EEET ECOLOGICAL ENGINEERING & ENVIRONMENTAL TECHNOLOGY

Ecological Engineering & Environmental Technology 2023, 24(3), 258–265
https://doi.org/10.12912/27197050/160002
ISSN 2719-7050, License CC-BY 4.0

Received: 2023.01.13
Accepted: 2023.01.27
Published: 2023.02.25

Environmental Assessment Using Canadian Water Quality Index for Hilla River in Babylon Governorate, Iraq

Alaa Adnan Obayes[1], Sundus Saleh Nehaba[2*], Zaid Basim Hameed[3]

[1] Al-Musayyib Technology College, Al-Furat Al-Awsat Technical University, 51001, Babylon, Iraq
[2,3] Environmental sciences, Al-Qasim Green University, 51001, Babylon, Iraq
* Corresponding author's e-mail: sundus@environ.uoqasim.edu.iq

ABSTRACT

The goal of the current study is to use the Canadian Water Mechanism Manual to assess the water quality at five stations along the Shatt Al-Hilla river in the Iraqi province of Babylon. The current research demonstrates how the Shatt Al-Hilla River and five other locations in Babel City, Iraq, were evaluated using the Water Quality Index developed by the Canadian Council of Ministers of the Environment (CCME WQI). The fieldwork was finished in April 2019, between November 2018, and this month. The CCME WQI was built using thirteen factors for measuring water quality (chromium, chemical oxygen demand, lead, biological oxygen demand, dissolved oxygen, turbidity, sulphate, nitrite, nitrate, total hardness, total dissolved solids, pH magnitude and water temperature). The average magnitudes for five stations along the CCME WQI for the Shatt Al-Hilla River ranged from 61.94 to 81.93 depending on the index's findings. It was also noted that there is a variation in the studied physical and chemical properties of the samples taken from the five stations distributed along the Shatt al-Hilla River. These data show that the water quality for drinking purposes may be assessed as marginal in all sites, with the exception of station 1, where the water quality index was evaluated as good. In order to prevent pollution, conserve water, and achieve proper management, this study article underlines the need for substantial action to control river water quality.

Keywords: water quality; water quality index; Shatt Al-Hilla River.

INTRODUCTION

Recently, the water performs a quintessential role as a most important for industrial, agriculture, and other activities as nicely as human existence. Thus, it's a critical unit of our existence and, therefore, the water aid assessment, display and upkeep is tremendously endorsed specifically for growing nations [1]. As a most imperative component of our earth's surface, water is well thought out. For all living beings, it is essential, and man is no exemption. In today's world, river is considered one of the main sources of surface water and contributes significantly to the transportation of water and nutrients to regions around the world. It plays an important role in the water cycle, functioning as a surface water drainage pipe. Nearly 40% of the world's food supply is irrigated and a wide variety of industrial processes depend on water [2].

Communicating the state of the environment to decision-makers and the general public is one of the toughest issues in environmental management. This issue was originally partially resolved by combining and indexing a variety of water quality metrics to create a Water Quality Index (WQI). Aquatic production directly correlates with the quality of the water. The ideal level of physicochemical characteristics is necessary for max production [3].

An easy approach to communicate complicated information about water quality to the general public is to use a water quality index. The British Columbia Ministry of the Environment, Lands and Parks devised the algorithm on which the CCME Water Quality Index (1.0) is based. There are three components to the index: scope-number of parameters that fall short of goals for water quality [4].

In order to optimize the health of any aquaculture system, certain indicators or parameters of water quality must be monitored and controlled. For consistent communication to managers and the general public, a water quality index (WQI) aggregates vast amounts of water quality data in simple words (such as excellent, good, terrible, etc.) [5].

Both human health and aquatic life are closely tied to the evaluation of water quality. Water quality significantly affects water availability and frequently impacts supply alternatives [6, 7].

Additionally, the information gleaned from the computation of a water quality index offers hints to support environmental and health decision-making. Water quality magnitudes are helpful and sensitive indications of changes in the physical, chemical, or biological makeup of the overall water condition in water management procedures [8].

