International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 748-754

Received: 14-07-2018
Accepted: 18-08-2018

Priyanky Tamuli
M. F. Sc., Department of Aquatic Environment Management, College of Fisheries, Assam Agricultural University, Raha, Nagaon Assam, India

Sarada Kanta Bhagabati
Head and Assistant Professor, Department of Aquatic Environment Management
College of Fisheries, Assam Agricultural University, Raha, Nagaon Assam, India

Rajdeep Dutta
Assistant Professor, Department of Aquatic Environment Mangement
College of Fisheries, Assam Agricultural University, Raha, Nagaon Assam, India

ASN Zaman
Principle Scientist, Soil Science, Regional Agricultural Research Station,
Assam Agricultural University, Shillongoni, Nagaon Assam, India

Jiten Sarma
Assistant Professor, Department of Fisheries Resource Management
Assam Agricultural University, Raha, Nagaon Assam, India

Abhijit Choudhury
M. F. Sc., Department of Aquatic Environment Mangement
College of Fisheries, Assam Agricultural University, Raha, Nagaon Assam, India

Labwanu Prashad Mudoi
M. F. Sc., Department of Aquatic Environment Mangement
College of Fisheries, Assam Agricultural University, Raha, Nagaon Assam, India

Dibya Jyoti Debnath
M. F. Sc., Department of Aquatic Environment Mangement
College of Fisheries, Assam Agricultural University, Raha, Nagaon Assam, India

Correspondence
Priyanky Tamuli
M. F. Sc., Department of Aquatic Environment Management, College of Fisheries, Assam Agricultural University, Raha, Nagaon Assam, India

Physico-chemical characteristics of 47 no. Morakolong *Beel*, Morigaon district, Central Brahmaputtra Valley Zone, Assam

Priyanky Tamuli, Sarada Kanta Bhagabati, Rajdeep Dutta, ASN Zaman, Jiten Sarma, Abhijit Choudhury, Labwanu Prashad Mudoi and Dibya Jyoti Debnath

Abstract
The bank of the river Brahmaputra and Barak are covered with myriads of fish prone derelict and semi derelict wetlands in the form of floodplain lakes or oxbow lakes locally known as *beel*. In Assam, *beels* constitute boundless and varied Fisheries resources covering an area of 1, 00,815 hectares. The basic understanding of the limnology, productive potentials and fish populations of *beels* is very essential for the sustainable development of *beel* fisheries in Assam. Therefore, a study was conducted on physico-chemical characteristics of Morakolong *beel* (47 no.), Morigaon district, Central Brahmaputra Valley Zone, Assam, during February, 2017 to January, 2018. Different parameters were taken in the study were Atmospheric and water temperature, water depth, Water turbidity, pH, Dissolved oxygen, Total alkalinity, Total hardness, Free carbon dioxide, Specific conductivity, Total dissolved solids, Nitrate-nitrogen and Phosphate-phosphorous. The results of the present study indicated that the water of the *beel* is productive.

Keywords: 47 no. morakolong *beel*, morigaon district, physico-chemical characteristics, central brahmaputra valley zone

