

Physicochemical Assessment and Water Quality Index-Based Evaluation of Groundwater in Some selected Districts of Assam, India: A Case Study

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ABSTRACT

In India, the rapid urbanization and poor waste management have heightened the risk of groundwater pollution, often from industrial effluents and agricultural pesticides. The quality of groundwater is often assessed using the water quality index (WQI), a non-regulatory tool that provides an overall indication of the status of water and helps identify areas needing further study. This case study evaluates the status of groundwater of ten districts in Assam by analyzing physico-chemical parameters, including pH, electrical conductivity, Biochemical oxygen demand (BOD), total dissolved solids, fluoride, arsenic, nitrate-N + nitrite-N, total coliform, and fecal coliform. The data were sourced from the central pollution control board under the ministry of environment, forest and climate change, Government of India. Year-wise variations of these parameters were critically assessed, and WQI values were used to determine drinking water quality at each sampling site. The results revealed that all physico-chemical parameters are found to be within permissible limits prescribed by the World Health Organization and Bureau of Indian standard standards. In most sites, values were even below the allowable thresholds of earlier standards. Consequently, WQI values classified as excellent and safe for human consumption. Nonetheless, the study highlights that drinking water chemistry can change during storage or transportation due to factors such as exposure to light or seasonal variations. Thus, while the current status of the groundwater in the study areas is satisfactory, continuous monitoring is crucial in ensuring safe and sustainable use for drinking purposes.

Key words: Contamination, Drinking water, Groundwater, Hardness, Physico-chemical, Water quality index.

1. INTRODUCTION

India relies heavily on groundwater in its socioeconomic growth and water supply, with over a thousand millions of people relying on it globally. India has only 4% of the available global freshwater resources while sustaining over 16% of the global population. Water scarcity is significantly impacted by population growth and industrial development, due to which the ground-water bodies being polluted, reducing the accessibility of potable drinking water [1,2]. Groundwater contamination in the Northeast, India, negatively impacts human healthiness, commercial development, and social well-being. Comprehensive data on current and potential groundwater quality is vital for effective management. Ground water quality degradation due to geological progressions and man-made activities, including contamination for civic and rural household purposes, is a growing concern. The status of ground water is basically influenced by geochemical cycles and anthropogenetic activities such as mining, sewage sludge disposal, and agricultural and industrial activities, which are irresistible [3,4]. Although the seasonal instabilities, such as wind, rain, and precipitation, significantly impact the quality of the same [5,6].

Water exists on and below the Earth's surface, but potable surface water is limited. In India, a substantial part of the inhabitants are dependent on ground water for drinking, both in rural as well as in urban areas [7]. Increasing urbanization and insufficient waste managing policies are significantly raising the risk of ground water contamination. Untreated consumption of polluted ground water can result in health hazards if the pollution source is not effectively controlled [8,9]. Ground water in many regions of India is contaminated by industrial waste and

agricultural pesticides, resulting in release of numerous hazardous chemicals into water bodies [10].

Physico-chemical parameters, namely, pH, temperature, dissolved oxygen, Biochemical oxygen demand (BOD), alkalinity, salinity, electrical conductivity (EC), total hardness, total dissolved solids (TDS), and presence of some metal and non-metal ions, assess water quality and determine its usability for drinking and other purposes. To get more information about the status of water and its purity, it is essential to test for trace metal, heavy metal content, and organic pesticide residue [11]. The status of drinking water is assessed on the basis of physical, chemical, and microbiological impurities and is taken as suitable for drinking if they don't exceed the maximum permissible limits set by the World Health Organization (WHO) or other local authorities [Table 1] [12,13]. It has been reported that the ground water quality is rapidly deteriorating in several Indian states, making it unsuitable for various uses [14-16]. The consumption of the polluted ground water causes various chronic diseases like fluorosis,

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Table 1: Water quality standards in terms of some physico-chemical parameters as per WHO (WHO, 2017) and BIS (BIS, 2012).

GWQI	Units	WHO international standard (WHO 2017)		BIS 2012	
		Desirable limits	Permissible limits	Desirable limits	Permissible limits
pH	-	6.5	8.5	6.5–8.5	No relaxation
EC	µs/cm	-	-	-	-
TDS	mg/L	500	1500	500	2000
BOD	mg/L	-	5.0	-	5.0
F ⁻	mg/L	0.5	1.5	1	1.5
As	mg/L	0.5	1.5	1	1.5
Nitrate-N+nitrite-N	mg/L	50	-	45	No relaxation
Total coliform	mg/L	0	0	12	12
Faecal coliform	mg/L	0	0	12	-

WHO: World Health Organization, BIS: Bureau of Indian standard, EC: Electrical conductivity, TDS: Total dissolved solids, GWQI: Groundwater quality index

Table 2: Classes of water based on WQI values.