The water quality index gives a single magnitude while reducing the greatest number of water characteristics employed in the evaluation. utilizing the analytical magnitudes of chemical and physical characteristics, this magnitude represents the average water quality at a certain period in a straightforward and logical manner.

MATERIALS AND METHODS

Description of Study Area and Sampling Collection

In this study, we took five stations were located along Shatt Al-Hilla river in the Babylon governorate in Iraq was demonstrated in Figure 1. Five specimens were collected in each month from the five stations through six month started from November 2018 to April 2019. Specimens were taken two twice in each season, In this research was studied some physic and chemical parameters. Water specimens for physio-chemical parameters were collected in polyethylene container having volume five liters under surface water about 20-40 cm after the pumping the container with water specimens twice before filling. The limitations utilized here were the Canadian Drinking Water Guidelines and if there was not met with it, Iraqi standard for drinking water or the World Health Organization guidelines are utilized [9, 10]. All tests were carried out following the (APHA) American Public Health Association standard methods [11, 12].

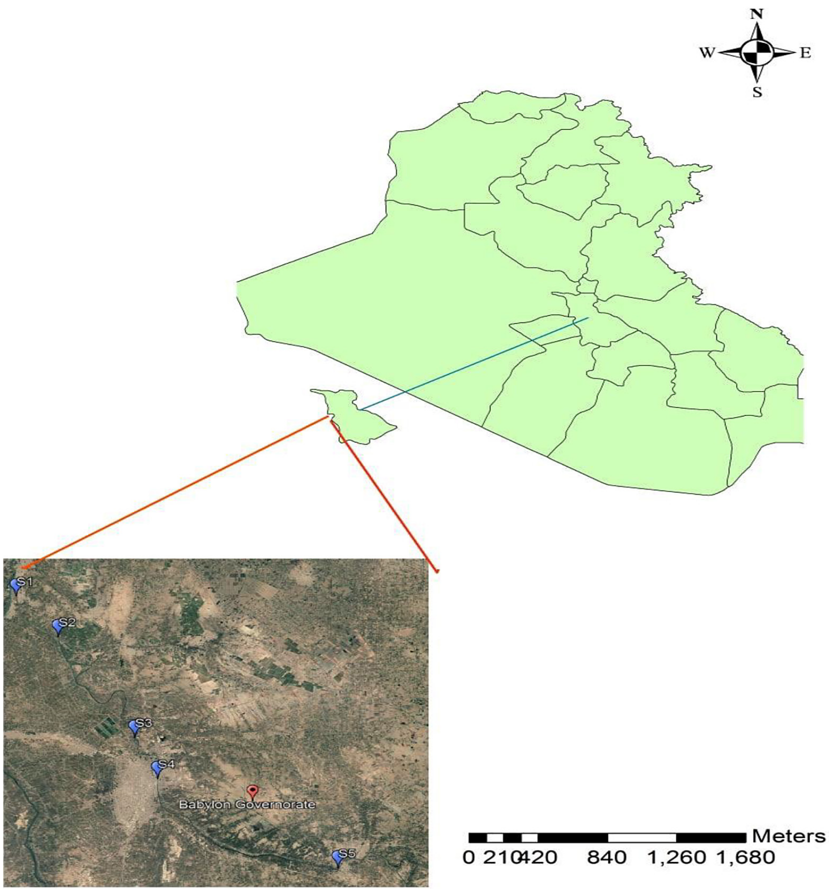


Figure 1. Map of the study area

Calculation of the CCME WQI

The Canadian's model for water quality is described by high precision and has been applied to decide the nature of surface water in the review region for drinking purposes. The detailed formula of the WQI, as described in the Canadian Water Quality Index and found the index magnitude by calculating three factors:

$$F1 = \frac{Number\ of\ Failed\ Variables}{Total\ Number\ of\ Variables} * 100\% \quad (1)$$

$$F2 = \frac{Number\ of\ Failed\ tests}{Total\ Number\ of\ tests} * 100\% \quad (2)$$

Scope, *F1*: It represents the percentage of the number of variables exceeding the standard limits compared to the total number of variables.