1. Introduction

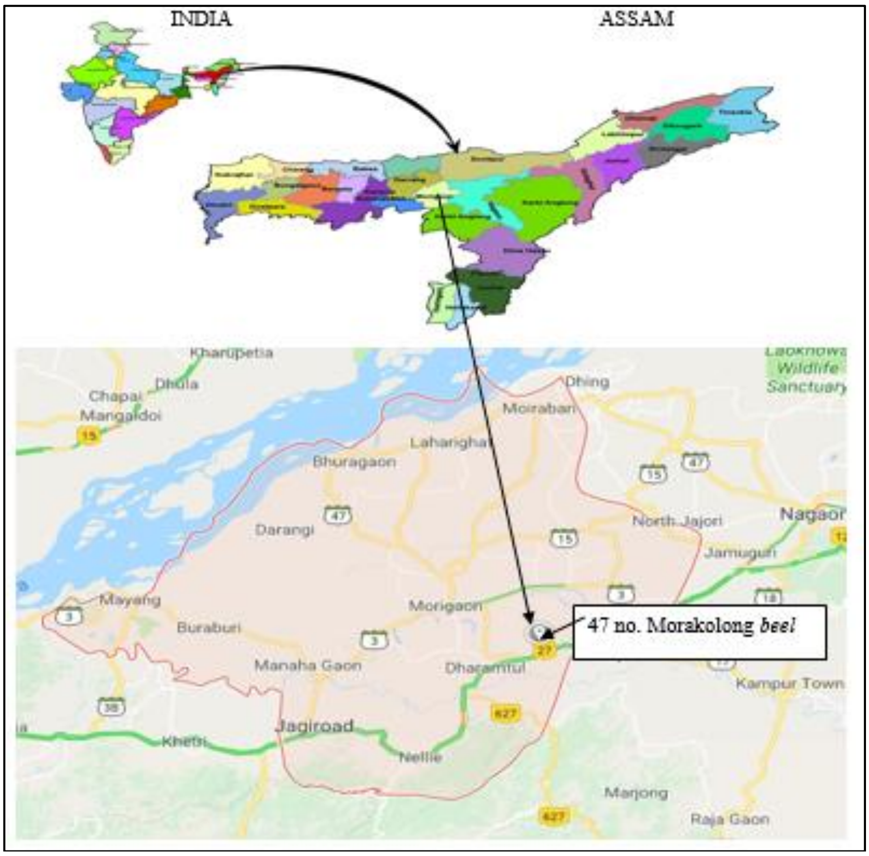
Wetlands are one of the important sources of water and transitional area between land and water. They are potentially rich in aquatic resources. They provide suitable habitats that support growth of a variety of aquatic forms. Wetlands are not only important life-support system for the flora and fauna alone but also supply bio resources as well as act as sources of livelihood for the people living in its vicinities. Wetlands are often described as “kidneys of the landscape” (Mitsch and Gosselink, 1986) [1]. Wetland includes a differential habitat with permanent or temporary water bodies with variety of function and value like diversity of organism included threatened and endangered species, nutrient recycling, purification of water and ground water recharge (Pramod *et al*., 2011) [2]. The wetlands of India are mostly situated on floodplains of major rivers, which form a rich and varied inland fishery resource; they are better designated as floodplain wetlands or floodplain lakes (Sugunan, 1997) [3]. India has extensive areas covered by floodplain wetlands which are an integral component of Brahmaputra and Ganga river systems. These wetlands together cover an area of 0.2 million hectares and constitute important fishery resources in the states of Assam, West Bengal, Bihar, Manipur, Arunachal Pradesh, Tripura and Meghalaya. This water bodies are locally known as *beels* (in most states including Assam), *mauns*, *chaurs* and *dhars* (Bihar), *pats* (Manipur), *charles* and *anoas* (parts of West Bengal and Assam bordering Bangladesh). *Beel* constitute an important fishery resource contributing significantly to the fish production of these states apart from providing livelihood to thousands of poor fishers. Since wetlands are one of the most threatened habitat in the world, so conservation of wetlands are very much important. One of the most important steps for conservation of wetlands is to maintain a proper water quality (Smitha and Shivashankar, 2013) [4]. The water quality is directly is directly related to the health of the water body. So, proper management in water quality of aquatic environment is very much essential. Some of the most recent works on water quality of various aquatic environment was those of Bhuyan and Gupta (2007) [5], Bhattacharyya and Kapil (2010) [6], Dutta (2011) [7], Suravi *et al*. (2013) [8], Hussain *et al*. (2015) [9] and Abir (2014) [10].

