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Studies on Seasonal Variation of Water Quality Parameters of River Mara Bharali in Sonitpur District of Assam

A. Das[1], S.P. Biswas[2]

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ABSTRACT

Background: Freshwater is not only a finite resource but also essential for agriculture, industry and even human existence. The present investigation on seasonal water quality parameters was conducted in the remnants of old channel of river Jia Bharali called as Mara Bharali at Tezpur in the Sonitpur district of Assam from December, 2017 to November, 2020.

Methods: Five sampling stations were selected that covers a stretch of 16.5 km. Physico-chemical parameters were determined seasonally by following the standard methods of APHA (1998) and Trivedy *et al*., 1987. The statistical analyses of the data were done by one way ANOVA using Statistical Package for Social Scientists.

Result: TDS in monsoon in all the locations remained lowest ($171.33^{a}\pm3.059$ mg/L at MB2) and highest in winter ($320.11^{c}\pm2.441$ mg/L at MB3). The pH value is within the permissible limit except for site MB4 during the winter and post monsoon when the values were 6.38±0.146 and 6.44±0.039 respectively. Maximum DO of $7.878^{d}\pm0.074$ mg/L was observed at site MB1 during the winter season and minimum DO of $5.444^{a}\pm0.047$ mg/L was observed at site MB4 during the monsoon season. BOD was recorded below the tolerance limit of 3 mg/L in all sampling stations.

Key words: Biological oxygen demand, Dissolved oxygen, Mara Bharali river, One way ANOVA, Water quality parameters.

INTRODUCTION

Rivers are considered as the pillars of human civilization all over the world. The presence of irrigated agriculture, towns, cities and industrial sites along the river bank shows the inextricable dependence of human races on riverine ecosystem. Tropical floodplains play a significant role in providing highly productive ecosystem services (Pettit *et al*., 2011), vital to a range of ecosystem processes (Hamilton 2002). The deteriorating water quality affects man, animals and plant life with far-reaching consequences. In India, due to tremendous urbanization and industrialization, the problem of water pollution has assumed an alarming situation and about 70% of rivers in India are polluted. In the last few decades, there has been increasingly greater emphasis on the deterioration of water quality of Indian rivers (Jindal and Sharma, 2011; Matta *et al*., 2020). The destruction of natural habitats and the presence of environmental pollutants may affect the ecological balance of every ecosystem (Begon *et al*., 2009). Dwivedi and Pandey (2002) reported that industrial waste water, sewage and municipal wastes are being continuously added to water which affect the physicochemical quality of water and also making them unfit for even use of livestock and other organisms. All these impurities result in degradation of water quality, like bad taste, colour, odour, turbidity, hardness, corrosiveness, staining and frothing (Saha *et al*., 2017).

MATERIALS AND METHODS

Description of study area

The present investigation was conducted in the remnants of old channel of Jia Bharali called as Mara Bharali at Tezpur in the Sonitpur district of Assam during the period from December, 2017 to November, 2020. The 05 sampling stations were demarcated as MB1 (Pumpani village, N-26°45′10.52″and E-92°50′07.93″), MB2 (Amlopam village, N-26°41′16.84″ and E-92°48′58.88″), MB3 (Dolabari village, N-26°40′00.65″ and E-92°49′43.64″), MB4 (Porowa Bridge, N-26°39′10.05″ and E-92°47′49.28″) and MB5 (Maithan, N-26°37′05.69″ and E-92°49′34.34″) that covers a stretch of about 16.5 km (Fig 1).

Collection of water samples for analysis of physicochemical parameters

The samples were collected in plastic container from a depth of 5-10 cm below the surface water at each sampling sites. The physicochemical characteristics of water like temperature, pH, transparency, conductivity, dissolved oxygen (DO), biochemical oxygen demand (BOD), total dissolved solids (TDS), total alkalinity, total hardness and calcium were determined seasonally by following the

[1]Darrang College, Tezpur-784 001, Assam, India.
[2]Department of Life Sciences, Dibrugarh University, Dibrugarh-786 004, Assam, India.

Corresponding Author: A. Das, Darrang College, Tezpur-784 001, Assam, India. Email: abhijitd23@gmail.com

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standard methods of APHA (1998) and Trivedy *et al*., 1987. Temperature, pH, transparency, conductivity, DO of the water were measured at their collection sites. Temperature was recorded with the help of mercury thermometer, pH was recorded by hand pH meter, water transparency was measured by using black and white disc (Secchi disc), conductivity was measured by using hand conductivity meter (EC TESTER) and DO was measured by following Winkler's iodometric method. For the measurement of other physicochemical parameters, water samples were collected in plastic sampling bottles and transported to the laboratory. All the water samples were collected on a monthly basis and analyzed.

The data obtained for four different seasons in a year were calculated as mean values of the whole three years of the study period. Comparison was done between the values obtained in different seasons. The significance were recorded at 1% ($p<0.01$) and 5% ($P<0.05$) level. The statistical analyses of the data were done by one way ANOVA using Statistical Package for Social Scientists (SPSS) Windows version 20.0.