Frequency*, F2*: The percentage of the number of tests that exceed the limits of the standard on the total number of tests.

Amplitude*, F*3: is calculated based on the excursion of each failed test relative to its objective. A failed test can either be greater than its objective or less than its objective or, at different times. It is calculated in two stages:

The first stage: in this stage we calculate Excursions:

$$Excursions = \left(\frac{Failed\ Test\ Value}{Objective}\right) - 1 \quad (3)$$

$$\text{Excursions} = \left(\frac{Objective}{Failed\ Test\ Value}\right) - 1 \quad (4)$$

The second stage: in this stage we calculate Normalization of excursion, It is symbolized by nse.

$$nse = \frac{\sum Excursions}{Total\ Number\ of\ tests} \quad (5)$$

$$F3 = \frac{nse}{0.01nse + 0.01} \quad (6)$$

After finding the three factors, the Canadian index is calculated from the following equation:

$$CWQI = 100 - \left(\frac{\sqrt{F_1 + F_2 + F_3}}{1.732}\right) \quad (7)$$

Table 1. Canadian Water Quality Index categorization schema [13]

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

Table 2. Water parameters for surface water in five stations

Sta	Descriptive	Water temperature	pH	TDS	DO	Tur.	TH	No_2^-	No_3^-	SO_4	Cd	Pb
Sta.1	Max.	23.90	7.7	768.00	9.10	15.40	52.00	32.40	21.20	92.00	0.0019	0.07
	Min.	17.00	6.4	725.00	7.80	4.79	22.00	1.34	0.17	12.00	0	0.00
	Mean	19.22	6.91	8.45	10.04	35.50	14.27	4.34	41.25	42.25	0.0003	0.04
Sta.2	Max.	18.40	7.9	728.00	6.60	3.39	25.00	1.16	0.40	10.00	0.00	0.11
	Min.	20.17	6.6	747.33	8.18	11.80	38.00	11.47	6.49	30.51	0.01	0.62
	Mean	20.60	7.01	862.00	10.00	16.70	53.00	36.00	21.20	39.36	0.01	1.54
Sta.3	Max.	15.50	8.08	721.00	7.50	4.04	23.00	0.32	1.20	1.81	0.00	0.05
	Min.	780.83	6.66	9.20	11.32	40.33	14.74	10.23	22.58	0.01	0.41	-
	Mean	15.40	7.482	740.00	7.62	6.60	24.00	0.32	0.36	16.08	0.00	0.05
Sta.4	Max.	17.80	7.94	782.83	9.63	11.47	42.83	17.39	14.43	61.96	0.01	0.42
	Min.	16.00	6.5	749.00	7.69	4.45	23.00	0.28	0.10	10.55	0.01	0.05
	Mean	17.66	7.465	773.20	8.92	9.81	39.20	8.99	4.16	39.06	0.11	0.45
Sta.5	Max.	19	7.8	846	10.4	58	15	40.23	14.4	56.32	0.2181	1.1438
	Min.	16	6.58	749	7.69	23	4.45	0.28	0.104	10.547	0.0113	0.0527
	Mean	17.66	7.366	773.2	8.924	39.2	9.806	8.98	4.163	39.0614	0.1147	0.45306

By magnitude, CWQI magnitude varied from 0 to 100 (with 0 being the poorest and 100 indicating the excellent water quality) that rep- resents the overall water quality. The water quality was classified into five groups as demonstrated in Table 1 which are «poor, marginal, fair, good, or excellent». These same designations have been adopted for the indicators developed here [5, 13].

The main indicators of water quality for this current study involved thirteen pparameters and were: temperature, turbidity (Turb.), pH, dissolved oxygen (DO), five-day biochemical oxygen demand (BOD5), chemical oxygen demand (COD), total dissolved solids (TDS), total hardness (TH), amount of: nitrate (NO3), nitrite(NO2), sulfates (SO4), lead (Pb) and cadmium (Cd).