Among the North-Eastern states, Assam has the maximum number and the largest water area under floodplain wetlands (*beels*), mainly associated with the Brahmaputra and Barak river systems (Sugunan and Bhattacharyya, 2000) [11]. Assam is gifted with 3,513 nos. wetlands covering an area of 1, 00,815 hectares, around half of national wetland coverage and is capable of producing 1000 kg $ha^{-1}yr^{-1}$ of fishes with moderate level of management (CIFRI, 2000) [12]. Although, there are 3,513 nos. wetlands in Assam, only 1,392 nos. are listed as floodplain wetlands, of which 423 nos. are registered and remaining 969 nos. are unregistered. The latter are under the control of both government (505) and private (464) ownership (Chandra, 2011) [13]. But the present level of fish production from these *beels* is only $1/5^{th}$ of the potential i.e. 173 kg $ha^{-1}yr^{-1}$ on average (Sugunan and Bhattacharjya, 2000) [11]. The basic understanding of the limnology, productive potentials and fish populations of *beel*s is very essential for the sustainable development of *beel* fisheries in Assam. The physico-chemical characters of water strongly influence the fish production potential of a *beel* ecosystem. Though several workers have done physico-chemical studies of different wetlands of India and Assam, so far there was no scientific study of water quality parameters on the studied *beel*. Considering all above the present study was mainly focused on the physico-chemical parameters of water of the *beel* '47 no. Morakolong' which is located in the Southern part of Morigaon District (Central Brahmaputra Valley Zone).

2. Materials and Methods

2.1 Study area

The 47 no. Morakolong *beel* located in the southern parts of Morigaon district of Central Brahmaputra Valley Zone, Assam at latitude 26º20'61.98" N and longitude 92º42'30.93" E. The *beel* was created by Kolong River, which is one of the largest rivers flowing through this sub-zone. This is an open beel which retain it connection with Kolong River through a connecting channel (*Arakolong Jan*). The total area of the *beel* is 25 ha. This is a registered *beel* under the administrative control of the Assam Fisheries Development Corporation (AFDC), Guwahati and are leased to local fishers' cooperative society i.e. *Meen Somabai Samiti* for five-year terms.



Google Map Showing the Location of the Study Area

2.2 Sampling

Observation for of the present study were carried for a period of one year (February, 2017 to January, 2018). Observation and analysis were done every month. Three sampling sites (1, 2 and 3) were selected based on the connection of the *beel* to Kolong River, heavy aquatic weed infestation and magnitude of human influences. The sampling was done during morning hour (6 am to 9.30 am). Surface water samples for determination of various physico-chemical parameters were collected using a clean plastic bucket.

2.3 Physico-chemical parameters

Physico-chemical parameters like temperature, water depth, turbidity, water pH and specific conductivity and total dissolved solids were analyzed with the help of mercury glass thermometer, a graduated rope, Digital Nephelo-Turbidity Meter 132, Elico-LI 120 pH Meter and Systornics Water Analyser 371. For analysis of other physico-chemical parameters like dissolved oxygen, total alkalinity, total hardness, free carbon dioxide, nitrate-nitrogen and phosphate-phosphorous, the collected samples were transported into the laboratory and were analyzed as per procedure given by APHA (2005) [15]. The collected data were statistically analyzed by using software programme IBM SPSS (version 22).

3. Results & Discussion

Monthly variations were noted in physico-chemical properties, physico-chemical parameters were analyzed and assessed in order to understand and comprehend the variations of the various parameters at different sites during the monthly intervals of the *beel*.

3.1 Atmospheric and water Temperature

Temperature is a physical factor that alters the water characteristics and considered is one of the most important water quality variables, since it has a pronounced effect on chemical and biological processes. In general, the rates of chemical and biological reactions are doubled with every $10^{o}C$ increases in temperature (Boyd, 1984). In the present study monthly variability of atmospheric and water temperature have been observed. It was maximum during the month of August and minimum during the month of January. Bhat (1979) [16] and Bhattacharyya *et al*. (2001) [17] also found similar results as observed in the present study. Water temperature closely followed the changes in the atmospheric temperature in the *beel* as revealed by the significant (p ≤0.01) and positively correlated (r = 1.000) with air temperature. Direct relationship between air and water temperature was also reported by Yadava *et al*. (1987) [18] in Dighali *beel*, lower Assam.