RESULTS AND DISCUSSION

Seasonal fluctuations in the values of various physicochemical parameters at different stations are given in Table 1 and 2. Air temperature at five different locations of Mara Bharali river were recorded in four different seasons of the year. At location MB1, the air temperature was significantly higher ($p<0.01$) in monsoon ($31.08^{c}\pm0.432$) followed by post monsoon ($28.44^{b}\pm1.022$) and pre monsoon ($27.00^{b}\pm 0.589$) and lowest in winter season ($20.23^{a}\pm0.934$). Similar pattern of temperature variations were observed in other locations that is, MB2, MB3, MB4 and MB5 (Table 1). The water temperature of any river does not remain the same due to environmental conditions (Kumari *et al*. 2013). During the entire study period, water temperature remained lowest in winter ($14.23^{a}\pm0.745$°C at MB3) and highest in monsoon ($27.11^{c}\pm0.613$°C at MB5)**.** Similar seasonal fluctuation of temperature was also recorded in all the other sampling sites. No significant differences were observed between pre monsoon and post monsoon temperatures in all the locations. The differences are statistically highly significant ($p<0.01$).

Table 1: Seasonally evaluated physical parameters of river Mara Bharali.

Parameter	Season	MB1	MB2	MB3	MB4	MB5
Air Temperature (°C)	Winter	$20.23^{a} \pm 0.934$	$19.67^{a}\pm 0.901$	$19.94^{a}\pm 0.843$	$20.17^{a}\pm 0.722$	$19.67^{a}\pm 0.717$
	Pre monsoon	$27.00^{b}\pm 0.589$	$27.44^{b}\pm 0.626$	$27.28^{b}\pm 0.472$	$27.39^{b}\pm 0.526$	$28.00^{b}\pm 0.5$
	Monsoon	$31.08^{c}\pm 0.432$	$31.06^{c} \pm 0.529$	$30.83^{c}\pm 0.363$	$30.71^{c}\pm 0.347$	$31.54^{c}\pm 0.489$
	Post monsoon	$28.44^{b}\pm 1.022$	$28.08^{b}\pm 1.098$	$27.69^{b}\pm 0.943$	$28.02^{b}\pm 0.999$	$28.59^{b}\pm 0.972$
	P value	0.000	0.000	0.000	0.000	0.000
Water Temperature (°C)	Winter	$14.31^{a}\pm0.788$	$14.38^{a}\pm0.737$	$14.23^{a}\pm0.745$	$14.40^{a}\pm0.763$	$14.29^{a}\pm0.889$
	Pre monsoon	$23.63^{b}\pm0.433$	$23.63^{b}\pm0.505$	$23.83^{b}\pm0.368$	$23.52^{b}\pm0.471$	$24.00^{b}\pm0.351$
	Monsoon	$26.77^{c}\pm0.492$	$26.69^{c}\pm0.56$	$27.01^{c}\pm0.396$	$26.20^{c}\pm0.503$	$27.11^{c}\pm0.613$
	Post monsoon	$25.16^{bc}\pm0.953$	$24.81^{bc}\pm1.029$	$24.54^{b}\pm0.963$	$24.41^{bc}\pm0.988$	$24.52^{b}\pm1.099$
	P value	0.000	0.000	0.000	0.000	0.000
Transparency (cm)	Winter	$27.03^{a}\pm0.457$	$28.06^{a}\pm0.311$	$25.03^{a}\pm0.222$	$18.08^{a}\pm0.525$	$24.67^{a}\pm0.333$
	Pre monsoon	$36.00^{b}\pm0.725$	$36.25^{b}\pm0.456$	$32.53^{c}\pm0.531$	$24.25^{b}\pm0.417$	$28.56^{b}\pm0.291$
	Monsoon	$26.44^{a}\pm0.482$	$28.39^{a}\pm0.477$	$27.19^{b}\pm0.416$	$18.31^{a}\pm0.343$	$24.97^{a}\pm0.429$
	Post monsoon	$39.39^{c}\pm1.558$	$40.44^{c}\pm1.629$	$33.14^{c}\pm1.172$	$25.78^{c}\pm0.678$	$31.28^{bc}\pm0.899$
	P value	0.000	0.000	0.000	0.000	0.000
Electrical conductivity (µs/cm)	Winter	$173.56^{d}\pm2.996$	$167.56^{c}\pm2.102$	$187.56^{d}\pm5.728$	$191.56^{c}\pm4.553$	$175.44^{c}\pm6.625$
	Pre monsoon	$160.44^{c}\pm7.459$	$156.56^{c}\pm8.268$	$166.11^{c}\pm10.257$	$175.11^{c}\pm11.043$	$164.33^{c}\pm9.299$
	Monsoon	$95.22^{a}\pm1.544$	$94.00^{a}\pm2.906$	$105.22^{a}\pm3.666$	$106.33^{a}\pm3.571$	$92.11^{a}\pm2.044$
	Post monsoon	$129^{b}\pm2.687$	$126.67^{b}\pm2.224$	$134.78^{b}\pm2.743$	$133.56^{b}\pm3.520$	$122.67^{b}\pm2.863$
	P value	0.000	0.000	0.000	0.000	0.000
Total dissolved solid (mg/L)	Winter	$254.56^{c}\pm3.902$	$264.89^{d}\pm7.125$	$320.11^{c}\pm2.441$	$274.00^{b}\pm7.238$	$294.56^{c}\pm3.448$
	Pre monsoon	$245.33^{c}\pm4.888$	$244.78^{c}\pm4.551$	$311.89^{c}\pm9.519$	$250.22^{c}\pm3.792$	$275.33^{c}\pm3.189$
	Monsoon	$179.44^{a}\pm2.577$	$171.33^{a}\pm3.059$	$179.00^{a}\pm4.589$	$179.67^{a}\pm4.525$	$192.11^{a}\pm7.466$
	Post monsoon	$215.11^{b}\pm8.227$	$205.44^{b}\pm9.897$	$244.00^{b}\pm15.889$	$212.56^{b}\pm9.665$	$231.89^{b}\pm12.235$
	P value	0.000	0.000	0.000	0.000	0.000
Turbidity (NTU)	Winter	$22.89^{a}\pm0.618$	$22.72^{a}\pm0.319$	$22.32^{a}\pm0.439$	$35.49^{a}\pm0.525$	$46.24^{a}\pm0.644$
	Pre monsoon	$23.99^{a}\pm0.493$	$23.10^{a}\pm0.289$	$24.10^{b}\pm0.319$	$36.41^{a}\pm0.554$	$47.27^{a}\pm0.343$
	Monsoon	$33.39^{c}\pm0.492$	$26.15^{b}\pm0.299$	$31.12^{d}\pm0.359$	$43.00^{c}\pm0.334$	$49.65^{b}\pm0.294$
	Post monsoon	$30.77^{b}\pm0.959$	$23.63^{a}\pm0.542$	$27.56^{c}\pm1.047$	$39.37^{b}\pm1.163$	$50.49^{b}\pm0.839$
	P value	0.000	0.000	0.000	0.000	0.000