RESULTS AND DISCUSSION

A systematic procedure for testing the Shatt Al-Hilla River's physical and chemical characteristics in the Babel Governorate was documented. The majority of our research was done between November 2018 and April 2019 for five stations. Table 1 displays the mean, maximum, and lowest magnitudes of all monitored magnitudes in each observation for each station and the test results of several parameters, indicating monthly fluctuation for the Shatt al-Hilla River. Beginning with the warm limit, thickness, explicit weight, consistency, surface pressure, explicit conductivity, saltiness, and solvency of broken down gases, in addition to its impact on the amount of dissolved oxygen in water and the breakdown of the organic components of water, the temperature of water influences a portion of the significant actual properties and attributes of water. As temperature rises, the pace of chemical and biological reactions accelerates (WHO, 2011). The range of the water temperature throughout the research period for all stations within the WHO guidelines for drinking purposes is (15.40-23.9)°C, as demonstrated in Figure 2A. An essential indicator of water quality and the level of pollution in aquatic life is the hydrogen content (pH) of surface water. The chemistry of the water is directly impacted. The biological activity and chemical processes that take place in them cause the magnitudes to increase [14]. The pH findings from stations 1 to 5 are demonstrated in Table 1 and Figure 2B, with the greatest magnitude at station 3 being 8.08 in November and the minimum magnitude at station 1 being 6.4 in January. At every location, the measured turbidity levels exceeded the World Health Organization's recommended limit of fewer than 5 NTU for drinking purposes. Table 2 demonstrate that the study's average turbidity level ranged from 3.39 to 21 NTU The Shatt Al Hilla river's total TDS varies from 721 mg/L to 862 mg/L, which is good in terms of TDS (Fig. 2C), although all of the TDS readings for the study's five stations fall within the accept range as per WHO criteria for drinking purposes. Dissolved oxygen (DO) is a crucial component of water quality that supports aquatic life. The low amount of oxygen has detrimental effects on the aquatic ecosystem because it increases the activity of anaerobic microorganisms, altering the reaction pathways of organic materials and resulting in the production of substances harmful to the aquatic environment. Oxygen works on anaerobic decomposition of organic matter into environmentally harmless products, preventing the formation of toxic substances and unpleasant odors [9]. It should be mentioned that the standard for drinking is 10 mg/L. (WHO, 2011). DO in the Shatt Al-Hilla River ranges from 6.66 to 11 mg/L, suggesting that the relevant DO levels in certain water specimens are within the

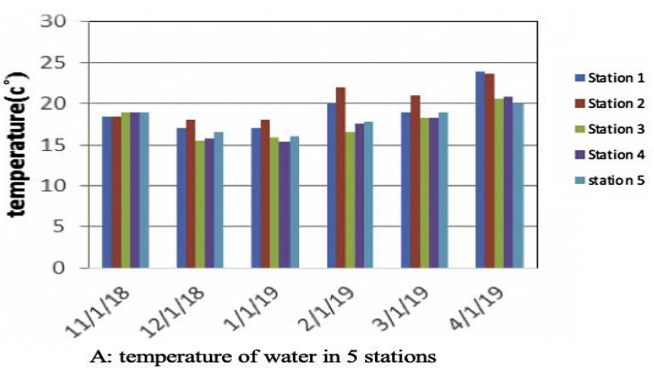
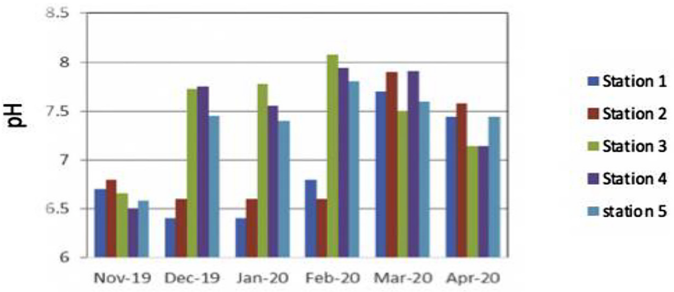
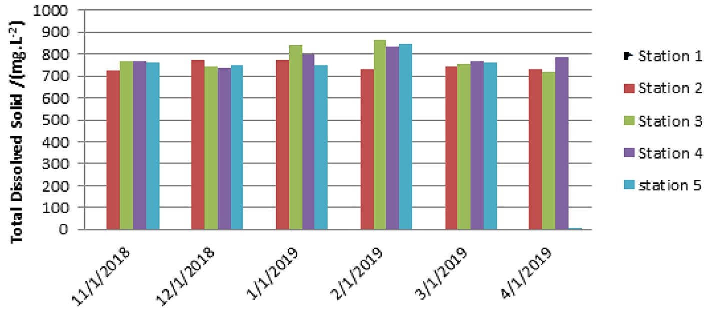