3.2 Water depth

Depth is one of the main morphometric features that influence the productivity of *beel* ecosystem, which have close relation with hydro dyanamics of wetlands (*beels*). Sugunan and Bhattacharjya (2000) [11] suggested that *beels* having depth upto 5 meters are comes under shallow *beel*, depth upto 5 to 10 m are comes under medium *beels* and maximum depth of over 10 meters are comes under deep *beel*. In the present study the depth of the studied *beel* was ranged from 2.81 to 4.96 m which was under shallow *beel*. During the present investigation minimum water depth was recorded in the winter season and maximum depth was recorded in monsoon season, it is because of high rainfall in the area and incursion of flood water through the river. Depth showed significant (p≤0.05) positive correlation with air temperature (r = 0.958) and water temperature (r = 0.951) and significant (p≤0.05) negative correlation with water pH (-0.987). Similar observation was also recorded by Gupta and Dey (2012) [19] in a semi-intensive fish culture pond in Nagaon district, Assam and Bordoloi (2012) [20] in an open type wetland of Brahmaputra Valley, Assam.

3.3 Water turbidity

The turbidity fluctuated widely (2.6 to 5.2 NTU) and showed irregular temporal variations in 47 no. Morakolong *beel*. Even though the penetration of solar radiation in natural waters is a function of the angle of light falling on the water surface, the geographical position of the water body, presence of dissolved and particulate materials and other interfering factors will affect the rate of penetrating during different times of the day and year (Bhat,1979) [16]. In the present study the turbidity was recorded higher during pre-monsoon and monsoon season may be attributed to heavy rainfall in the period and higher growth of macrophytes. Similar results were also observed by Alam *et al*. (2015) [21] and Bordoloi and Baruah (2015) [22] that during pre-monsoon and monsoon season turbidity was higher as compared to other season. In the present study turbidity was positively correlated with depth, total alkalinity, total dissolved solid, specific conductivity, phosphate and negatively correlated with dissolved oxygen, pH, free carbon dioxide, total hardness, nitrate which is supported by the findings of Bordoloi and Baruah (2015) [22].

3.4 Water pH

The pH of 47 no, Morakolong *beel* water showed considerable variations ranging from acidic to slightly alkaline (6.3 to 7.3). These levels were within in the board range of water pH of the Brahmaputra Valley *beels* but more acidic compared to those of the Central Brahmaputra Valley Zone (Sugunan and Bhattacharjya, 2000) [11]. Apparently, the fluctuation in pH of water was influenced by the acidic character of the basin soil and the dense aquatic vegetation (Yadava *et al*., 1987) [18] as well as by the inflowing surface run-off/floodwater. In the present study pH was positively correlated with total alkalinity, total hardness, total dissolved solids, specific conductivity and showed negative correlation with free carbon dioxide, Nitrate and with phosphate but Sivlingam *et al*. (2013) [23] also reported that the pH is positively correlated with alkalinity, dissolved oxygen and phosphate.