N.B.: Values with superscript a, b, c… differs significantly within the column

Dokulil *et al*. (2006) reported that water transparency is not only a crucial parameter of river optics but also one of the important indexes of eutrophication evaluation of a river system. The transparency of water was highest in post monsoon season (40.44^{c}±1.629 cm at MB2) in all the locations and the differences are statistically highly significant ($p<0.01$). The post monsoon value was followed by pre monsoon values in all the cases. Differences between monsoon and winter transparency values remained non significant in all the cases except in location MB3.

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. Electrical conductivity is found to be good indicator of water quality (Gaikwad *et al*., 2008). Electrical conductivity in monsoon was recorded lowest (94.00^{a}±2.906 µs/cm at MB2) and in winter it was highest in all the locations of the river (191.56^{c}±4.553 µs/cm at MB4). Electrical conductivity was recorded below the WHO standards of 1400 µs/cm during all seasons (Fig 2). The differences were statistically highly significant ($p<0.01$). Total dissolved solids (TDS) is an important parameter in determining the water quality standards (Jayakumar *et al*., 2009). TDS was maximum during summer and minimum during monsoon (Narayan *et al*., 2007; Jacklin Jemi and Regini Balasingh, 2011). In the present investigation also, TDS in monsoon in all the locations remained lowest (171.33^{a}±3.059 mg/L at MB2) and highest in winter (320.11^{c}±2.441 mg/L at MB3) and pre monsoon seasons followed by post monsoon season. TDS was found below the ISI standard of 500 mg/L in all seasons (Fig 3). The differences are statistically highly significant ($p<0.01$).

Table 2: Seasonally evaluated chemical parameters of river Mara Bharali.