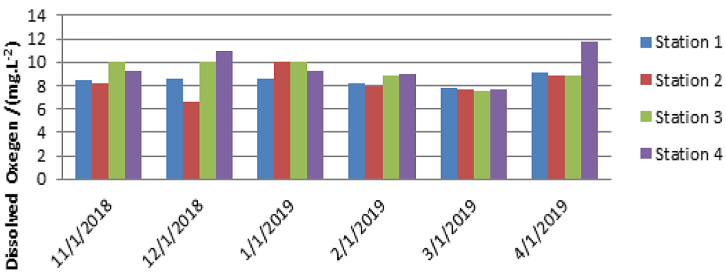
Figure 2. Water quality parameters in five stations (A)



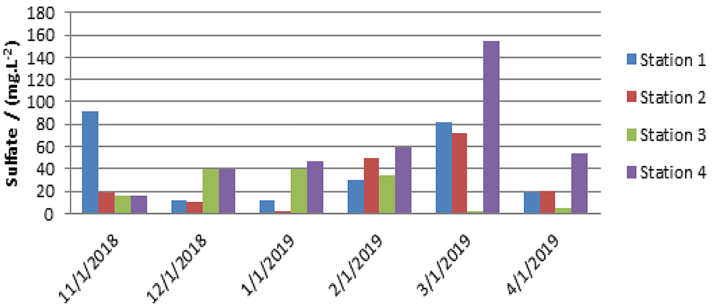
B: pH of water in 5 stations



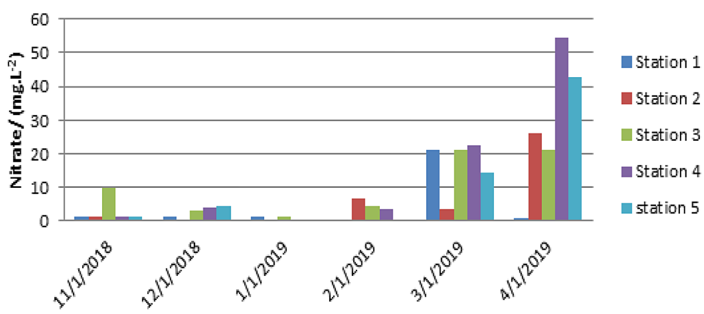
C: TDS of water in 5 stations



D: DO of water in 5 stations



E: So_4 of water in 5 stations



F: No_3 of water in 5 stations

Figure 2. Water quality parameters in five stations (B-F)