WQI range	Water quality status	Classification of water	Designated-best-use
0–25	Excellent	A	Use in drinking purposes treated solely through disinfection, without conventional methods.
26–50	Good	B	Use in drinking purposes with minor conventional treatment and after disinfection.
51–75	Poor	C	Use in drinking purposes after major treatment by conventional and through disinfection.
76–100	Very poor	D	Use in growth and preservation of wildlife and fisheries
>100	Unsuitable	E	Use in irrigation, industrial cooling, and controlled disposal of waste

WQI: Water quality index

arsenicosis, hemochromatosis, bronchitis, cancer, and other health issues across the country [17].

Assessing ground water quality plays a key role in scientific research. The variation in groundwater quality within a region depends on physicochemical characteristics, which are strongly affected by geological settings and human activities. Human interventions influence water quality either by extracting water from aquifers or by releasing chemicals and pollutants into them. The discharges from agricultural, industrial, and urban sources are common contributors of contaminants to groundwater. These waste sources and the pollutants they carry are often the primary factors affecting groundwater quality. In India, the quality of ground water is generally assessed in terms of its water quality index (WQI) value. The WQI is a non-regulatory indicator used as a thumbnail indicator of the quality of water to assess surface waters and identify water bodies requiring further study. Based on the calculated WQI, the status of water is ascertained and divided into five types [18-20] as shown in Table 2.

It has been reported that the status of potable drinking-water is deteriorating nowadays [21,22]. Therefore, a study on the assessment of the ground water quality parameters and their seasonal changes for its efficient use in urban and semi-urban areas is the urgent requirement. In this case study, the status of water quality parameters of ten selected districts of Assam is assessed in terms of the pH, EC, Biochemical oxygen demand (BOD), TDS, fluoride, arsenic, nitrate-N+ nitrite-N, total coliform, fecal coliform (FC) found in the samples. The data required for this study were gathered from the website of central pollution control board (CPCB) under ministry of environment, forest and climate change (MoEFCC), Government of India. The year-wise variation of the water quality parameters is then critically analyzed,

Table 3: List of sampling sites.

Sampling site no.	Sampling site
SL01	Kokrajhar
SL02	Bongaigaon
SL03	Barpeta
SL04	Goalpara
SL05	Nalbari
SL06	Guwahati
SL07	Nagaon
SL08	Biswanath
SL09	Tezpur
SL10	Jorhat

and the status of the drinking water quality at each sampling sites are ascertained from their WQI values.

2. MATERIALS AND METHODS

2.1. The Study Area

Assam is a Northeastern state of India, covering approximately 78,438 km², recognized for its widespread forestry areas, the mighty Brahmaputra and Barak rivers, and high rainfall during monsoon season. Its geography includes vast river valleys and protected areas. The state is categorized as north and south bank of the Brahmaputra River flowing Northeast to Southwest and the

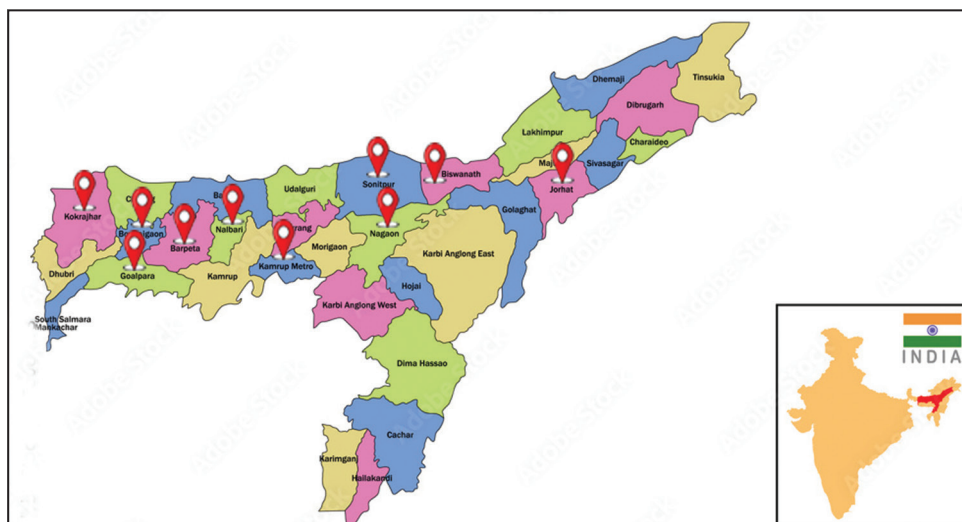


Figure 1: Map of Assam.

southern Barak River. High rainfall is received during the Southwest monsoon, from April to September. In this study, we have selected 10 sampling sites [Table 3] from the northern area of Assam, as shown in Figure 1.

2.2. Data Collection

The investigation of the physico-chemical parameter is vital in assessment and understanding the quality of various substances, particularly water, and its effect on human health, industrial processes, and the environment. These parameters reveal valued perceptions about the physico-chemical parameters of ground water, helping to identify potential hazards and inform decision-making in diverse fields.

The data are collected by monitoring the water quality of ten districts of Assam from the authorized monitoring stations. The water quality parameters are being continuously monitored with the assistance of state pollution control boards, pollution control committees. The data reported in the current study were taken from the website of CPCB (<https://cpcb.nic.in/nwmp-data-2021>) under MoEFCC, Government of India. The year-wise variation of some of the physico-chemical parameters is then critically analyzed, and the status of the drinking water at each sampling sites are ascertained.

2.3. Calculation of WQI

The WQI of the water sample was obtained by the method of weighed arithmetic index developed by Brown *et al.*, 1972 [23] as shown below.

Step 1: The unit weight (W_n) factors for each parameter are calculated using the formula:

$$W_n = K/S_n \quad (i)$$

Where, $K = 1/\sum(1/S_n)$ and S_n is the standard desirable value of the n^{th} parameters. The sum of W_n of all selected parameter is always equal to unity.

Step 2: The sub-index (Q_n) value is then found by the formula:

$$Q_n = (V_n/S_n) \times 100 \quad (ii)$$

Where, V_n is the average value of the n^{th} parameters, V_o is the ideal value of the particular parameters in pure water (generally $V_o = 0$ for most parameters except pH). But, for pH,

$$Q_n (\text{pH}) = [(V_{\text{pH}}-7)/(8.5-7)] \times 100 \quad (iii)$$

Step 3: Now, by combining steps (i) and (ii), the WQI is found from the following equation:

$$\text{WQI} = \sum W_n \times Q_n \quad (iv)$$

3. RESULTS AND DISCUSSION

3.1. pH

The pH is the negative logarithm of hydrogen ion concentration which is the measure of acidic or basic character of water. From the examination of all data, it can be concluded that the pH of the sampling districts ranges from 6.1 to 7.9 as displayed in Table 4. The minimum pH value (6.1) is exhibited in Kokrajhar (2018), and the highest pH value (7.9) is exhibited in Nalbari (2021), followed by pH value (7.8) in Biswanath (2020 and 2021) and in Jorhat (2022).

3.2. EC

EC is the capacity of water to conduct electrical current. In water, EC is produced by the presence of various ionic species. EC is also dependent on the amount and degree of ionization of the various solid substances involved [24]. Conventionally, the EC is reported in $\mu\text{s}/\text{cm}$ at 25°C as the ionization of the solutes depends on temperature. The EC is highly correlated with the TDS, which measures the total dissolved minerals. As shown in Table 5, the EC value ranges from 47 to 606 $\mu\text{mho}/\text{cm}$ at 25°C . It is observed that EC recorded at Nagaon (47 $\mu\text{mho}/\text{cm}$) has the lowest value in 2020, whereas EC recorded at Guwahati (606 $\mu\text{mho}/\text{cm}$) has the lowest value in 2018.

3.3. Biochemical Oxygen Demand (BOD)

BOD is a measure of oxygen consumption by organisms. The value of BOD gives an indication of organic pollution in freshwater bodies, correlated to microbiological contamination in freshwater bodies [25]. High BOD concentrations, primarily from human activities, degrade aquatic habitats, biodiversity, and water use, aided by microbial degradation and dilution [26]. The BOD concentration of the selected areas falls in the range 1.0–2.6 mg/L, which falls within the permissible limits (Table 6). The lowest BOD of 1.0 mg/L was found in Barpeta and Nalbari in 2018, and Tezpur in 2018 and 2019, respectively, while the highest BOD concentration of 2.6 mg/L was found in Nalbari, Nagaon, Biswanath, and Jorhat in 2022.

Table 4: Variation of pH of the sampling sites.