Parameter	Season	MB1	MB2	MB3	MB4	MB5
pH	Winter	6.95^{ab}±0.045	7.31^{c}±0.039	6.88^{a}±0.097	6.38±0.146	7.35^{c}±0.032
	Pre monsoon	7.22^{c}±0.054	7.26^{bc}±0.059	7.11^{b}±0.073	6.63±0.055	7.36^{c}±0.046
	Monsoon	7.06^{b}±0.038	7.14^{ab}±0.038	6.87^{a}±0.032	6.62±0.039	7.17^{b}±0.029
	Post monsoon	6.86^{a}±0.031	7.09^{a}±0.034	6.83^{a}±0.017	6.44±0.039	7.06^{a}±0.41
	P value	0.000	0.004	0.017	0.107	0.000
Dissolved oxygen (mg/L)	Winter	7.878^{d}±0.074	7.7^{c}±0.067	6.822^{b}±0.175	6.244^{b}±0.082	6.978^{b}±0.043
	Pre monsoon	7.344^{c}±0.044	6.922^{b}±0.049	5.70^{a}±0.119	5.489^{a}±0.090	6.644^{a}±0.100
	Monsoon	6.989^{b}±0.089	6.656^{a}±0.114	5.722^{a}±0.199	5.444^{a}±0.047	6.60^{a}±0.068
	Post monsoon	6.689^{a}±0.048	6.611^{a}±0.075	6.01^{a}±0.238	5.467^{a}±0.134	6.544^{a}±0.100
	P value	0.000	0.000	0.000	0.000	0.003
Free CO_2 (mg/L)	Winter	13.69^{b}±0.265	13.10^{b}±0.259	21.76^{c}±0.234	24.53^{b}±0.276	13.50^{c}±0.165
	Pre monsoon	14.62^{c}±0.341	14.56^{c}±0.334	25.57^{d}±0.691	28.61^{c}±0.597	15.26^{d}±0.254
	Monsoon	12.20^{a}±0.222	12.21^{a}±0.230	17.01^{a}±0.274	19.55^{a}±0.649	11.86^{a}±0.267
	Post monsoon	12.31^{a}±0.183	12.56^{ab}±0.291	18.59^{b}±0.283	20.09^{a}±0.520	12.71^{b}±0.179
	P value	0.000	0.000	0.000	0.000	0.000
Biological oxygen demand (mg/L)	Winter	0.803^{a}±0.014	0.766^{a}±0.024	1.701^{a}±0.057	1.477^{a}±0.027	0.874^{a}±0.014
	Pre monsoon	1.67^{b}±0.053	1.612^{b}±0.058	2.69^{b}±0.065	2.378^{b}±0.040	1.18^{b}±0.086
	Monsoon	1.793^{b}±0.074	1.667^{b}±0.059	2.838^{b}±0.022	2.44^{b}±0.045	1.708^{c}±0.030
	Post monsoon	1.723^{b}±0.086	1.669^{b}±0.054	2.795^{b}±0.048	2.385^{b}±0.046	1.47^{c}±0.141
	P value	0.000	0.000	0.000	0.000	0.000
Total alkalinity (mg/L)	Winter	115.11^{a}±1.16	102.11^{a}±1.645	100.89^{a}±2.95	99.89^{a}±2.452	109.00^{a}±1.312
	Pre monsoon	146.33^{c}±1.616	129.67^{c}±1.333	124.56^{c}±1.519	116.89^{b}±1.585	123.56^{b}±2.381
	Monsoon	112.11^{a}±1.719	101.22^{a}±1.176	95.22^{a} ±0.997	99.44^{a}±2.328	107.00^{a}±2.96
	Post monsoon	132.44^{b}±3.096	119.11^{b}±2.705	108.67^{b}±2.629	104.11^{a}±2.463	113.67^{a}±3.215
	P value	0.000	0.000	0.000	0.000	0.000
Total hardness (mg/L)	Winter	43.62^{b}±1.759	48.13^{b}±2.355	66.23±0.429	69.12^{b}±1.094	40.73^{b}±1.458
	Pre monsoon	36.85^{a}±0.447	39.14^{a}±0.387	67.39±0.412	66.47^{a}±0.459	36.53^{a}±0.496
	Monsoon	37.25^{a}±0.516	39.18^{a}±0.585	68.17±1.036	68.17^{ab}±0.652	40.61^{b}±1.047
	Post monsoon	43.50^{b}±1.319	42.54^{a}±2.801	67.07±0.389	69.34^{b}±0.583	43.99^{c}±0.382
	P value	0.000	0.005	0.201	0.038	0.000
Calcium (mg/L)	Winter	9.19±0.239	10.19±0.350	15.73±0.156	18.56^{b}±0.435	9.44±0.268
	Pre monsoon	8.43± 0.284	9.51±0.127	15.61±0.176	18.00^{ab}±0.465	8.89±0.212
	Monsoon	9.12±0.164	9.67±0.298	15.44±0.325	16.82^{a}±0.466	9.47±0.206
	Post monsoon	8.68±0.328	9.33±0.316	15.96±0.313	17.62^{ab}±0.175	9.26±0.162
	P value	0.146	0.196	0.518	0.035	0.223

N.B.: Values with superscript a, b, c… differs significantly within the column.

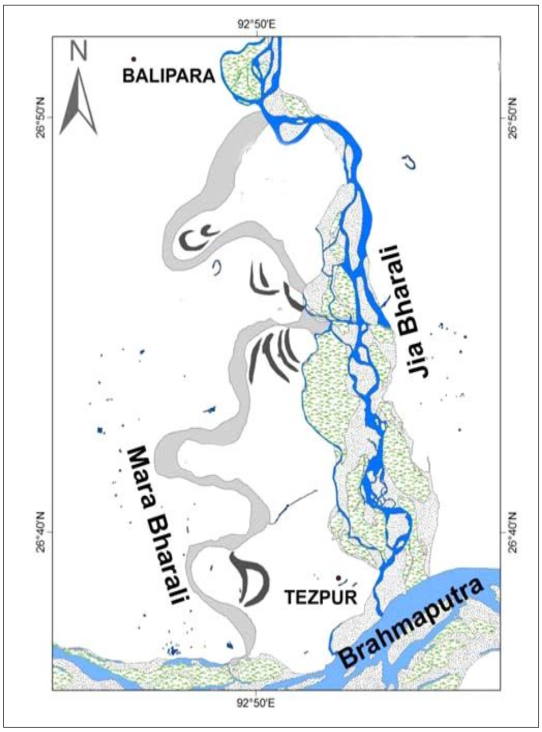

Fig 1: Present courses of river Jia Bharali and the Mara Bharali.

Water turbidity remained highest in monsoon ($49.65^{b}\pm0.294$ NTU at MB5) at all locations except in MB5 where a non significant higher mean value is recorded in comparison to the monsoon value. The differences in all other cases were highly significant ($p<0.01$). Water turbidity was recorded lowest in the winter season ($22.32^{a}\pm0.439$ NTU at MB3) at all sampling sites. Matta *et al*., 2020 working on the Ganga river system has obtained similar results.

pH is an important parameter which helps to determine the acid-base balance of river water (Bhalla and Waykar 2012). Moreover, pH is also positively correlated with electrical conductance and total alkalinity (Gupta *et al*. 2009). In the present investigation, pH value at all the locations in post-monsoon season was recorded lowest except in MB4. Significant differences in seasonal values were recorded in all locations except in MB4. At location MB1, pre-monsoon value was recorded highest ($7.22^{c}\pm0.054$), followed by monsoon ($7.06^{b}\pm0.038$), winter and post monsoon ($p<0.01$). At location MB2, pH was recorded highest in winter ($7.31^{c}\pm0.039$) followed by pre monsoon, monsoon and post monsoon ($p<0.01$). In MB3, it was highest in pre monsoon ($7.11^{b}\pm0.073$) and all other seasons have almost similar mean values ($p<0.05$). In MB5, the mean value in pre monsoon and winter was high followed by monsoon and post monsoon (Table 2; Fig 4). The differences were statistically highly significant ($p<0.01$). The pH value was within the permissible

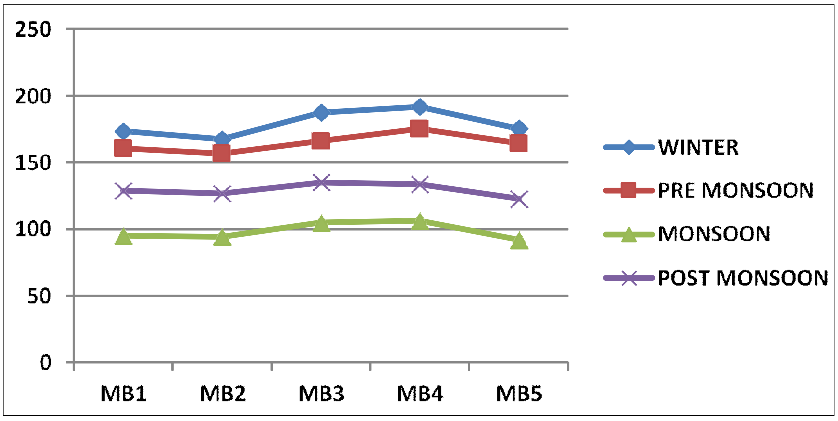

Fig 2: Seasonal fluctuation of conductivity (µs/cm) at the sampling sites of R. Mara Bharali.

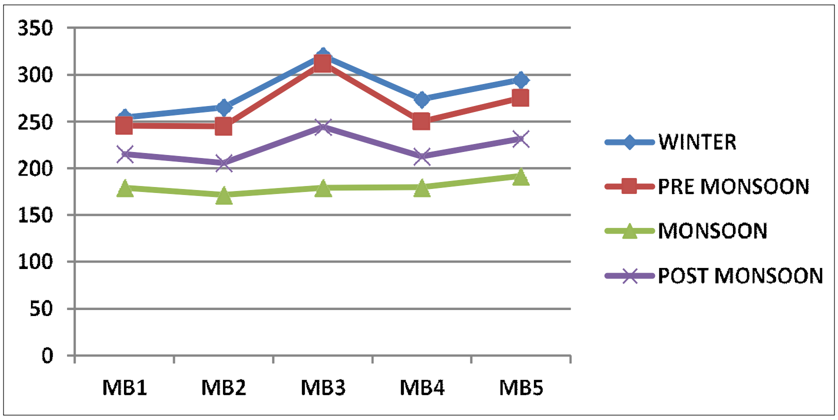

Fig 3: Seasonal fluctuation of TDS at the sampling sites of R. Mara Bharali.

limit except for site MB4 during the winter and post monsoon when the values were 6.38±0.146 and 6.44±0.039 respectively (ISI permissible limit being 6.5-8.5).

Dissolved oxygen (DO) is an indicating parameter of water quality. Dissolved oxygen varies or changes with many factors including water flow rate, depth, temperature and time of the day (Tyagi *et al*., 2013). In natural water, the maximum DO concentration is highest at 0°Cand decreases with an increase in temperature (Mia *et al*., 2017). During the study, maximum DO of 7.878^d±0.074 mg/L was observed at site MB1 during the winter season and minimum DO of 5.444^a±0.047 mg/L was observed at site MB4 during the monsoon season. The differences were statistically highly significant ($p<0.01$). DO was found to be above the tolerance limit of 4 mg/L at all sampling stations during all seasons of the study period (Fig 5).

Relatively higher values of free CO_2 were observed during pre-monsoon season (28.61^c±0.597 mg/L at MB4). The results of the present findings are in conformity with the finding of Nath and Srivastava (2001) and Gurumayum *et al*. (2002) who also have reported higher values of free CO_2 during pre monsoon season (28.61^c±0.597 mg/L). Moreover, low values of free CO_2 was recorded in monsoon season (11.86^a±0.267 mg/L at MB5) which complies with the findings of Das *et al*. (2003) who reported low values of free CO_2 during monsoon in river Brahmaputra. CO_2 concentration significantly varied ($p<0.01$) among all the seasons at all the locations, where pre monsoon CO_2 concentration was recorded highest and monsoon was the lowest in all the cases (Fig 6).

Biochemical oxygen demand (BOD) is an essential parameter, which shows the quantity of consumed oxygen in biochemical decomposition of organic matter present in water. DO and BOD are inversely proportional to each other. This is because bacteria will consume oxygen while decomposing the available BOD (Sawyer *et al*., 2003). In the present investigation, BOD in winter remained significantly low ($p<0.01$) in all the locations (0.766^a±0.024 mg/L at MB2) and recorded highest at MB3 during the monsoon season (2.838^b±0.022). However, in all the sampling stations BOD was recorded below the tolerance limit of 3 mg/L during all seasons of the study period (Fig 7). No significant differences were recorded between pre monsoon, monsoon and post monsoon seasons at all the locations except MB5 where monsoon and post monsoon values remained significantly ($p<0.01$) higher than pre monsoon value. The differences were statistically highly significant ($p<0.01$).

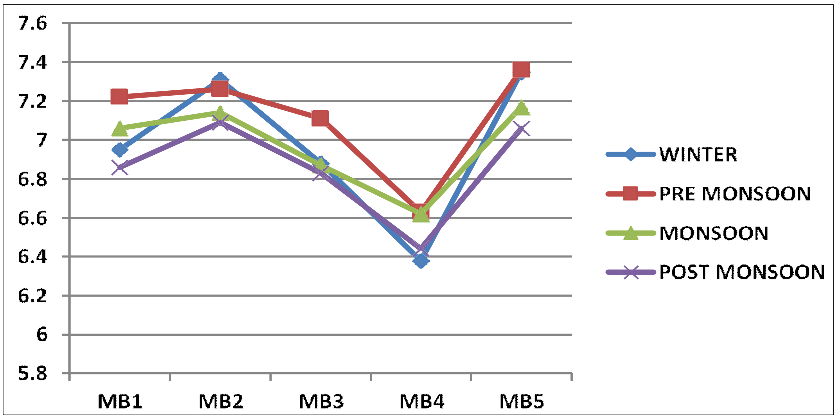

Fig 4: Seasonal fluctuation of pH at the sampling sites of R. Mara Bharali.

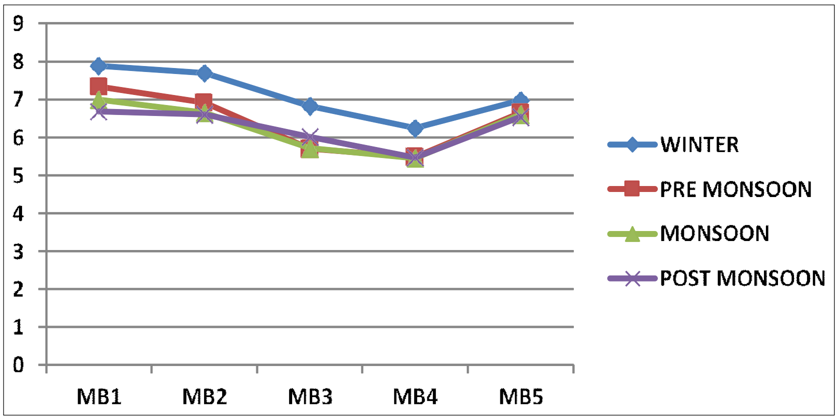

Fig 5: Seasonal fluctuation of DO (mg/L) at the sampling sites of R. Mara Bharali.

