	1	3.96	2-4	Slightly polluted
S3	1.74	2.23	2.32	1.68	3.9	3.8	1	2.38	2-4	Slightly polluted
S4	1.9	1.91	1.71	8.04	20.3	9.93	1	6.39	4-8	Polluted
S5	1.95	3.06	1.97	7.78	6.1	4.73	1	3.79	2-4	Slightly polluted
S6	3.03	3.24	1.41	8.32	9.7	5.3	1	4.57	4-8	Polluted
S7	2.09	3.53	1.65	8.37	5.6	4.48	1	3.78	2-4	Slightly polluted
S8	1.44	4.02	2.29	8.76	6.9	5.1	1	4.21	4-8	Polluted
S9	3.32	3.79	2.37	9.27	8.8	5.22	1	4.82	4-8	Polluted
S10	1.203	3.93	1.94	9.36	10.1	5.34	1	4.69	4-8	Polluted

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