S. No.	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	6.1	6.8	6.5	7.1	7.0	7.7	7.4	7.8	6.9	7.7
2	Bongaigaon	7.0	7.4	7.2	7.3	7.3	7.5	7.2	7.6	6.8	6.9
3	Barpeta	6.9	7.4	7.2	7.5	7.0	7.3	7.4	7.5	7.6	7.6
4	Goalpara	6.6	7.2	7.0	7.7	7.0	7.2	7.3	7.5	6.8	6.9
5	Nalbari	6.3	6.8	6.8	7.8	7.2	7.6	7.4	7.9	7	7.2
6	Guwahati	6.8	6.9	6.8	7.5	6.8	7.1	7.3	7.3	6.8	7.0
7	Nagaon	6.3	7.1	7.3	7.2	7.2	7.2	7.2	7.3	6.8	6.8
8	Biswanath	6.4	7.2	7.0	7.3	7.0	7.8	7.6	7.8	7.4	7.5
9	Tezpur	6.6	6.7	6.7	7.2	7.0	7.1	7.4	7.4	6.8	7.0
10	Jorhat	6.7	7.7	7.0	7.5	7.4	7.8	7.0	7.2	6.9	7.8

Table 5: Electrical conductivity ($\mu\text{mho/cm}$) of the sampling sites.

S. No.	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	101	336	168	268	201	346	361	362	342	348
2	Bongaigaon	96	139	104	110	201	366	366	390	312	318
3	Barpeta	222	580	278	578	276	392	304	329	166	166
4	Goalpara	324	333	201	299	217	341	320	362	332	336
5	Nalbari	188	195	171	301	193	230	241	312	340	344
6	Guwahati	220	606	61	534	76	408	289	340	198	346
7	Nagaon	256	287	306	306	47	47	246	380	196	196
8	Biswanath	181	258	149	151	162	253	258	262	262	270
9	Tezpur	179	208	137	268	151	368	195	195	280	280
10	Jorhat	225	416	130	237	223	365	276	278	274	366

Table 6: BOD (mg/L) of the sampling sites.

S. No.	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	1.2	1.2	1.1	1.2	1.1	1.8	2.0	2.2	2.4	2.5
2	Bongaigaon	1.1	1.2	1.4	1.8	1.3	1.5	2.0	2.1	2.3	2.4
3	Barpeta	1.0	1.5	1.3	1.6	1.7	2.1	2.0	2.1	2.5	2.5
4	Goalpara	1.3	1.8	1.3	2.0	1.2	1.8	2.1	2.3	2.3	2.4
5	Nalbari	1.0	1.5	1.2	4.2	1.2	1.4	2.4	2.5	2.5	2.6
6	Guwahati	1.5	1.6	1.1	1.5	1.3	1.8	2.1	2.2	2.2	2.5
7	Nagaon	1.4	2.0	1.2	1.2	1.8	1.8	1.9	2.3	2.6	2.6
8	Biswanath	1.1	2.4	1.3	2.4	1.1	1.8	2.2	2.3	2.4	2.6
9	Tezpur	1.0	1.8	1.0	2	1.2	1.8	2.1	2.1	2.3	2.4
10	Jorhat	1.5	2.6	1.1	2.3	1.1	1.3	2.3	2.3	2.4	2.6

BOD: Biochemical oxygen demand

3.4. TDS

The TDS measures the total amount of dissolved minerals. Water with a very high TDS value is a measure of highly mineralized water. According to Sasikaran *et al.*, 2012 [27], TDS of potable water should not cross 1000 mg/L. Water having high value of TDS is detrimental to

people who are having kidney and heart disease. The TDS value of the current investigation ranged between 38 and 212 mg/L. From Table 7, it is seen that Nagaon possesses the lowest value of TDS (32 mg/L) in 2020, and Kokrajhar possesses the highest TDS value (212 mg/L) in 2022.

3.5. Fluoride

Fluoride, a naturally occurring mineral, prevents tooth decay in children and can be added to drinking water for fluoridation, but excessive intake can cause dental fluorosis. The optimal level of fluoride in drinking water is as follows.

- The U.S. Public Health Service recommends 0.7 mg/L of fluoride in drinking water
- Health Canada recommends 0.7 mg/L of fluoride for good dental health
- The WHO suggests 1.5 mg/L as an upper limit for safe drinking water.

In this present investigation, as displayed in Table 8 it was noticed that the level of fluoride in the samples fall within the permissible limits (0.21–0.33 mg/L).