3.5 Dissolved oxygen

Dissolved oxygen is one of the most critical water quality variables governing fish production, since it regulates the metabolic processes of aquatic plants and animals. Dissolved oxygen content of water widely fluctuated in 47 no. Morakolong *beel* (5.13 to 7.73 mgl^{-1}). Lower dissolved oxygen level was recorded from May to June in the present study may be attributed to the extensive growth of water hyacinth covering the surface and thereby reducing free surface area for diffusion/ wind action. Wide fluctuations in dissolved oxygen content of water in the *beels* might be due to dense aquatic vegetation and intense fishing activities at times (Yadava *et al.*, 1987) [18]. Dissolved oxygen was inversely related to water temperature (r = -0.825). The solubility of oxygen in water is increased by lowering the temperature (Reid, 1961). Thus, the high dissolved oxygen concentrations were recorded during the winter and pre-monsoon months. During the present study a tertiary peak of dissolved oxygen was also observed in August which may be due to high rainfall and similar finding was also obtained by Bhattacharjya (2002). Lower level of dissolved oxygen was also observed in the months of September and October, which may be due to the decomposition process of macrophytes and other organic matter. Similar findings were also observed by Welch (1935) [25] and Goswami (1985) [26].

3.6 Total alkalinity

Alkalinity is a measure of buffering capacity of the water. During the present study the total alkalinity varied moderately from 32 to 62 mgl^{-1} in 47 no. Morakolong *beel*. Boyd (1984) stated that the availability of carbon dioxide for primary production is related to alkalinity; water with total alkalinity levels of 20 to 150 mg l^{-1} contains suitable quality of carbon dioxide. Therefore Total alkalinity of the *beel* was found within this favorable range. Total alkalinity was inversely related with free carbon dioxide (r = -0.425). During the monsoon season, free carbon dioxide concentrations increased in the *beel* resulting in lowering of alkalinity levels, while reverse trend was observed during the winter season. Total alkalinity had a direct relation (r = 0.831) with pH of water, which is in conformity with the observations made by Pahwa and Melhotra (1966) [27].

3.7 Total hardness

Total hardness in water is the sum of the concentration of alkaline earth metals cations like Ca^{2+} and Mg^{2+}. Hardness is generally governed by calcium and magnesium salts which largely combines with bicarbonates and carbonates giving temporary hardness and with sulphates, chlorides and others anions of a minerals acids causing permanent hardness. Water hardness up to 60 mgl^{-1} was considered as soft water, from 61 to 121 mgl^{-1} as moderately hard water, from 121 to 180 mgl^{-1} as hard water and above 180 mg l^{-1} as very hard water (Kannan, 1991). In the present study total hardness of water had an equal magnitude as that of total alkalinity (45 to 66 mgl^{-1}) and exhibited similar spatio-temporal variations. Based on average hardness levels, 47 no. Morakolong *beel* can be considered as a soft water *beel*. The total hardness level of the *beel* was comparable with those of the *beels* of the Central Brahmaputra Valley Zone (Sugunan and Bhattacharjya, 2000) [11]. Total hardness showed insignificant positive correlation ($r = 0.313$) with total alkalinity.

3.8 Free carbon dioxide

Free carbon dioxide dissolved in water is essentially the only source of carbon that can be assimilated and incorporated into the skeleton of living matter of all the aquatic autotrophs. Most of the carbon in fresh water system occurred as equilibrium products of carbon dioxide. Carbon dioxide is added to aquatic ecosystem by other factors like rainwater, inflowing ground water and respiration of aquatic flora and fauna. Fishes can tolerate high concentration of free carbon dioxide, although they avoid levels as low as 5 mgl^{-1}. Most fish species will survive in waters containing up to 60 mgl^{-1} (Hart, 1944). In 47 no. Morakolong *beel* free carbon dioxide concentration fluctuated from 6.90 to 18.02 mgl^{-1}, which remained well within the tolerable range. The carbon dioxide levels recorded in the *beel* was comparable to that of Central Brahmaputra Valley Zone (Sugunan and Bhattacharjya, 2000) [11]. During the present study highest concentration of free carbon dioxide was recorded in May to June which indicates its influx through rain water in the form of carbonic acid (Chakravarty *et al*., 1959) [30] as well as decomposition of organic matter brought by surface run-off. Free carbon dioxide had inverse correlation with pH of water ($r = -0.425$). Similar inverse relationship between these parameters was observed by many workers in lakes (Gonjalves and Joshi, 1956 and Varduin, 1956) [31, 32] and *beels* (Goswami, 1985; Acharjee, 1997; Bhattacharjya, 2002) [33, 26].