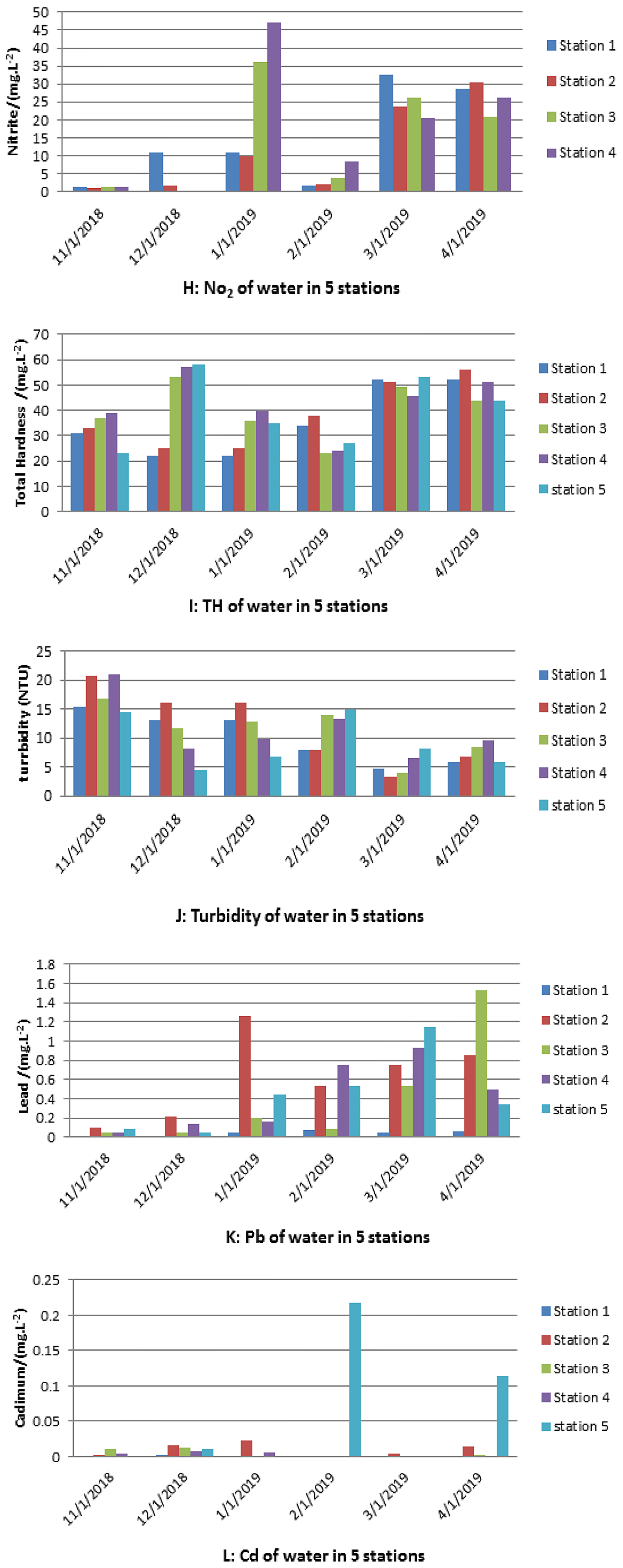


Figure 2. Water quality parameters in five stations (H-L)