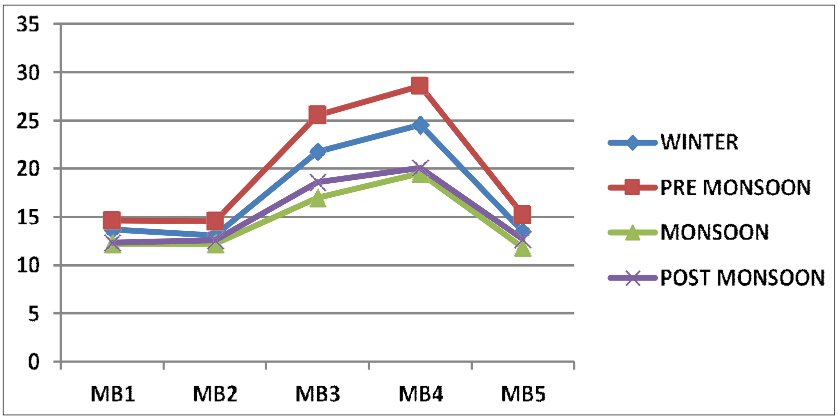

Fig 6: Seasonal fluctuation of free CO_2 (mg/L) at the sampling sites of R. Mara Bharali.

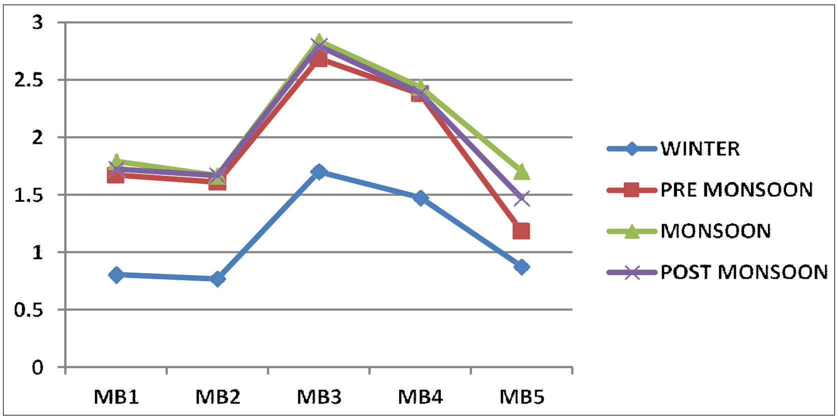

Fig 7: Seasonal fluctuation of BOD (mg/L) at the sampling sites of R. Mara Bharali.

The alkalinity was found to be maximum in the pre-monsoon (146.33^{c}±1.616 mg/L at MB1) and post monsoon season (132.44^{b}±3.096 at MB1) whereas total alkalinity in monsoon and winter remained significantly low at 99.44^{a}±2.328 mg/L (site MB4) and 99.89^{a}±2.452 mg/L (site MB4) respectively ($p<0.01$). The major constituents of alkalinity in water are carbonates, bicarbonates and hydroxides which come from salts or sediments and dissolved rocks (Trivedy and Goel, 1986).

Hardness is an important parameter for detecting water pollution. According to Baruah *et al*. (1993) and Rao (2001), total hardness of water indicates the water quality in terms of calcium and magnesium only. In the present investigation, variation in total hardness was observed among different seasons. The hardness was highest ($p<0.01$) in winter and post monsoon at MB1 (43.62^{b}±1.759 mg/L in winter), in winter at 48.13^{b}±2.355 mg/L at MB2 ($p<0.01$) and non significant in MB3. Hardness was highest in winter (69.12^{b}±1.094 mg/L) and post monsoon (69.34^{b}±0.583 mg/L) and lowest in pre monsoon at MB4 (66.47^{a}±0.459 mg/L) ($p<0.05$) and highly significant ($p<0.01$) at MB5 where the post monsoon value is the highest followed by winter, monsoon and pre monsoon. Hardness was obtained much below the permissible limit of 200 mg/L in all sampling stations during the study period.

Calcium level does not vary significantly except in location MB4 where it is found highest in winter (18.56^{b}±0.435) and lowest in monsoon (16.82^{a}±0.466).

CONCLUSION

The study evaluated the water quality of R. Mara Bharali with the assessment of seasonal fluctuation of certain important physicochemical parameters. The study revealed that the water quality of river Mara Bharali exhibited significant seasonal variability throughout the study period. The pH was slightly acidic, TDS was on a higher side during winter, a moderate concentration of dissolved oxygen, fairly high amount of alkalinity and BOD level within the permissible limit. The study showed that the physicochemical parameters of the R. Mara Bharali were within the permissible limit and productive for fisheries.

Conflict of interest: None.

REFERENCES

APHA, AWWA, WPCF. (1998). Standard Methods for the Examination of Water and Wastewater, 20th edn. American Public Health Association, Washington.

Baruah, A.K., Sharma, R.N., Borah, G.C. (1993). Impact of sugar mill and distillery effluents on water quality of river Gelabil, Assam. Indian Journal of Environmental Health. 35: 288-293.

Begon, M., Townsend, C.R., Harper, J.L. (2009). Ecology: From Individuals to Ecosystems. London, UK: Blackwell Publishing.

Bhalla, R. and Waykar, B. (2012). Physicochemical profile of the Godavari River at Nashik in context of pollution. The Ecoscan. 6 (1and2): 29-34.