3.9 Specific conductivity and total dissolved solids (TDS)

The specific conductivity of water or a solution in its capacity to conduct electric current and depends on the nature and concentration of ionized salts**.** It ranged from 69.8 to 163.2 μmho cm^{-1} in 47 no. Morakolong *beel*. It had positive correlation with total alkalinity ($r = 0.673$) and total hardness ($r = 0.223$), which is natural since all three parameters are related to the sum of the total ions, cations and anions respectively. Specific conductivity also had a significant ($p \leq 0.01$) positive correlation ($r = 0.997$) with total dissolved solids (TDS).

In water TDS are mainly composed of carbonates, bicarbonates, chlorides, sulphate, calcium, magnesium, sodium, potassium, organic matter, suspended particles and other ions. TDS ranged from 40.2 to 82.3 ppm in 47 no. Morakolong *beel*. Slightly higher levels of specific conductivity and TDS have been recorded in other *beels* of the Central Brahmaputra Valley Zone surveyed by CIFRI (Sugunan and Bhattacharjya, 2000) [11]. Both of these parameters followed a similar pattern of seasonal variation, with maximal values recorded during April-May, and may be due to the rainfall and floodwater incursion. Their levels sharply declined during post-monsoon season, which may be due to the decomposition of aquatic macrophytes. Similar findings were also reported by Acharjee (1997) [33] and Bhattacharjya (2002). Northcote and Larkin (1956) [34] observed better correlation of productivity with solids than with any other single factor. Both specific conductivity and TDS had direct correlation with organic carbon (0.763 and 0.745) and available phosphorus in bottom sediment of the *beel* (0.764 and 0.747), suggesting that both these water quality variables were directly influenced by the soil fertility.

3.10 Nitrate-nitrogen (NO_3 - N)

The role of nitrate-nitrogen in biological productivity of aquatic ecosystem is well recognized. In aquatic environment nitrogen is present in the combined forms of ammonia, nitrite, nitrate, urea and dissolved organic compounds. Nitrate is the most oxidized form of nitrogen and is usually the most abundant from of combined inorganic nitrogen in water bodies. Goldman and Horne (1983) [35] reported that the nitrate level usually found in natural water bodies is up to 1 mgl^{-1} and is not toxic. The nitrate-nitrogen level was recorded varied from 0.02 to 0.30 mgl^{-1} in 47 no. Morakolong *beel*, which was within the desirable range of fish production. In the present investigation, nitrate values were recorded higher during the post-monsoon and pre- monsoon months and lower in the winter and monsoon months and it showed positive correlation with phosphate-phosphorus of *beel* water. Similar result was also recorded by Yadavi *et al*. (2013) [36]; Abir (2013) [10]; Pathak and Mankodi (2013) [37] and Barman *et al*. (2015) [10].

3.11 Phosphate-phosphorus (PO_4- P)

Phosphate is an essential nutrient for primary producers and hence acts as one of the factors limiting growth of aquatic plants. Phosphorus occurs in nature in very small quantities, but is not the critical single factor in maintenance of pond fertility (Jhingran, 1991). Phytoplankton are able to use phosphorous only in the phosphate form for their growth. The main source of phosphorus in natural waters is from the withering of phosphorous bearing rocks and from the leaching of soils of the catchment area by rain. According to Jhingran (1991) natural waters having a phosphorous content of more than 0.20 mgl^{-1} phosphate are likely to be quite productive. The phosphate-phosphorus level was recorded varied from 0.002 to 0.018 mgl^{-1} in 47 no. Morakolong *beel*, which can be considered as productive. The present level was much higher than those recorded in other *beels* of the Central Brahmaputra Valley Zone and was similar to those in the Brahmaputra Valley *beels* (Sugunan and Bhattacharjya, 2000) [11]. Phosphate-phosphorous exhibited an irregular fluctuation pattern of seasonal variation in the present study, which may be related to the cycle of utilization of this important nutrient element by the primary producers. The peak phosphate level was recorded in July may be partly due to the leaching of soils of the catchment areas by rain or floodwater, which is one of the main sources of phosphorus in natural waters. Such high level of nutrient recorded during the period of flood or high water level may also be attributed to the death and decomposition of submerged macrophytes and their subsequent mineralization.

