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Assesment of Water Quality Index of Dibrugarh & Tinsukia Districts, Assam

Neelakshi Hazarika

Assistant Professor, Department of Chemistry, Digboi College, Tinsukia, Assam, India

Abstract:
The present study focuses on the determination of various physical and chemical parameters of subsurface water of some selected areas situated between river Noadihing and Buridihing rivers bounded by longitude $95^0 0'$ N and $96^0 0'$ E and latitude $27^0 0'$ E and $28^0 0'$ N of Dibrugarh and Tinsukia districts of Assam, India. The quality of water samples has been assessed in terms of a rating method, Water Quality Index (WQI) which assesses the overall quality of water in a single value. Water samples have been categorized as "excellent", "good", "poor', "very poor" etc for drinking purpose by comparing WQI value with standard values.

Keywords: Biological oxygen demand, Chemical, Dissolved oxygen, Physical, Total dissolved solid, Water Quality Index

1. Introduction:

Water is a primary natural resource and is an important constituent of ecosystem. The main sources of water are rivers, ponds, rain water, glaciers, ground water etc. Water is not only important for drinking purpose but also for other aspects such as household activities, agriculture, hydropower generation, industries, fisheries, other aquatic lives and many other purposes. However freshwater qualities are not preserved in all water sources. The quality of water especially surface water is greatly affected due to human activities like growing civilization, urbanization, increasing populations, technological development etc[1,10] . Limited available surface water sources are mostly overused by human. Poor quality water may in tern affect human health, aquatic lives as well as crop production. According to World Health Organization (WHO) over three million people including children in developing countries die each year because of water born diseases [19]. Thus it has become very important to monitor water quality periodically.

Various physico-chemical and biological parameters are used to assess water quality. The parameters should not exceed the permissible limits suggested by different standard organizations[10,19,20]

Different parameters can be summarized into a single figure using a mathematical expression known as Water Quality Index (WQI)[12,14]. It was first developed by Horton in 1970[8,16] Later on many indices have been developed by different workers. WQI gives a comprehensive picture of overall quality of water.

The objective of the present work is to characterize the surface water of different places of Dibrugarh and Tinsukia Districts of Assam between Buridihing and Noadihing rivers bounded by longitude $95^0 0'$ N and $96^0 0'$ E and latitude $27^0 0'$ E and $28^0 0'$ N. Since these areas are situated in an around coal mining, crude oil drilling areas and oil refinery, it is utmost important to monitor the water quality periodically.

The study includes the determination of different physical and chemical parameters of the samples of the selected areas and then classifying them by computing their WQI values.

2. Materials and methods:

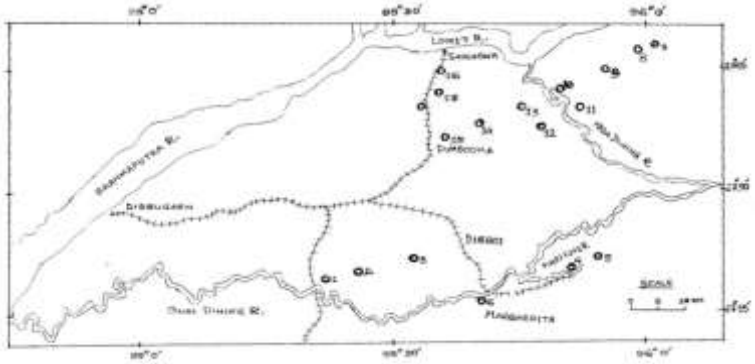
13 surface water samples were collected from various ponds, open wells, river, stream from selected areas situated between river Noadihing and Buridihing rivers bounded by longitude $95^0 0^{'}$ N and$96^0 0^{'}$ E and latitude $27^0 0^{'}$ E and $28^0 0^{'}$ N of Dibrugarh and Tinsukia districts of Assam (Fig 1) in the year 2022. The location of the places from where the samples were collected is listed in Table 1.

Table 1: List of the places from where the water samples were collected

Sample No.	Places	Details of location
1	1No. Rongagora	N-$27^0$19 26.5″ E-$95^0$22 47.9″
2	2 No. Kothalguri	N-$27^0$20 11.1″ E-$95^0$26 54.7″
3	Borjan Digboi	N-$27^0$21 35.3″ E-$95^0$32 28.6″ Elev^n- 121 m
4	Udaipur	N-$27^0$20 542.0″ E-$95^0$51 42.5″ Elev^n- 144 m
5	Jagun	N-$27^0$22 57.1″ E-$95^0$51 13.3″ Elev^n- 151 m
6	Margherita	N-$27^0$17 11.2″ E-$95^0$39 39.6″
7	Chowkham2	N-$27^0$48 29.3″ E-$96^0$01 53.4″ Elev^n- 143 m
8	Momong	N-$27^0$47' 26.5″ E-$95^0$59' 25.7″ Elev^n -134 m
9	Lathau	N-$27^0$44' 32.3″ E-$95^0$55' 15.6″ Elev^n -134 m
10	Nanam Budha Bihar	N-$27^0$42' 25.2″ E-$95^0$53' 55.6″ Elev^n- 134 m
11	Namsai	N-$27^0$40' 0.08″ E-$95^0$52' 22.9″ Elev^n- 133 m
12	Nabajoti	N-$27^0$88' 19.9″ E-$95^0$47' 19.5″

		Elev^{n}- 139 m
13	Amguri	N-27^{0}40 24.5″ E-95^{0}45' 5.9″ Elev^{n}- 129 m

Figure 1: Map of the places from where the water samples were collected



About 13 physicochemical parameters were analyzed for each of the samples such as pH, electrical conductivity, total dissolved solids(TDS), total hardness(TH) as calcium carbonate, carbonate, bicarbonate, chlorides, nitrates, sulphate, fluoride and cations like calcium, magnesium, iron, sodium, potassium, Biological oxygen demand(BOD), Dissolved oxygen(DO) were determined using standard procedures.[13, 17]

Residual Sodium Carbonate (RSC) is calculated using the following formula [2,11]

$$RSC\ (meq/L) = (CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+}) \quad (1)$$

Total Hardness (TH) is expressed as equivalent of $CaCO_3$ [2,11]. It is calculated as

$$TH = 2.497\ Ca + 4.115\ Mg \quad (2)$$

Biochemical oxygen demand (BOD) is the amount of biodegradable matter in water in which oxygen is required by microorganisms in aerobic conditions. BOD test is done to find the amount of biochemically oxidizable carbonaceous matter [7, 15]

Dissolved oxygen (DO) is a very important parameter in assessing water quality. This determines the biological changes that take place in the water body.

Water Quality Index (WQI) was calculated using Weighted Arithmetic Water Quality Index Method.[3,5, 6, 8, 9, 16]. WQI was determined using Indian Standard of drinking water specified by Bureau of Indian Standards [4, 20]. The calculation was made as shown below

The weight, W_i of all the parameters were calculated using equation 3

$$W_i = \frac{K}{S_i} \quad (3)$$

Where W_i is the weight of ith parameter

S_i is the recommended standard value of ith parameter and

K is the proportionality constant which can be calculated as given in equation 4

$$K = \frac{1}{\sum \frac{1}{S_i}} \quad (4)$$

Standard values, Si of each parameter were taken from Indian Standard of drinking water specified by Bureau of Indian Standards [4, 18] as given in Table 2.

The quality rating scale, Q_i for each parameter were calculated using the equation 5

$$Q_i = \frac{C_i - V_o}{S_i - V_o} X\ 100 \quad (5)$$

Where Ci is the concentration in g/L of each chemical parameter in each water sample.

S_i is the Indian drinking water standard in g/L for each chemical parameter

V_o is the value of parameter in pure water and

V_o =0 except for pH= 7.0 and DO= 14.6 mg/L

Utilising these Q_i values, the subindex, SI_i for each chemical parameter were calculated using equation 6

$$SI_i = W_i X Q_i \quad (6)$$

After that WQI was calculated as equation 7

$$WQI = \frac{\sum Q_i W_i}{\sum W_i} \quad (7)$$

Where SI_i is the subindex of ith parameter

W_i is the relative weight of ith parameter

Q_i is the quality rating of ith parameter

The rating of water quality as calculated by the above method are given in Table 3[4, 18]

Table 2: Standard values (S_i) of different parameters given by BIS

Chemical parameters (g/L)	Indian standards
Ph	6.5-8.5
Total dissoloved solids (TDS)	500-2000
Total hardness (TH)	300-600
Bicarbonate	244-732
Chloride	250-1000
Sulphate	200-400
Nitrate	45-100
Flouride	1-1.5
Calcium	75-200
Magnesium	30-100
Iron	0.3-1.0
Manganese	5-15

Table 3: Water Quality Rating as per Weight Arithmatic Water Quality Index Method

WQI	Rating of water Quality	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very poor water quality	D
Above 100	Unsuitable for drinking purpose	E

3. Result and Discussions :

Reports of water analysis that includes determination of pH, conductivity, amount of chlorides,

carbonates and bicarbonates, calcium and magnesium, sodium and potassium, iron, residual sodium carbonate as well as Water Quality Index (WQI) are shown in table 4, 5 and 6. The physical and chemical parameters of all the water samples are represented in bar diagram shown in Figure 2 and Figure 3.

Table 4: Results of physical parameters of Water Samples

Sample no.	**Places**	pH	TDS mg/L	EC micro S	BOD mgO2/L	DO mg/L	RSC mg/L	TH
1	1No. Rongagora	6.46	172.36	127.3	12.5	11	2.75	207.90
2	2 No. Kothalguri	7.6	169.86	99.2	8.5	12.2	75.17	135.26
3	Borjan Digboi	7.42	152.34	71.3	18.9	10.4	78.99	51.56
4	Udaipur	7.34	396	79.9	22.2	4.2	112.51	158.03
5	Jagun	7.22	452.12	407.3	14.3	7.2	44.33	281.14
6	Margherita	7.78	326.23	446.3	21.6	8.9	37.43	115.98
7	Chowkham2	8.07	256.1	163.1	4.5	7.4	64.18	281.86
8	Momong	6.65	296.12	32.4	3.6	7.3	96.16	55.07
9	Lathau	7.48	156.52	171.1	29.1	8.6	73.20	155.84
10	Nanam Budha Bihar	7.84	197.35	177.7	1.9	8.5	16.84	186.74
11	Namsai	6.77	114	128.9	5.6	1.5	32.82	73.26
12	Nabajoti	7.58	98.69	307.8	4.9	11.3	40.55	168.78
13	Amguri	6.82	127.56	89.9	5.3	18.9	5.43	108.64

Note: EC= Conductivity micro S, TDS= Total dissolved solid as $CaCO_3$ mg/L, BOD = Biological oxygen demand, DO= Dissoloved oxygen, RSC= Residual Sodium Carbonate, TH= Total hardness [1000 mg= 1 g; 10^6 micro S= 1 S]

Table 5: Results of chemical parameters of water samples

Sample no.	K^+ g/L	Na^+ g/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Cl^- mg/L	SO_4^{2-} mg/L	NO_3^- mg/L	CO_3^{2-} mg/L	HCO_3^- mg/L	Fe mg/L
1	0.045	0.242	44.4	23.58	12.25	1.00	0.40	13.73	57	0.1008
2	0.025	0.208	14.6	24.01	12.65	4.60	9.21	10.88	102.9	0.1152
3	0.057	0.156	19	4.91	9.5	14.13	7.15	70.56	32.34	0.1439
4	0.0223	0.217	38.8	14.86	15.7	16.30	8.89	17.64	148.53	0.1399
5	0.1622	1.476	72.1	24.57	2.31	9.96	7.00	11.76	129.3	0.5499
6	0.0324	0.584	24.3	13.44	1.268	6.00	1.23	22.93	52.24	0.072
7	0.0085	0.025	28.12	7.296	1.109	7.35	0.52	64.1	35.5	0.226

8	0.0047	0.030	18.7	2.056	5.54	16.13	0.75	41.08	75.84	0.4032
9	0.0571	0.073	46.7	9.533	7.85	1.02	1.46	46.73	92.7	0.4608
10	0.0212	0.060	64.1	6.485	6.01	9.29	6.26	64.12	23.3	0.182
11	0.0761	0.031	24	3.24	1.33	10.4	3.01	24.05	36.3	0.07
12	0.0167	0.049	41.1	16.075	8.78	9.16	2.12	41.12	56.6	0.648
13	0.0134	0.024	35.5	4.859	7.39	3.62	0.79	35.52	10.27	0.36

1000 mg= 1 g, 10^6 micro S= 1 S

Table 6: Calculated WQI for each sample with grading

Sample number	Locations	WQI value	Grading	Rating of water quality
1	1No. Rongagora	36.65	B	Good water quality
2	2 No. Kothalguri	41.72	B	Good water quality
3	Borjan Digboi	50.05	B	Good water quality
4	Udaipur	49.27	B	Good water quality
5	Jagun	12.40	A	Excellent water quality
6	Margherita	28.18	B	Good water quality
7	Chowkham2	76.27	D	Very poor water quality
8	Momong	36.67	B	Good water quality
9	Lathau	55.57	C	Poor water quality
10	Nanam Budha Bihar	61.74	C	Poor water quality
11	Namsai	26.97	B	Good water quality
12	Nabajoti	51.83	C	Poor water quality
13	Amguri	116.79	E	Unsuitable for drinking purpose

Figure 2: Bar diagram for the physical parameters of water samples

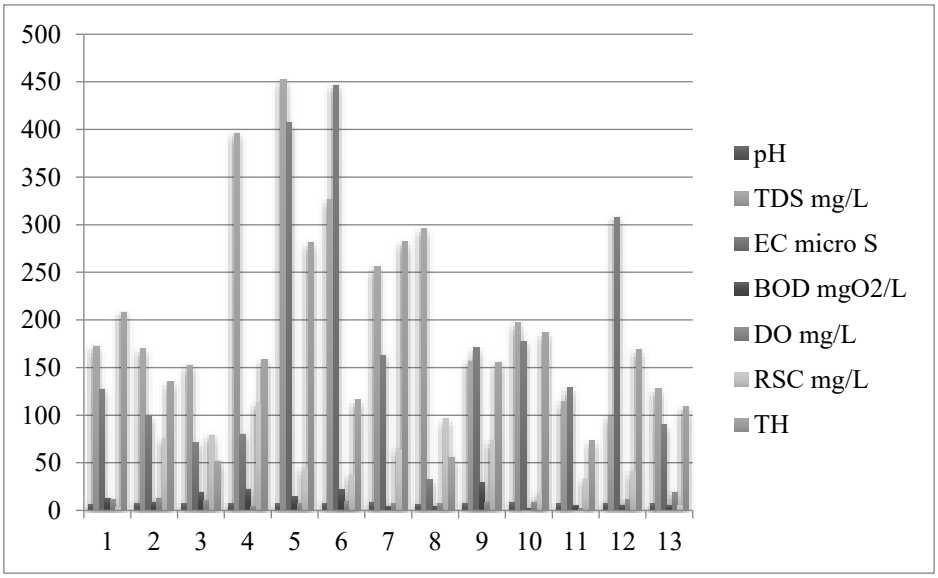
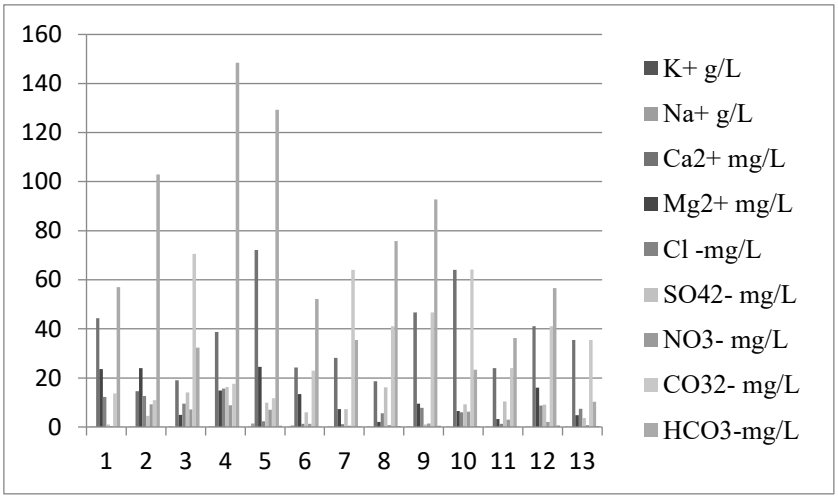


Figure 3: Bar diagram for the chemical parameters of water samples



pH and Total dissolved Solids: pH of the water samples ranges from 6.46 to 8.07 which indicates neutral to slightly alkaline. The Total Dissolved Solids (TDS) of the samples ranges from 98.69 to 452.12 meq/L. This indicates that all the samples are suitable for drinking purpose [4, 18, 21] Electrical conductivity (EC): Water samples with low EC value are in excellent to good quality range as this denotes the presence of low concentration of ions like sodium and thus reduces sodium hazards. Samples from Udaipur, Margherita, Momong and Jagun have high values of EC which is an indication of presence of high concentration of ionic species in these samples. This is because these places are located at higher altitude and are not washed out by river water regularly. There may be another reason that these samples had been collected from sources which are near to human habitation.

Residual Sodium Carbonate (RSC): RSC value less than 1.25 meq/L represents water suitable for irrigation purpose. RSC value higher than 2.5 meq/L are unsuitable for irrigation.[21 Thus sample from Margherita, Momong, Lathau, Nanam Budha Bihar and Namsai are seen to be unsuitable for this purpose. Sample from 1 No. Rongagora , 2 No. Kathalguri, Jagun and Dhola are of medium quality whereas Borjan, Udaipur, Chowkham and Nabajoti samples are safe for irrigation.

Total Hardness (TH): TH of all water samples are within the permissible limit of BIS as shown in Table 2. This means that all water samples are soft in nature and safe for drinking.

Cations present: The concentration of calcium and magnesium determines the hardness of water samples. The concentration of calcium was found to be lowest in water sample from 2 Number Kothalguri. This sample was also found to contain a low value of magnesium. However, the lowest value of magnesium was encountered for water of Namsai. The highest concentration of calcium was detected in water from Jagun. The highest concentration of magnesium was reported for water at Jagun and 2 No. Kothalguri. Highest concentration of iron has been reported for water sample of Jagun (0.5499) and Nabajoti (0.648). But these values are still in the range as prescribed by BIS[4, 18, 15, 21] (Table 2). So after doing simple filtration process and simple treatment all the samples are found to be suitable for domestic uses.

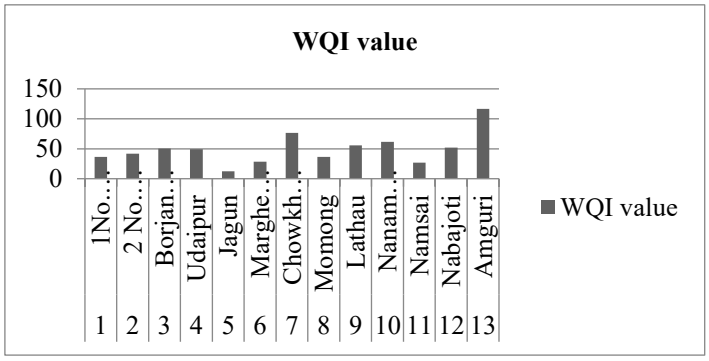
Biochemical oxygen demand: The BOD values of the water samples ranges 1.9 to 29.1 mg/l, which might be attributed to the reason that organic matters enter water bodies at the sampling points.

Dissolved oxygen: DO is a key parameter in determining water quality. This factor helps us in determining the biological and physical changes occurring in the water body. Highest value of DO is

seen in the sample from Amguri that is 18 mg/L. This is a very high value indeed and needs further investigation.[5, 6, 15, 21]

Water Quality Index: However the WQI values of individual water samples suggest that only one sample which is from Jagun is found to be "excellent". The sample from Amguri is found to be "unsuitable" for drinking purpose although the individual parameters are within permissible limit. This may be attributed to high electrical conductivity and chloride concentration in this area. Water sample from Chowkham 2 is of "very poor" quality. WQI values of samples from locations Lathau, Nanam Budha Bihar and Nabajoti are reported to be of "poor" quality. These water samples need further investigations. Whereas rest of the samples i.e., from 1No. Rongagora, 2 No. Kothalguri, Borjan Digboi, Udaipur, Margherita, Momong and Namsai are reported to be of "good" quality for drinking purpose.[6, 15, 16]

Figure 4: Diagrammatical Representation of WQI values of water samples



Note: Lower value indicates desirable limits and higher value indicates permissible limit [4]

4. Conclusion:

Higher Water Quality Index value suggests the presence of higher concentration of various ions in water which is an indication of pollution resulting from nearby human habitations and industrial activities. The acidic pH of water may be harmful to the aquatic lives as well as crop production. All the water samples studied are found to be suitable for all aquatic lives. The presence of low value of calcium, magnesium and residual sodium carbonate in water makes it suitable for domestic usages. A higher residual sodium carbonate makes the water unsuitable for domestic use. However the mineral content increases the usefulness of water in agricultural purposes. Water samples with high WQI values need to be treated prior to domestic uses. Comparing WQI of the samples during different seasons of the year may be helpful for the complete monitoring of water bodies.

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