allowed limit for drinking purposes, with the exception of some magnitudes that are over the permitted limit as demonstrated in Figure 2D. Aquatic life was impacted by the low amount of dissolved oxygen below the standard limit. It indicates that certain organic contaminants are present in the water and are being broken down by the bacteria. One other reason to reduce the flow rate and the DO level at this time may be to lower the water level. Chemical Oxygen Demand is a crucial indicator of water quality because, like BOD, it offers a scale to evaluate the impact that wastewater discharge will have on the ecosystem. The biological and chemical oxygen demand declined during the course of the investigation and at all locations. When many polyvalent positive ions are present, such as calcium and magnesium ions, as well as other positive ions like barium, iron, manganese, and zinc, but very little orca, the result is hardness, which determines the appropriateness of water for various home purposes [12]. According to the findings in Table 2 and Fig. 2I, the overall hardness amounts at every station decreased during the course of the research period. (Fig. 2F, 2H) demonstrates that while the amount of nitrite (NO_2) was over the acceptable. limit for drinking purposes in accordance with WHO guidelines, the ion (NO_3) was below the legal range for drinking uses at several stations throughout the research period. They may be efficiently connected to the Shatt al-Hilla River's agricultural and industrial operations in this study. Human health is affected by high levels; for instance, it might result in methemoglobinemia in newborns [15, 16]. Sulphate (SO_4^{-2}) is a nutrient that is necessary for both plant and animal tissue development. Sulfate levels were displayed in Figure 2E. All specimen locations had sulphate amounts that were within the WHO's permitted range for use in drinking water. According to Fig. 2K, there are five stations where the lead amount (Pb) is higher than the WHO threshold for use in drinking water. Humans and all aquatic species are at danger of health problems at the current levels. Lead exposure has been related to a number of illnesses, involving anemia, memory loss, appetite loss, brain damage, and mortality [17]. As demonstrated in Fig. 2L, certain stations' cadmium (Cd) measurements were outside of the allowable limits set by the WHO The high levels of cadmium amount discovered might put the living things in risk. Additionally, the water's Cd content rendered it unsuitable. for aquaculture and the irrigation of fresh vegetable. fields. Cadmium is a substance that should be avoided since it poses a risk to human health and that of other living things. High levels of cadmium may have been caused by companies and risky waste areas discharging contaminants into the air and water. The high amount of Cd has been linked to a number of diseases in humans and aquatic species, involving cancer, lung, kidney, and immune system damage, which might ultimately result in death [10]. The physical and chemical metrics for surface water quality have changed, and these characteristics may be utilized as markers of ecological variation in the aquatic system. This information has largely been advanced in the publications. By connecting water quality to possible uses of water, it is possible to link temporal changes in an aquatic system and document how these changes affect the environment [18]. CCME WQI average magnitudes for five stations varied from 61.94 to 81.93. These data reveal that the water quality for drinking purposes may be assessed as Marginal in

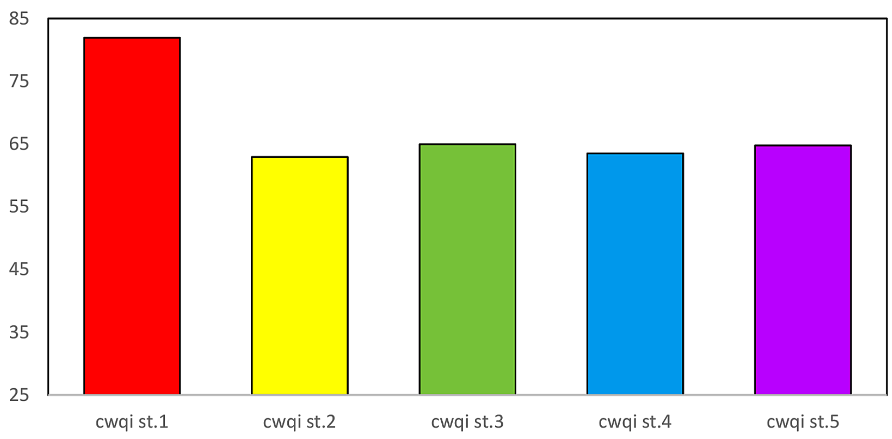


Figure 3. Average magnitudes of Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) for five station

all sites, with the exception of Station 1, where the water quality index was evaluated as good as demonstrated in Figure 3. Different sorts of pollutants that flow to the Shatt Al-Hilla river, involving as household garbage, rainwater, industrial wastes, agricultural waste runoff, and other sources, are to blame for the river's declining condition. All of which, if left unchecked, may have significant short- and long-term consequences on a river system's health. Additionally, the area's recent dry spell may be to blame for the declining indication of water quality.

CONCLUSIONS

This study evaluated the quality of water for the five locations sited along with Shatt Al-Hilla River in Babel city by utilizing the CWQI. Based on the obtained magnitudes of the water quality the it were accomplished to follow ends:

The magnitude of CWQI for all station indicate that water quality for drinking uses can be rated as Marginal in all site except station 1 water quality index was rated good.

The CCME is an excellent tool for integrated watershed planning and management in the water quality sector to improve the quality future change of water quality parameters.

In general, it is recommended that pre-treatment of water is very important before consumption to avoid diseases that water-borne.