Table 1: Monthly variation of physical parameters of 47 no. Morakolong *beel* water.

Months	Air temperature (^oC)	Water temperature(^oC)	Water depth (m)	Turbidity (NTU)
Feb' 2017	20.70 ± 0.25	20.43 ± 0.12	2.81 ± 0.77	2.87 ± 0.18
Mar	22.67 ± 0.22	21.57 ± 0.47	3.02 ± 0.77	3.27 ± 0.23
April	24.27 ± 0.19	23.03 ± 0.29	3.54 ± 0.67	3.93 ± 0.45
May	27.73 ± 0.39	26.60 ± 0.26	4.15 ± 0.67	4.60 ± 0.17
June	31.97 ± 0.32	30.77 ± 0.34	4.51 ± 0.68	4.80 ± 0.21
July	32.97 ± 0.15	31.30 ± 0.42	4.63 ± 0.67	4.27 ± 0.45
Aug	35.13 ± 0.32	32.97 ± 0.44	4.96 ± 0.68	2.70 ± 0.47
Sept	31.23 ± 0.09	29.93 ± 0.38	4.63 ± 0.63	2.82 ± 0.24
Oct	28.33 ± 0.66	26.73 ± 0.48	4.36 ± 0.62	2.70 ± 0.06
Nov	22.20± 0.38	20.83 ± 0.37	3.95 ± 0.63	3.20 ± 0.15
Dec' 2017	20.07 ± 0.28	19.10 ± 0.35	3.57 ± 0.71	2.20 ± 0.32
Jan' 2018	18.50± 0.12	17.47 ± 0.07	3.17 ± 0.72	3.20 ± 0.38

Table 2: Monthly variation of chemical parameters of 47 no. Morakolong *beel* water.

Months	Water pH	Dissolved oxygen (mgl^{-1})	Total alkalinity (mgl^{-1})	Total hardness (mgl^{-1})	Free carbon dioxide (mgl^{-1})
Feb' 2017	7.07 ± 0.03	7.17± 0.43	45.33±3.71	61.00 ± 0.58	7.61 ± 0.31
Mar	7.2 ± 0.06	7.01 ± 0.42	43.33±3.28	64.00 ± 0.58	10.50 ± 0.84
April	7.13 ± 0.03	6.02 ± 0.35	47.33±1.76	60.00 ± 0.00	13.12 ± 0.53
May	6.81 ± 0.16	5.62 ± 0.35	43.00±3.79	60.00 ± 2.89	16.40 ± 0.86
June	6.37 ± 0.07	5.92 ± 0.13	49.33±2.33	57.33 ± 3.18	14.46 ± 0.38
July	6.43 ± 0.09	5.39 ± 0.12	35.00±1.53	53.33 ± 6.01	12.72 ± 0.34
Aug	6.63 ± 0.15	6.46 ± 0.08	34.00±0.58	58.67 ± 1.76	12.42 ± 0.35
Sept	6.60 ± 0.06	5.63 ± 0.26	34.67±1.20	59.33 ± 3.53	10.37 ± 0.34
Oct	6.77 ± 0.03	5.82 ± 0.06	40.67±0.88	56.67 ± 1.76	9.70 ± 0.33
Nov	6.80 ± 0.06	6.01 ± 0.43	36.00±2.08	66.00 ± 2.31	8.24 ± 0.54
Dec '2017	7.13 ± 0.09	7.39 ± 0.24	55.33±4.81	61.33 ± 3.71	8.06 ± 0.04
Jan' 2018	7.20 ± 0.06	6.69 ± 0.33	53.00±4.36	48.33 ± 3.84	7.26 ± 0.22

Table 3: Monthly variation of chemical parameters of 47 no. Morakolong *beel* water.