Das, A. C., Baryagm, B. K., Baruah, D., Sengupta, S. (2003). Study on wetland of Guwahati city: Water quality of rivers and drains. Pollution Research. 22(1): 117-119.

Dokulil, M.T., Jagsch, A., George, G.D., Anneville, O., Jankowski, T., Wahl. B., Lenhart, B., Bleckner, T., Teubner, K. (2006). Twenty years of spatially coherent deep water warming in lakes across Europe related to North-Atlantic oscillation. Limnology and Oceanography. 51: 2787-2793.

Dwivedi, B.K. and Pandey, G.C. (2002). Physico-chemical factors and algal diversity of two ponds, (Girija and Maqubara Pond), Faizabad. Pollution Research. 21: 361-370.

Gaikwad, S.R., Ingle, K.N., Thorat, S.R. (2008). Study of zooplankton pattern and resting egg diversity of recently dried water bodies in north Maharastra region. Journal of Environmental Biology. 29: 353-356.

Gupta, D.P., Sunita, S.J.P., Saharan, J.P. (2009). Physiochemical analysis of ground water of selected area of Kaithal City (Haryana) India. Researcher. 1(2): 1-5.

Gurumayum, S.D., Daimari, P., Goswami, B.S.J., Sarkar, A., Chaudhury, M. (2002). Physico-chemical qualities of water and plankton of selected rivers in Meghalaya. Journal of the Inland Fishries Society of India. 34(2): 36-42.

Hamilton, S.K. (2002). Comparison of inundation patterns among major South American floodplains. Journal of Geophysical Research. 107: 8038.

Jacklin Jemi, R. and Regini Balasingh, G.S. (2011). Studies on physico-chemical characteristics of freshwater temple ponds in Kanyakumari district (South Tamil Nadu). International Journal of Geology, Earth and Environmental Sciences. 1(1): 59-62.

Jayakumar, P., Jothivel, N., Thimmappa, A., Paul, V.I. (2009). Physico-chemical characterization of a lentic water body from Tamil Nadu with special reference to its pollution status. The Ecoscan. 3 (1 and 2): 59-64.

Jindal, R. and Sharma, C. (2011). Studies on water quality of Sutlej river around Ludhiana with reference to physicochemical parameters. Environmental Monitoring and Assessment. 174: 417-425.

Kumari, M., Mudgal, L.K., Singh, A.K. (2013). Comparative studies of physiochemical parameters of two reservoirs of Narmada river, M.P, India. Current World Environment. 8: 473-478.

Matta, G., Kumar, A., Nayak, A., Kumar, P., Kumar, A., Tiwari, A.K. (2020). Ditermination of water quality of Ganga river system in Himalayan region, referencing indexing techniques. Arabian Journal of Geosciences. 13: 1-11.

Mia, M.Y., Sultana, R., Rahman, M.M., Sarker, M.S.A. (2017). Physico-chemical parameters and heavy metal concentration of the Turag river water, Bangladesh. BOUJARD. 9 (1 and 2): 13-25.

Narayan, R., Saxena, K.K., Chauhabn, S. (2007). Limnological investigations of texi temple pond in district Etawah (U.P.). Journal of Environmental Biology. 28(1): 155-157.

Nath, D. and Srivastava, N.P. (2001). Physico-chemical characteristics of Narmada for the stretch Sandia to Mola in M.P. state in the context of construction of reservoirs on the river or its tributaries. Journal of the Inland Fishries Society of India. 33(1): 17-24.

Pettit, N.E., Bayliss, P., Davies, P.M., Hamilton, S.K., Warfe, D.M., Bunn, S.E., Douglas, M.M. (2011). Seasonal contrasts in carbon resources and ecological processes on a tropical floodplain. Freshwater Biology. 56(6): 1047-1064.

Rao, A.M. (2001). An environmental assessment on SIPCOT industrial complex, Cuddalore, Tamilnadu in relation to water pollution and its ethical implications. Ph.D. Thesis, Annamalai University, India, pp 1-7.

Saha, S., Mandal, A., Sahoo, D. (2017). Study of physico-chemical parameters of three different urban pond water of Nadia district, WestBengal, India. International Journal of Fisheries and Aquatic Science. 5(6): 23-27.

Sawyer, C.N., McCarty, P.L., Parkin, G.F. (2003). Chemistry for Environmental Engineering and Science, 5th edition McGraw-Hill, New York.

Trivedy, R.K., Goel, P.K., Trisal, C.L. (1987). Practical Methods in Ecology and Environmental Science. Enviro Media Publication, Karad (India), 340 pp.

Trivedy, R.K. and Goel, P.K. (1986). Chemical and biological methods for water pollution studies. Environmental Publication, Karad.

Tyagi, S., Dobhal, R., Kimothi, P.C., Adlakha, L.K., Singh, P., Uniyal, D.P. (2013). Studies on river water quality using river bank filtration in Uttrakhand, India. Water Quality Exposure and Health. 5: 139-148.