3.6. Arsenic

Arsenic in drinking water poses a substantial health hazard, particularly in high ground water level areas, leading to cancer, cardiovascular disease, and skin lesions. Thus, a continuous checking of the status of water and setting drinking water standards can help protect public health. Hence, raising awareness about the risks of arsenic contamination and promoting safe water practices can empower individuals and communities to protect themselves. In India, Arsenic contamination

is a significant issue in several parts of India, particularly in Bengal, Bihar, and West Bengal. Many communities rely on wells with high arsenic levels in drinking water. In this regard, the WHO and other organizations are working with the Indian government to address this issue. As shown in Table 9, the current recommended limit of arsenic in drinking-water is 0.01–0.05 mg/L, and the level of Arsenic in this investigation falls within the limits.

3.7. Nitrate-N + Nitrite-N

The standard values of nitrate and nitrite, expressed as nitrate-N and nitrite-N in mg/L, are 10 mg/L for nitrate-N and 1 mg/L for nitrite-N. Testing labs often analyze nitrate and nitrite together as nitrate + nitrite as N, with the combined standard being 10 mg/L. Levels exceeding these standards may indicate a need for water treatment. The Vermont Health Department recommends treating water if nitrate levels exceed 10.0 mg/L. The maximum contaminant level (MCL) for nitrate is 10 mg/L (as N), and for nitrite is 1 mg/L (as N), as prescribed by environmental protection agency. Levels below these MCLs are generally not expected to cause significant health problems. Some testing labs combine nitrate and nitrite measurements. The combined standard is also 10 mg/L, meaning the total amount of nitrogen from both compounds should not surpass 10 mg/L. Elevated levels of nitrate and nitrite in drinking water can become a serious concern, especially for infants and pregnant women, as it may cause methemoglobinemia, a condition that reduces

Table 7: TDS (mg/L) of the sampling sites.

S. No.	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	-	-	-	-	118	192	202	202	196	212
2	Bongaigaon	-	-	-	-	118	202	202	218	182	198
3	Barpeta	-	-	-	-	166	212	172	180	124	124
4	Goalpara	-	-	-	-	190	BDL	176	200	190	106
5	Nalbari	-	-	-	-	114	130	138	174	194	218
6	Guwahati	-	-	-	-	48	220	164	192	142	190
7	Nagaon	-	-	-	-	32	32	142	208	134	134
8	Biswanath	-	-	-	-	96	144	148	148	148	158
9	Tezpur	-	-	-	-	96	198	144	144	166	166
10	Jorhat	-	-	-	-	132	200	156	224	196	204

Table 8: Fluoride (mg/L) of the sampling sites.

S. No	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	-	-	-	-	BDL	BDL	0.30	0.30	0.32	0.33
2	Bongaigaon	-	-	-	-	BDL	BDL	0.30	0.30	0.31	0.32
3	Barpeta	-	-	-	-	BDL	0.22	0.30	0.30	0.32	0.32
4	Goalpara	-	-	-	-	BDL	0.21	0.30	0.30	0.28	0.31
5	Nalbari	-	-	-	-	0.21	0.23	0.30	0.30	0.26	0.30
6	Guwahati	-	-	-	-	0.22	0.23	0.30	0.30	0.28	0.32
7	Nagaon	-	-	-	-	0.21	0.21	0.30	0.30	0.33	0.33
8	Biswanath	-	-	-	-	BDL	0.21	0.30	0.30	0.30	0.31
9	Tezpur	-	-	-	-	BDL	0.24	0.30	0.30	0.27	0.33
10	Jorhat	-	-	-	-	0.23	0.24	0.30	0.30	0.28	0.31

Table 9: Arsenic (mg/L) of the sampling sites.

S. No.	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	-	-	-	-	-	-	0.01	0.01	0.01	0.02
2	Bongaigaon	-	-	-	-	-	-	0.01	0.01	0.01	0.01
3	Barpeta	-	-	-	-	-	-	0.01	0.01	0.02	0.02
4	Goalpara	-	-	-	-	-	-	0.01	0.01	0.01	0.01
5	Nalbari	-	-	-	-	-	-	0.01	0.01	0.01	0.01
6	Guwahati	-	-	-	-	-	-	-	-	0.01	0.01
7	Nagaon	-	-	-	-	-	-	-	-	0.01	0.01
8	Biswanath	-	-	-	-	-	-	0.01	0.01	0.01	0.01
9	Tezpur	-	-	-	-	-	-	0.001	0.001	0.01	0.01
10	Jorhat	-	-	-	-	-	-	0.010	0.010	0.01	0.01

Table 10: Nitrate-N+nitrite-N (mg/L) of the sampling sites.