Months	Free carbon dioxide (mgl^{-1})	Specific conductivity (μmho cm^{-1})	Total dissolved solids (ppm)	Nitrate-nitrogen (mgl^{-1})	Phosphate-phosphate (mgl^{-1})
Feb' 2017	7.61± 0.31	132.30 ± 0.93	67.47 ± 0.65	0.03 ± 0.00	0.0057±0.0007
Mar	10.50 ± 0.84	140.93 ± 0.64	71.73 ± 0.54	0.12 ± 0.01	0.0040±0.0006
April	13.12 ± 0.53	149.47 ± 0.49	75.50 ± 0.64	0.13 ± 0.01	0.0027±0.0003
May	16.40 ± 0.86	162.23 ± 0.58	80.93 ± 0.75	0.10 ± 0.01	0.0053±0.0003
June	14.46 ± 0.38	120.17 ± 0.64	60.40 ± 0.96	0.11 ± 0.01	0.0087±0.0003
July	12.72 ± 0.34	100.61 ± 1.01	51.23 ± 0.81	0.05 ± 0.00	0.0153±0.0015
Aug	12.42 ± 0.35	72.40 ± 1.42	49.30 ± 0.46	0.04 ± 0.01	0.0047±0.0003
Sept	10.37 ± 0.34	68.77 ± 1.22	47.43 ± 0.58	0.17 ± 0.00	0.0143±0.0009
Oct	9.70 ± 0.33	81.63 ± 0.43	41.63 ± 0.78	0.28 ± 0.09	0.0053±0.0003
Nov	8.24 ± 0.54	96.70 ± 1.11	47.60 ± 1.11	0.15 ± 0.00	0.0073±0.0003
Dec' 2017	8.06 ± 0.04	110.00 ± 2.15	54.63 ± 2.12	0.04 ± 0.00	0.0090±0.0006
Jan' 2018	7.26 ± 0.22	128.20 ± 1.89	65.10 ± 1.12	0.02 ± 0.00	0.0033±0.0003

Table 4: Simple correlation co-efficient (r) between different physico-chemical parameters of 47 no. Morakolong *beel* water.

parameters	AT	WT	Turb.	Depth	DO	pH	TA	CO_2	TH	TDS	SC	NO_3- N
AT												
WT	1.000**											
Turb.	0.743	0.759										
Depth	0.958*	0.951*	0.522									
DO	-0.833	-0.825	-0.492	-0.870								
pH	-0.953	-0.947	-0.524	-0.987*	0.782							
TA	-0.815	-0.803	0.950	-0.906	0.976*	0.831						
CO_2	0.678	0.692	-0.345	0.471	-0.599	-0.425	-0.425					
TH	0.148	-0.154	-0.126	-0.100	-0.396	0.256	0.313	0.189				
TDS	-0.443	-0.423	0.257	-0.667	0.439	0.687	0.623	0.341	0.228			
SC	-0.513	-0.494	0.182	-0.725	0.499	0.742	0.673	0.266	0.223	0.997**		
NO_3-N	0.258	0.244	-0.088	0.397	-0.748	-0.254	-0.747	0.166	0.833	-0.320	-0.337	
PO_4-P	0.703	0.690	0.095	0.845	-0.547	-0.885	-0.690	-0.045	-0.394	-0.930	-0.952*	0.180

Note: * indicates significant coefficients at 5% level of significance.
** indicates significant coeifficents at 1% level of significance

N.B. Here AT= