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Evaluation of Water Quality Index (WQI) in and around Dhaka City Using Groundwater Quality Parameters

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Abstract: Groundwater quality deterioration due to anthropogenic natural activities and its immense utilization in various sectors is considered a great concern. The aim of this study is to determine the groundwater quality parameters at various sources in and around Dhaka city and compare them with Bangladesh drinking water standards. In this study, six groundwater quality parameters (pH, DO, COD, TS, TDS, and arsenic) and ten groundwater samples are analyzed to determine the water quality. The collected samples have maximum and minimum pH values of 6.9 and 6.4, respectively. Maximum and minimum DO values are 0.3 and 0.1 mg/L, respectively. The arsenic concentration is 0 mg/L for all collected groundwater samples. The maximum and minimum COD values are 0.3 and 0.1 mg/L, respectively. The maximum and minimum TS values are 4 and 1 mg/L, respectively. The obtained values are then compared with the Bangladesh drinking water quality standards. Finally, the water quality index (WQI) values are calculated to determine the suitable uses of groundwater in and around Dhaka city. Based on WQI values, the groundwater quality is excellent in the study area.

Keywords: groundwater; water quality index (WQI); water standards; drinking water quality standards; arsenic; groundwater quality

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1. Introduction

Usable water is limited but quite necessary for all living beings in the world. In the seas and in ice caps and glaciers, about 97 and 2% of the earth's water are reserved, respectively. However, the saline/salty water is quite unusable for drinking and even irrigation unless treated. In the atmosphere, only about 0.001% of total water is available [1–4]. It is important to conserve water by managing water resources properly and by using available water wisely. People should think about sustainable water use without diminishing the available water resources [5]. Water is an important component in environmental and water-related activities in all countries, such as maritime shipping, embankments, seaports, dams, and inland waterways.

Human activities and natural phenomena affect groundwater in terms of quality and quantity [6]. It is a big concern nowadays as usable water shortage is increasing day by day. In many places of the world, people cannot obtain enough water to wash their dishes, so they use various sands to wash and clean utensils.

Groundwater's physicochemical and microbiological characteristics reveal how safe drinking water is, and its examination is crucial for research on public health and pollution. The purpose of collecting representative samples of groundwater is to identify basic scientific knowledge about the parameters for a particular water usage. Groundwater quality must be determined regularly because it is neither uniform nor equal. The measurement of water parameters is used to describe the water's quality [7,8]. Various kinds of water quality parameters, such as physicochemical parameters, hazardous compounds, and microbiological parameters, can be determined to know their nature and potential impact.

User perception is one of the most significant factors when it comes to drinking water quality. The perception of drinking water quality is influenced by a variety of elements such as odor, taste, and color, and taste is especially significant since it may identify chemical contamination of the water. In drinking water, concentrations of metals, which impact taste and affect public health, should be monitored regularly [9]. pH and alkalinity play important roles in groundwater quality [10]. The water is viewed as being of poor quality when it turns yellow in color. People only depend on groundwater for drinking even though it is slightly alkaline and moderately hard in Nanganur, South India [11].

When people experience health issues brought on by water, they may perceive hazards [12,13]. There are no globally recognized and agreed international standards for drinking water, despite the fact that every human on earth needs access to clean drinking water to survive and that water can include a variety of dangerous contaminants. Even in cases when standards are present and being followed, the permissible concentration of each ingredient may differ by up to ten times between different sets of criteria [14].

The application of the water quality index (WQI), which depends on some water quality parameters, has great potential and is a useful tool in any region. In Malaysia, surface water quality was classified using WQI, which comprises six water quality parameters, e.g., pH, BOD, DO, COD, SS, and ammoniacal nitrogen (AN) [15,16].

Groundwater quantity and quality modeling is very important for sustainable uses of groundwater aquifers. Moreover, an estimation of the WQI of groundwater is quite necessary to realize the present condition. The groundwater quality such as poor, good, and excellent can be classified by WQI values [17]. Due to the agricultural effect and the infiltration of rainwater, ion concentrations are increased as indicated by WQI values at the Tefenni plain in Burdur, Turkey [18]. In Nanganur, South India, about 86% of groundwater samples are of poor quality for drinking, as indicated by a WQI value of 153 [11].