REFERENCES

1. Tirkey Poonam, Bhattacharya Tanushree, & Chakraborty Sukalyan 2015. Water quality indices-important toolsfor water quality assessment: A review. International Journal of Advances in Chemistry (IJAC), 1(1), 15–29. https://doi.org/10.5121/ijac.2015.1102
2. Dowgert, M. 2010. The impact of irrigated agriculture on a STab. Food Supply. Proceedings of the 22nd Annual Central Plains Irrigation Conference, 1–11.
3. Saffran, K., Environment, A., Cash, K., & Canada, E. 2001. Canadian Water Quality Guidelines for the Protection of Aquatic Life CCME WATER QUALITY INDEX 1.0. User's Manual. 1–5.
4. Mccarty, D. 2018. The Arizona Water Quality Index : A Communication Tool for Water Quality Summaries. April, 1–36.
5. Tyagi, S., Sharma, B., Singh, P., & Dobhal, R. 2020. Water quality assessment in terms of water quality index. American Journal of Water Resources, 1(3), 34–38. https://doi.org/10.12691/ajwr-1-3-3
6. Ouyang Y. 2005. Evaluation of river water quality monitoring stations by principal component analysis. Water Res. 39: 2621–2635.
7. Lodder W.J, Van den Berg, H.H., Rutjes, S.A, de Roda Husman, A.M. 2010. Presence of enteric viruses in source waters for drinking water production in The Netherlands. Appl. Environ. Microbiol. 76: 5965–5971.
8. Cambers G, Ghina, F. Water Quality, an Introduction to Sandwatch. An Educational Tool for Sustainable Development. United Nations Educational, Scientific and Cultural Organization (UNESCO): Paris, France. 2005; p. 25-31.
9. IQS: Drinking-Water Standard IQS: 417, Central Organization for Quality Control and Standardization, Council of Ministers, Republic of Iraq, 2001. 417, 2nd update 2009 for chemical and physical limits.
10. WHO. Guidelines for Drinking-Water Quality, 4th ed.; WHO: Geneva, Switzerland, 2011; p. 155.
11. APHA. Standard methods for the examination of water and waste water. 21stEdn., Washington, DC. 2005.
12. APHA. Standard methods for the examination of water and waste water. 23RD Edn., 2017.
13. Khan, H., Ali Khan, A., & Hall, S. 2005. The canadian water quality index: A tool for water resources management. MTERM International Conference, September, 8.
14. Al-Safawi, Abdel-Aziz Younis Talei; Al-Maadidi, Alaa Talaat Hussein 2017. Qualitative evaluation of effluents of Wadi Akab north of Mosul city for irrigation farms. Tikrit Journal of Pure Sciences. 22(12), 14-20.
15. Fox, C.; Richardson, K.; Maidment, I.D.; Savva, G.; Matthews, F.; Smithard, D.; Coulton, S.; Katona, C.; Boustani, M.A.; Brayne, C. 2011. Anticholinergic medication use and cognitive impairment in the older population: the medical research council cognitive function and ageing. Study. J. Am. Geriatr. Soc. 59, 1477–1483.
16. Nartey, V.K.; Hayford, E.K.; Ametsi, S.K. 2012. Assessment of the impact of solid waste dumpsites on some surface water systems in the Accra Metropolitan Area. Ghana. J. Water Resour. Prot. 4, 605.
17. Ayandiran, T.; Fawole, O.; Dahunsi, S. 2018. Water quality assessment of bitumen polluted Oluwa River, South-Western Nigeria. Water Resour. Ind. 19, 13–24.
18. Shala Abazi, A.M., Durmishi, B.H., Sallaku, F.S., Çadraku, H.S., Fetoshi, O.B., Ymeri, P.H., & Bytyçi, P.S. 2020. Assessment of water quality of sitnica river by utilizing water quality index (WQI). Rasayan Journal of Chemistry, 13(1), 146–159. https://doi.org/10.31788/RJC.2020.1315344