S. No.	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	0.1	0.6	1.0	1.1	0.6	0.7	0.9	0.9	0.8	1.0
2	Bongaigaon	0.1	0.5	1.1	1.2	0.5	0.5	0.7	1.0	0.7	0.9
3	Barpeta	0.2	0.7	0.7	0.7	0.5	0.7	0.8	0.8	0.9	0.9
4	Goalpara	0.3	3.3	1	1.2	0.6	0.7	0.9	1.0	1.0	1.1
5	Nalbari	0.2	2.3	0.6	1.1	0.6	0.6	0.8	1.0	0.9	2.5
6	Guwahati	0.8	0.5	0.8	1	0.7	0.7	0.7	0.9	0.7	1.0
7	Nagaon	0.6	0.7	0.7	0.7	0.6	0.6	0.7	0.8	1.2	1.2
8	Biswanath	0.1	0.5	0.5	0.7	0.4	0.6	0.8	0.8	0.8	1.1
9	Tezpur	0.7	1.3	0.3	0.7	0.5	0.6	0.9	0.9	0.8	1.6
10	Jorhat	0.2	1.6	1.3	3.2	0.7	1.8	0.7	0.8	0.8	0.9

Table 11: Variation of total coliform (MPN/100 mL) of the sampling area.

S. No.	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	2	2	2	2	BDL	BDL	2	2		
2	Bongaigaon	2	2	2	2	BDL	BDL	2	2	BDL	BDL
3	Barpeta	2	2	2	2	BDL	BDL	2	2	-	-
4	Goalpara	2	2	2	2	BDL	BDL	2	2	-	-
5	Nalbari	2	2	2	2	BDL	BDL	2	2	-	-
6	Guwahati	2	2	2	2	BDL	BDL	2	2	BDL	BDL
7	Nagaon	2	2	2	2	BDL	BDL	2	2	-	-
8	Biswanath	2	2	2	2	BDL	BDL	2	2	-	-
9	Tezpur	2	2	2	2	BDL	BDL	2	2	BDL	BDL
10	Jorhat	2	2	2	2	BDL	BDL	2	2	-	-

the blood's ability to carry oxygen. It's recommended that water must be tested for nitrate and nitrite, especially if you have a private well or are concerned about potential contamination. In this present investigation, as displayed in Table 10, it was noticed that the nitrate-N+ nitrite-N level in the study areas are within the permissible limits.

3.8. Total Coliform (Most Probable Number [MPN]/100 mL)

Total coliforms in drinking water indicate potential water quality issues, suggesting the existence of harmful bacteria such as fecal coliforms or *Escherichia coli*, thus serving as an indicator. Total coliforms are a group of bacteria found in soil, vegetation, and water that can indicate potential contamination in drinking water, despite their generally

Table 12: Variation of fecal coliform (MPN/100 mL) of the sampling sites.

S. No.	Sampling site	2018		2019		2020		2021		2022	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kokrajhar	2	2	2	2	BDL	BDL	2	2	-	-
2	Bongaigaon	2	2	2	2	BDL	BDL	2	2	-	-
3	Barpeta	2	2	2	2	BDL	BDL	2	2	-	-
4	Goalpara	2	2	2	2	BDL	BDL	2	2	-	-
5	Nalbari	2	2	2	2	BDL	BDL	2	2	-	-
6	Guwahati	2	2	2	2	BDL	BDL	2	2	-	-
7	Nagaon	2	2	2	2	BDL	BDL	2	2	-	-
8	Biswanath	2	2	2	2	BDL	BDL	2	2	-	-
9	Tezpur	2	2	2	2	BDL	BDL	2	2	-	-
10	Jorhat	2	2	2	2	BDL	BDL	2	2	-	-

Table 13: The calculation of maximum WQI of Kokrajhar in the year 2022.

Parameters	BIS Std. (Sn)	1/Sn	∑(1/Sn)	K=1/∑(1/Sn)	Wn=K/Sn	Ideal value (Vo)	Mean Conc. value (Vn)	Vn/Sn	Qn=(Vn/Sn)*100	Wn*Qn
pH	8.5	0.1176	2.4285	0.4118	0.0484	7	7.7	-	46.67	2.2607
EC (µmho/cm)	300	0.0033	2.4285	0.4118	0.0014	0	348	1.16	116.00	0.1592
BOD (mg/L)	5	0.2000	2.4285	0.4118	0.0824	0	2.5	0.5	50	4.1177
TDS (mg/L)	500	0.0020	2.4285	0.4118	0.0008	0	212	0.424	42.4	0.0349
F (mg/L)	1	1.0000	2.4285	0.4118	0.4118	0	0.33	0.33	33	13.5884
As (mg/L)	1	1.0000	2.4285	0.4118	0.4118	0	0.02	0.02	2	0.8235
Nitrate-N+Nitrite-N (mg/L)	45	0.0222	2.4285	0.4118	0.0092	0	1	0.02222	2.2	0.0203
Total coliform (MPN/100 mL)	12	0.0833	2.4285	0.4118	0.0343	0	0	0	0.00	0.0000
									WQI	21.00
									(∑Wn*Qn)=	

WQI: Water quality index, BIS: Bureau of Indian standard, EC: Electrical conductivity, TDS: Total dissolved solid

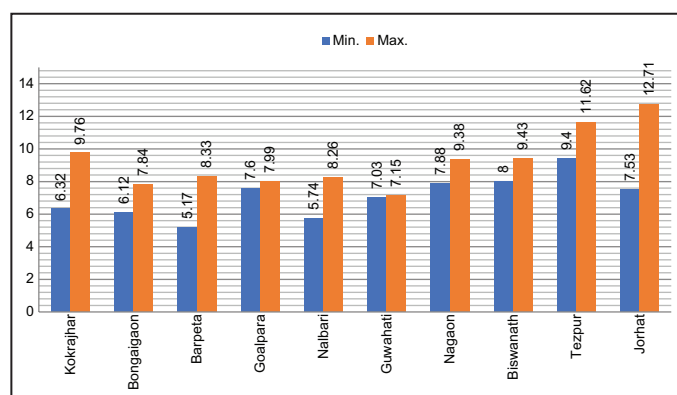


Figure 2: Variation of water quality index of the sampling sites in the year 2018.

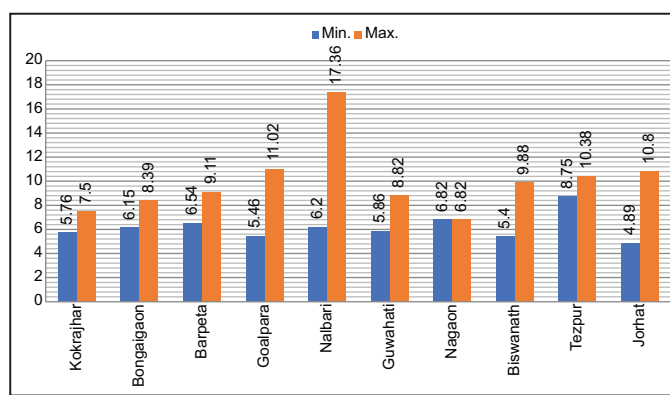


Figure 3: Variation of water quality index of the sampling sites in the year 2019.

harmless nature. Total coliforms are tested as an indicator of overall quality, as it is relatively easier to detect and grow in the lab. If total coliforms are present, it suggests that the water system might have a problem with the source water, the water distribution system, or the treatment process. In the context of drinking water, “MPN” refers to the MPN, a statistical method used to estimate the density of coliform

bacteria exist in water samples. The WHO recommends a MPL of 2.2 MPN/100 mL in drinking water for total coliforms. A sample exceeding this limit indicates potential contamination and could require further testing to find out the sources and severity of contamination. In the present case study, the amount of the total Coliform count is within the limits which is displayed in Table 11.

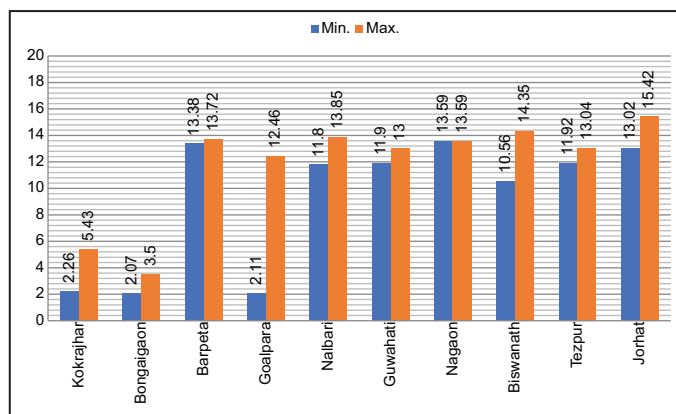


Figure 4: Variation of water quality index of the sampling sites in the year 2020.

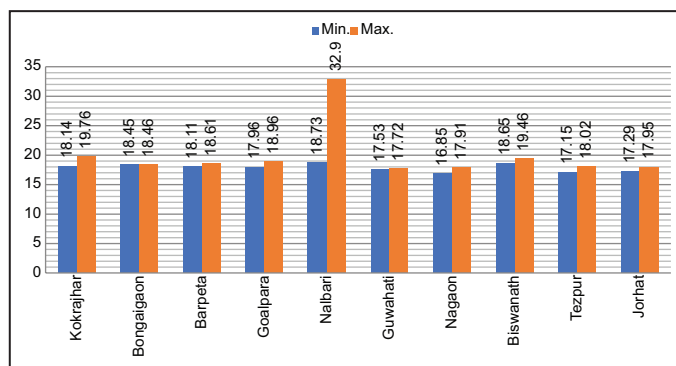


Figure 5: Variation of water quality index of the sampling sites in the year 2021.

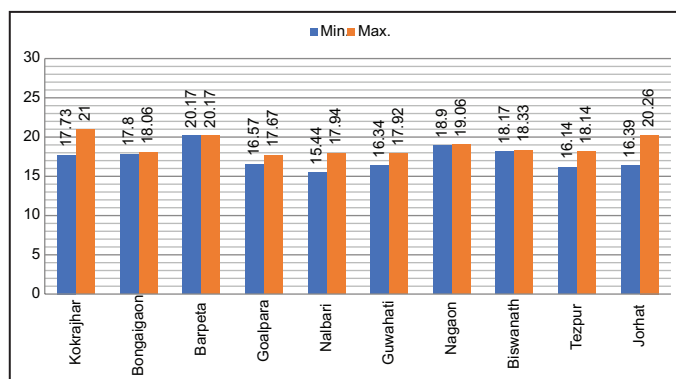


Figure 6: Variation of water quality index of the sampling sites in the year 2022.

3.9. Faecal Coliform

FCs in drinking water suggest recent contamination and potentially harmful pathogens, particularly *E. coli*, increasing the risk of waterborne illness. Fecal coliforms, found in warm-blooded animals, indicate the fecal contamination in drinking water, potentially causing the existence of other pathogens. Thus, regular testing for coliform bacteria, including fecal coliforms, is crucial for ensuring the safety of drinking water. In the context of drinking water, FC limits are vital in ensuring the status of water and safety. The CPCB and other regulatory bodies set permissible limits to protect public health. The CPCB sets a permissible limit of 2,500 MPN/100 mL for FC, while for drinking water, *E. coli* must be absent. In this case study, the total coliform count (Table 12) is within very low and almost below detectable limits in all sampling stations.

3.10. Analysis of WQI

The environmental agencies globally have concentrated on developing, refining, and validating the WQI models to assess water quality across diverse regions and water bodies [28]. The studies on WQI studies have aided in identifying water quality trends and understanding the effects of environmental policies and climate change [29]. There are numerous studies found in literature which investigated the connection between WQI values and ecosystem health and human health risks. As scientific knowledge advances, the WQI continues to be an important tool for assessing the quality of water and is expected to gain more significance in addressing environmental challenges and endorsing justifiable management of water resources [30]. The calculation of the maximum WQI of Kokrajhar in the year 2022 is shown in Table 13. Accordingly, the WQI values in other sampling areas were also calculated, and the variation of the same in each year is shown in Figures 2-6. From these Figures, it is revealed that the WQI values of the drinking water in the current investigation are normally excellent and safe for human consumption, because WQI is within the range of 0–25.

4. CONCLUSION

In the present case study, the data required for some of their physico-chemical parameter of drinking water samples were collected from the website of CPCB under MoEFCC, Government of India for the last 5 years. From the comparison of the results, it is revealed that all the physico-chemical parameters used for analysis come within the permissible limits as prescribed in the WHO standards and Bureau of Indian standard standards. In fact, the concentration of the parameters is lower than that of the permissible levels of the previous standards in most sampling sites. From the WQI values, it can be resolved that the water quality in the present investigation is normally excellent and found to be safe for human consumption. However, the chemistry of drinking water may change during transportation or storage, particularly by the influence of light or sunlight on the container. Furthermore, the chemical properties of the drinking water are changed by sessional variations as well. Therefore, continuous monitoring of the water quality parameters is very much essential when used for drinking purpose.

5. CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest, including any financial, personal, or other relationships with other people or organizations that can influence this work.

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