Mahmud et al. [19] assessed the groundwater quality in terms of WQI for drinking purposes in Khulna city of Bangladesh by using the procedure derived by Horton [20]. Akter et al. [21] investigated the groundwater quality parameters in rural areas (24 randomly selected upazilas) of Bangladesh, such as pH, salinity, Mn, As, and Fe. They found that 33% of collected groundwater samples had good-quality water for drinking purposes based on the WQI.

In Dhaka, groundwater quality has not been fully studied yet by using WQI. Therefore, the specific objectives of this study are to determine the groundwater quality parameters at various sources in and around Dhaka city, compare them with Bangladesh drinking water standards, and determine the WQI of groundwater for suitable uses. A huge quantity of groundwater is withdrawn daily for various purposes in Bangladesh, e.g., irrigation, industrial, and domestic uses. Therefore, the groundwater quality should be monitored regularly.

2. Methods

2.1. Study Area

Since the research was carried out on groundwater located in the Uttara and Gazipur areas (in and around Dhaka city, Bangladesh), all the groundwater samples were taken

carefully, where stations were about 5 km apart from each other. The study was carried out in Uttara and Gazipur of Bangladesh on the basis of water demand for the increasing rate of pollution and providing water for drinking purposes. To understand the pollution problem and to arrive at a planning solution to alleviate the problem, the following procedure was applied in completing the study.

2.2. Sample Collection

Groundwater samples were collected from ten different locations in Uttara (Sectors 4, 10, 11, and 12, Diyabari and Khalpar) and Gazipur. Before collecting water samples, the plastic bottles were washed thoroughly using pure water. The bottles were almost completely filled with sample groundwater and, for ease of identification, each bottle was marked by a marker. The samples were collected from 19 to 21 October (9.00 AM–2.00 PM) from Uttara and Gazipur (Table 1 and Figure 1). The samples were collected mostly from the residential areas in and around Dhaka city. A location in the Gazipur area and nine locations in the northern part of Dhaka were selected due to time constraints.

Table 1. Details of groundwater sample collection.

Sample No.	Location	Collection Date	Collection Time
1.	Khalpar, Sector 12, Uttara, Dhaka	19 October 2020	9.00 AM–2.00 PM
2.	Chandhona, Gazipur	19 October 2020	9.00 AM–2.00 PM
3.	Abdulapur, Uttara	19 October 2020	9.00 AM–2.00 PM
4.	Sector 11, Road 12, Uttara	20 October 2020	9.00 AM–2.00 PM
5.	Sector 4, Road 5, Uttara	20 October 2020	9.00 AM–2.00 PM
6.	Fulbaria, Uttara	20 October 2020	9.00 AM–2.00 PM
7.	Sector 11, Road 19, Uttara	20 October 2020	9.00 AM–2.00 PM
8.	Sector 7, Crescent hospital, Uttara	21 October 2020	9.00 AM–2.00 PM
9.	Sector 10, Road 11, Uttara	21 October 2020	9.00 AM–2.00 PM
10.	Sector 10, Road 20, Uttara	21 October 2020	9.00 AM–2.00 PM

Figure 1. Locations of groundwater sample collection (starred marked) in and around Dhaka city (adapted from Google Maps).

2.3. Data Collection

A few parameters were tested in the laboratory, such as pH, DO, COD, TS, TDS, and arsenic. DO, pH, arsenic, COD, TS, and TDS are measured by a DO meter (Lutron Electronic Enterprise Co., Ltd., Taiwan), pH meter (Hanna Instruments, Cluj, Romania), arsenic test kit, chemical analysis (titration), oven dry method, and filtration and drying method, respectively, according to standard methods. Then, the obtained results were analyzed and compared with the Bangladesh drinking water standards according to ECR [22].

2.4. WQI Calculation

The calculation of WQI was carried out in this study according to Horton [20]. The whole calculation was divided into three stages: (i) calculation of unit weight of water quality parameters, (ii) calculation of quality rating of water quality parameters, and (iii) calculation of water quality indices.

2.4.1. Calculation of Unit Weight

Equation (1) shows the calculation of the unit weight (W_n).

$$W_n = k/S_n \quad (1)$$

where S_n is the standard permissible value of a water quality parameter. Equation (2) shows the calculation of the constant of proportionality (k).

$$k = 1/\Sigma(1/Sn) \quad (2)$$

2.4.2. Calculation of Quality Rating

Equation (3) shows the calculation of the quality rating (q_n).

$$q_n = (V_n - V_{id})100/(S_n - V_{id}) \quad (3)$$

where V_n is the estimated value of the nth water quality parameter. V_{id} is the ideal value for the nth parameter in distilled water (V_{id} for pH = 7 and 0 for all other parameters).

2.4.3. Formula of WQI

Equation (4) shows the calculation of the WQI.

$$\text{WQI} = \sum q_n W_n / \sum W_n \quad (4)$$

3. Results and Discussion

3.1. Groundwater Quality Parameters

For the purpose of WQI calculation in the study area, six water quality parameters were selected. The higher values of these parameters would increase the WQI value.

Figure 2 shows the pH values of groundwater where the highest pH value was 6.9 and the lowest value was 6.4. The pH values of drinking water quality standards in Bangladesh according to ECR [22] range from 6.5 to 8.5. According to Huq and Hossain [23], the pH in groundwater ranges from 5.8 to 7.9 in Dhaka city (Zone 6), which is close to the findings of the present study. Figure 3 shows the COD values of groundwater where the highest COD value was 0.3 ppm and the lowest value was 0.1 ppm. In Bangladesh, the allowable limit of COD value is 4 ppm according to ECR [22]. It shows that all the tested parameters are within the limit of Bangladesh drinking water standards.

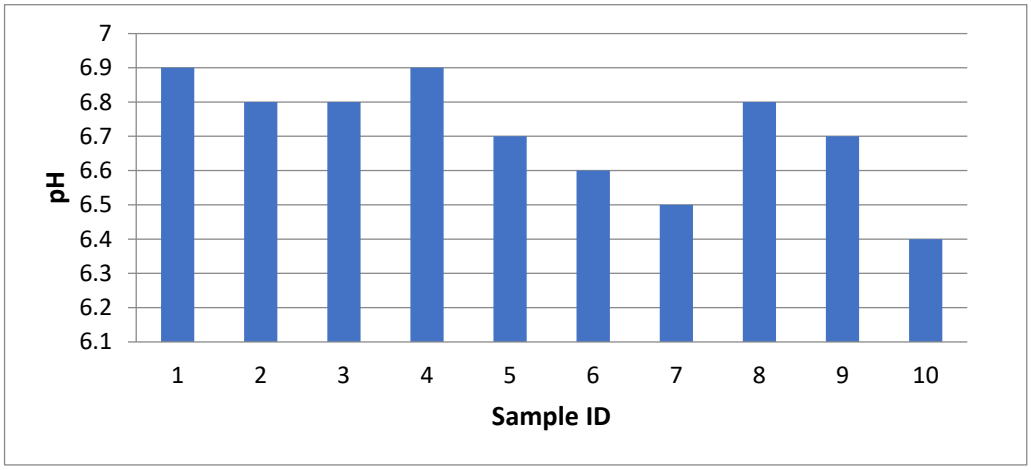

Figure 2. pH values of groundwater at various locations in Dhaka.

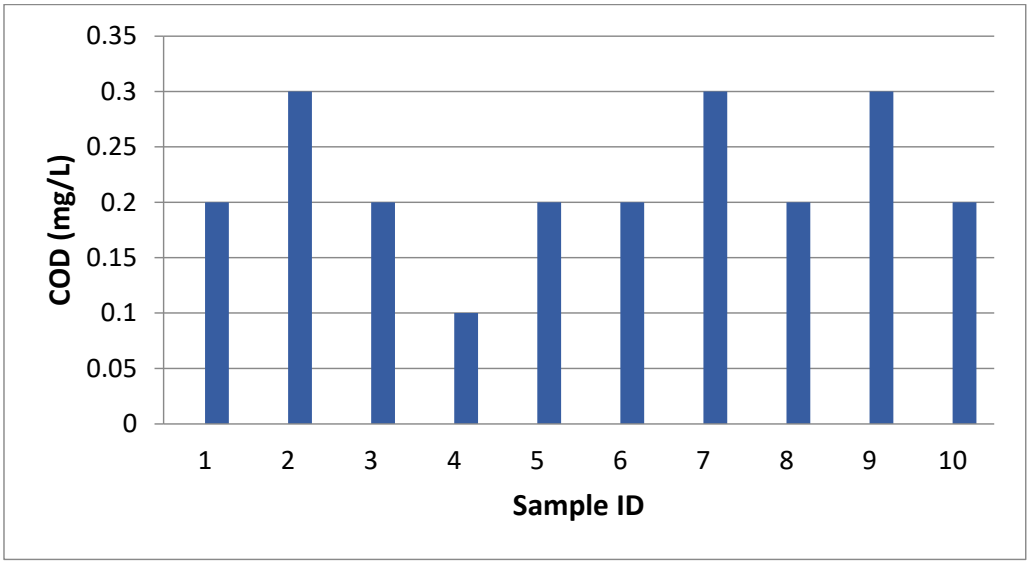

Figure 3. COD values of groundwater at various locations in Dhaka.

Figure 4 shows the TS values of groundwater where the highest TS value was 4 ppm and the lowest value was 1 ppm. In Bangladesh, the allowable limit of TS value is 1010 ppm according to ECR [22]. According to Huq and Hossain [23], the TS in groundwater ranges from 5.09 to 9.08 in Dhaka city (Zone 6), which is slightly different from the findings of the present study. Figure 5 shows the TDS values of groundwater where the highest TDS value was 0.3 ppm and the lowest value was 0.1 ppm. In Bangladesh, the allowable limit of TDS value is 1000 ppm according to ECR [22]. The TDS in groundwater ranges from 5.0 to 9.03 in Dhaka city (Zone 6), which is different from the findings of the present study (Huq and Hossain [23]). Therefore, to obtain accurate concentrations of groundwater quality parameters and the latest scenario, further studies are suggested. Figure 6 shows the DO values of groundwater where the highest DO value was 0.3 ppm and the lowest value was about 0.1 ppm. In Bangladesh, the allowable limit of DO value is 6 ppm according to ECR [22]. It shows that all the tested parameters are within the limit of Bangladesh drinking water standards. The arsenic concentration is 0 ppm for all collected groundwater samples, whereas in Bangladesh, the allowable limit of arsenic value is 0.05 ppm according to ECR [22].

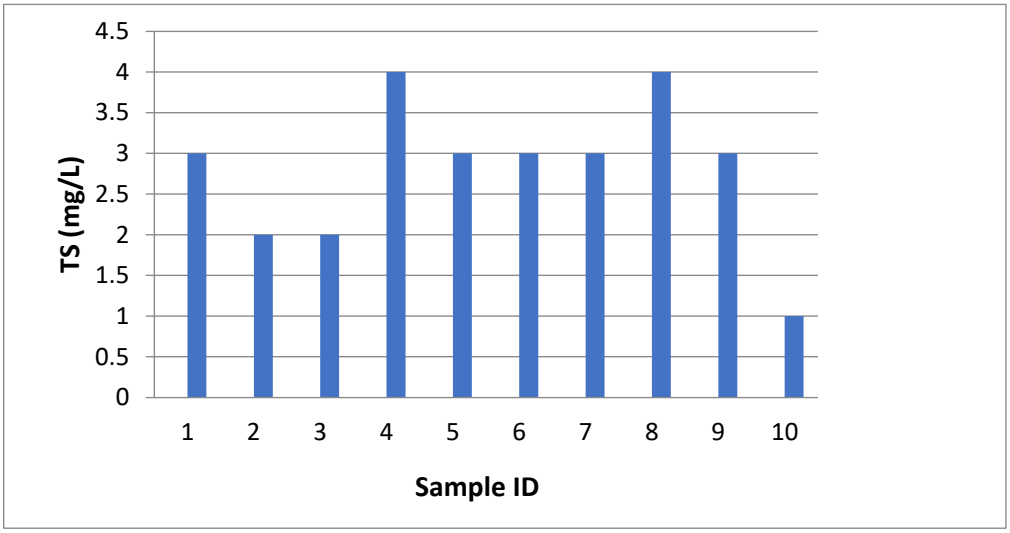

Figure 4. TS values of groundwater at various locations in Dhaka.

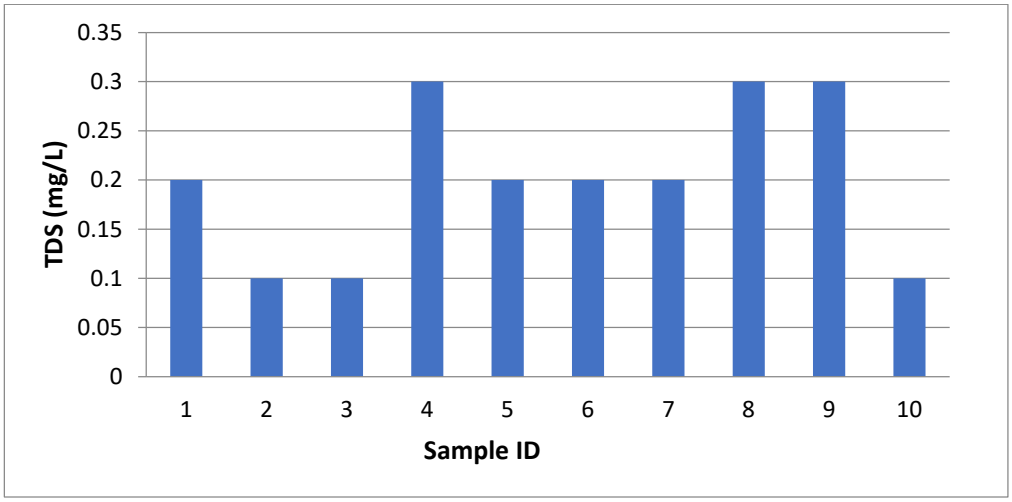

Figure 5. TDS values of groundwater at various locations in Dhaka.

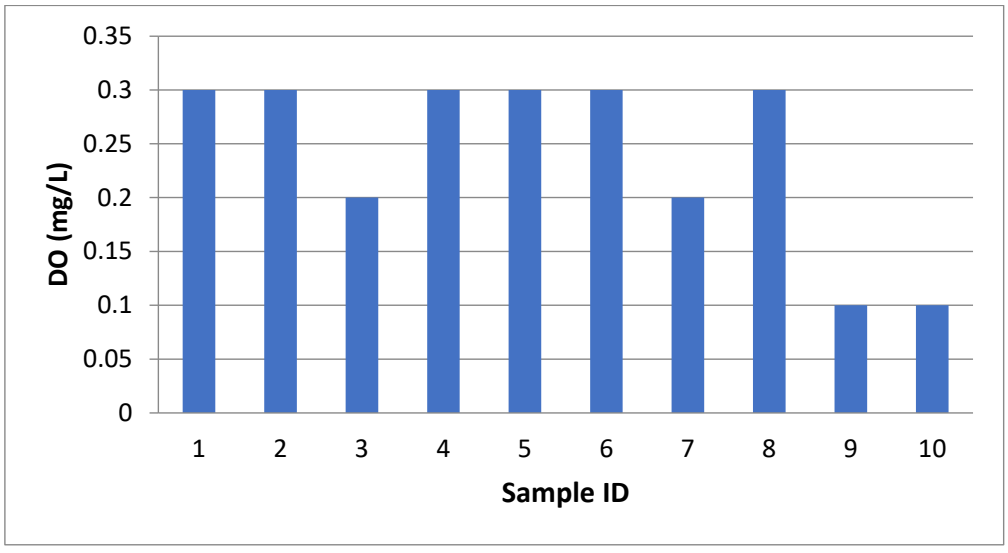

Figure 6. DO values of groundwater at various locations in Dhaka.

3.2. Unit Weight of Water Quality Parameters

In Table 2, the values of the constant of proportionality (k) and unit weight (Wn) were calculated according to formulae mentioned in the methodology section. The drinking water quality standards (S_n) in Bangladesh according to ECR [22] are shown to calculate k and Wn values, where the highest range of pH is taken. The summation of Wn values for a groundwater sample is 1. Wn values of groundwater quality parameters are required to calculate the WQI values of all groundwater samples.

Table 2. Unit weights and standard values of groundwater quality parameters to calculate WQI of groundwater samples.

SL. No.	Parameter	Standard Values, S_n	Recommended Agency for S_n	$1/S_n$	Constant of Proportionality, $k = 1/(\sum 1/Sn)$	Unit Weight, $W_n = k/Sn$
1	pH	6.5–8.5	ECR [22]	0.11765	0.04869	0.00573
2	DO (mg/L)	6	ECR [22]	0.16667	0.04869	0.00812
3	COD (mg/L)	4	ECR [22]	0.25000	0.04869	0.01217
4	TS (mg/L)	1010	ECR [22]	0.00099	0.04869	0.00005
5	TDS (mg/L)	1000	ECR [22]	0.00100	0.04869	0.00005
6	Arsenic (mg/L)	0.05	ECR [22]	20.00000	0.04869	0.97389
				$\sum 1/Sn$ = 20.5363		$\sum Wn$= 1.00000

3.3. WQI of Groundwater Samples

Table 3 shows two sample data sets of the WQI values out of 10 groundwater samples including the observed values, standard values, ideal values, unit weights, and quality rating of different water quality parameters (details in Appendix A). The ideal values of the parameters are the values of water quality parameters in distilled water. It shows that all the tested parameters are within the limit of Bangladesh drinking water standards.

Table 3. WQI values of groundwater samples.

Sample No.	Parameters	Observed Values, Vn	Standard Values, Sn	Recommended Agency	Ideal Value, Vid	Unit Weight, Wn	Quality Rating, $qn = (Vn - Vid)/(Sn - Vid) \times 100$	$Wnqn$	$\sum Wnqn$	WQI = $\sum Wn\,qn / \sum Wn$
1	pH	6.9	8.5	ECR [22]	7	0.005729	6.666667	0.038192	0.140	0.140
	DO (mg/L)	0.3	6	ECR [22]	0	0.008116	5.000000	0.040579		
	COD (mg/L)	0.2	4	ECR [22]	0	0.012174	5.000000	0.060868		
	TS (mg/L)	3	1010	ECR [22]	0	0.000048	0.297030	0.000014		
	TDS (mg/L)	0.2	1000	ECR [22]	0	0.000049	0.020000	0.000001		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		
2	pH	6.8	8.5	ECR [22]	7	0.005729	13.333333	0.076383	0.208	0.208
	DO (mg/L)	0.3	6	ECR [22]	0	0.008116	5.000000	0.040579		
	COD (mg/L)	0.3	4	ECR [22]	0	0.012174	7.500000	0.091302		
	TS (mg/L)	2	1010	ECR [22]	0	0.000048	0.198020	0.000010		
	TDS (mg/L)	0.1	1000	ECR [22]	0	0.000049	0.010000	0.000000		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		

In Table 4, the WQI values of ten groundwater samples are summarized. The average WQI value is 0.211. The water quality status based on WQI values of S1–S10 samples is shown in Table 5. The status is excellent, and the possible uses are drinking, irrigation, and industrial purposes.

Table 4. Summary of WQI values at various locations in Dhaka using the data of present study.

Sample No.	Sampling Location	WQI
1	Khalpar, Adjacent to Sector 12, Uttara, Dhaka	0.140
2	Chandhona, Gazipur	0.208
3	Abdulapur, Uttara	0.164
4	Sector 11, Road 12, Uttara	0.109
5	Sector 4, Road 5, Uttara	0.216
6	Fulbaria, Uttara	0.241
7	Sector 11, Road 19, Uttara	0.292
8	Sector 7, Crescent Hospital, Uttara	0.216
9	Sector 10, Road 11, Uttara	0.219
10	Sector 10, Road 20, Uttara	0.303
	Average	0.211

Table 5. Water quality status based on WQI values (Horton [20]).

SL. No.	WQI	Status	Possible Usages	Representing Samples (This Study)
1	0–25	Excellent	Drinking, Irrigation and Industrial	S1, S2, S3, S4, S5, S6, S7, S8, S9, S10
2	26–50	Good	Domestic, Irrigation and Industrial	Nil
3	51–75	Fair	Irrigation and Industrial	Nil
4	76–100	Poor	Irrigation	Nil
5	101–150	Very Poor	Restricted use for Irrigation	Nil
6	Above 150	Unfit for Drinking	Proper treatment required before use	Nil

In the Dhaka megacity, Sharmin et al. [24] investigated groundwater quality (47 groundwater samples) and provided an overview of the WQI of groundwater. The majority of the collected samples were categorized as "Excellent and Good". These are appropriate for any purpose (such as drinking, irrigation, and domestic) without posing any health risks to the public. The result of the present study is in line with it. They conducted a comprehensive study on groundwater in Dhaka; however, they did not consider microbiological parameters.

Huq and Hossain [23] assessed the groundwater quality parameters of Zone 6 in Dhaka city. They tested nine groundwater quality parameters such as pH, color, turbidity, TS, TDS, TSS, hardness, chloride, and iron. However, the microbiological parameters were not tested, and WQI values were not calculated. The WQI values are calculated in the present study by using the reported data (i.e., groundwater quality parameters). Table 6 shows the summary of WQI values at various locations in Dhaka (Zone 6) using the data of the previous study as reported by Huq and Hossain [23]. The average WQI value (39.099) shows that the status is "Good".

Table 6. Summary of WQI values at various locations in Dhaka (Zone 6) using the observed data of previous study *.

Sample No.	Sampling Location	WQI
1	PG Hospital "C" Water Pump	92.075
2	Circuit House "C" Water Pump	36.176
3	Bijoynagar "C" Water Pump	84.189
4	Shegunbagicha "A" Water Pump	15.733

Table 6. *Cont.*

Sample No.	Sampling Location	WQI
5	New Eskaton (Old Passport Office) "A" Water Pump	23.323
6	Dhaka Medical Water Pump	18.651
7	Rajarbag Old-1 "A" Water Pump	27.107
8	Fakirapul "A" Water Pump	22.369
9	Mogbazar Wireless "C" Water Pump	88.383
10	AGB Colony (SOC) Water Pump	86.514
11	MogbazarDilu Road "C" Water Pump	14.808
12	Kakrail Water Pump	43.715
13	Siddheswari Girls' School Water Pump	38.953
14	Vigarunnisa Water Pump	41.323
15	Khilgaon-2 Water Pump	32.675
16	Khilgaon-3 Water Pump	24.293
17	Polwel Water Pump	60.404
18	Shahjahanpur Water Pump	18.919
19	ArambagBalur Math Water Pump	17.723
20	Nagar Bhaban Water Pump	19.076
21	High Court Water Pump	26.903
22	Birdem Water Pump	26.860
	Average	39.099

* WQI values are calculated in this study using the data of the previous study of Huq and Hossain [23].

4. Conclusions

This study revealed that the collected groundwater samples had maximum pH, DO, COD, As, and TS values of 6.9 (-), 0.3, 0.3, 0, and 4 ppm, respectively. All the tested groundwater quality parameters comply with the Bangladesh drinking water quality standards, i.e., groundwater quality is excellent by considering ten groundwater samples with six groundwater quality parameters. The average WQI value is 0.211. The water quality status based on WQI values is excellent, and the possible uses are drinking, irrigation, and industrial purposes. Based on the findings, the following suggestions are recommended as only a few quality parameters were considered in this research due to time constraints. More samples can be collected and more water quality parameters can be tested for each sample, e.g., turbidity, NPK, heavy metals (As, Pb, Cd, Cr, and Fe), and color. Further research on the evaluation of microbiological water quality (e.g., total coliforms (TC), fecal coliforms (FC), and *Escherichia coli* (*E. coli*)) is recommended as compulsory, as it is associated with human health risks. Seasonal variations in groundwater quality parameters in Dhaka and in Bangladesh can be studied. Then, WQI can be estimated in further studies. Moreover, GIS-based studies can be conducted further, such as examining spatial changes in the measured hydrochemical parameters according to surface and subsurface conditions and the spatial distribution of WQI values according to the aquifer characteristics and surface environmental conditions. In the present study, only a site in the Gazipur area and nine sites in the northern part of Dhaka were selected due to time constraints. Therefore, further studies on the selected sites and on more sites in and around Dhaka city for the selected groundwater quality parameters are recommended to obtain accurate concentrations of groundwater quality parameters and the latest scenario. It is also necessary to further study the impacts of land use, land cover changes, and anthropogenic activities on groundwater quality parameters in the selected or other locations in and around Dhaka city.

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Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
ECR	Environment Conservation Rules
mg/L	Milligram per liter
TDS	Total Dissolved Solids
TS	Total Solids
TSS	Total Suspended Solids
WHO	World Health Organization
WQI	Water Quality Index

Appendix A

Table A1. Water quality index values of groundwater samples.

Sample No.	Parameters	Observed Values, *Vn*	Standard Values, *Sn*	Recommended Agency	Ideal Value, *Vid*	Unit Weight, *Wn*	Quality Rating, $qn = (Vn - Vid)/(Sn - Vid) \times 100$	*Wnqn*	$\sum Wnqn$	WQI = $\sum Wnqn / \sum Wn$
3	pH	6.8	8.5	ECR [22]	7	0.005729	13.333333	0.076383	0.164	0.164
	DO (mg/L)	0.2	6	ECR [22]	0	0.008116	3.333333	0.027052		
	COD (mg/L)	0.2	4	ECR [22]	0	0.012174	5.000000	0.060868		
	TS (mg/L)	2	1010	ECR [22]	0	0.000048	0.198020	0.000010		
	TDS (mg/L)	0.1	1000	ECR [22]	0	0.000049	0.010000	0.000000		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		
4	pH	6.9	8.5	ECR [22]	7	0.005729	6.666667	0.038192	0.109	0.109
	DO (mg/L)	0.3	6	ECR [22]	0	0.008116	5.000000	0.040579		
	COD (mg/L)	0.1	4	ECR [22]	0	0.012174	2.500000	0.030434		
	TS (mg/L)	4	1010	ECR [22]	0	0.000048	0.396040	0.000019		
	TDS (mg/L)	0.3	1000	ECR [22]	0	0.000049	0.030000	0.000001		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		
5	pH	6.7	8.5	ECR [22]	7	0.005729	20.000000	0.114575	0.216	0.216
	DO (mg/L)	0.3	6	ECR [22]	0	0.008116	5.000000	0.040579		
	COD (mg/L)	0.2	4	ECR [22]	0	0.012174	5.000000	0.060868		
	TS (mg/L)	4	1010	ECR [22]	0	0.000048	0.396040	0.000019		
	TDS (mg/L)	0.2	1000	ECR [22]	0	0.000049	0.020000	0.000001		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		
6	pH	6.6	8.5	ECR [22]	7	0.005729	26.666667	0.152766	0.241	0.241
	DO (mg/L)	0.2	6	ECR [22]	0	0.008116	3.333333	0.027052		
	COD (mg/L)	0.2	4	ECR [22]	0	0.012174	5.000000	0.060868		
	TS (mg/L)	3	1010	ECR [22]	0	0.000048	0.297030	0.000014		
	TDS (mg/L)	0.2	1000	ECR [22]	0	0.000049	0.020000	0.000001		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		
7	pH	6.5	8.5	ECR [22]	7	0.005729	33.333333	0.190958	0.292	0.292
	DO (mg/L)	0.3	6	ECR [22]	0	0.008116	5.000000	0.040579		
	COD (mg/L)	0.2	4	ECR [22]	0	0.012174	5.000000	0.060868		
	TS (mg/L)	4	1010	ECR [22]	0	0.000048	0.396040	0.000019		
	TDS (mg/L)	0.2	1000	ECR [22]	0	0.000049	0.020000	0.000001		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		

Table A1. *Cont.*

Sample No.	Parameters	Observed Values, *Vn*	Standard Values, *Sn*	Recommended Agency	Ideal Value, *Vid*	Unit Weight, *Wn*	Quality Rating, *qn* = (*Vn* − *Vid*)/(*Sn* − *Vid*) × 100	*Wnqn*	∑*Wnqn*	WQI = ∑*Wnqn*/∑*Wn*
8	pH	6.7	8.5	ECR [22]	7	0.005729	20.000000	0.114575	0.216	0.216
	DO (mg/L)	0.3	6	ECR [22]	0	0.008116	5.000000	0.040579		
	COD (mg/L)	0.2	4	ECR [22]	0	0.012174	5.000000	0.060868		
	TS (mg/L)	4	1010	ECR [22]	0	0.000048	0.396040	0.000019		
	TDS (mg/L)	0.2	1000	ECR [22]	0	0.000049	0.020000	0.000001		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		
9	pH	6.7	8.5	ECR [22]	7	0.005729	20.000000	0.114575	0.219	0.219
	DO (mg/L)	0.1	6	ECR [22]	0	0.008116	1.666667	0.013526		
	COD (mg/L)	0.3	4	ECR [22]	0	0.012174	7.500000	0.091302		
	TS (mg/L)	3	1010	ECR [22]	0	0.000048	0.297030	0.000014		
	TDS (mg/L)	0.3	1000	ECR [22]	0	0.000049	0.030000	0.000001		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		
10	pH	6.4	8.5	ECR [22]	7	0.005729	40.000000	0.229149	0.303	0.303
	DO (mg/L)	0.1	6	ECR [22]	0	0.008116	1.666667	0.013526		
	COD (mg/L)	0.2	4	ECR [22]	0	0.012174	5.000000	0.060868		
	TS (mg/L)	1	1010	ECR [22]	0	0.000048	0.099010	0.000005		
	TDS (mg/L)	0.1	1000	ECR [22]	0	0.000049	0.010000	0.000000		
	Arsenic (mg/L)	0	0.05	ECR [22]	0	0.973885	0.000000	0.000000		

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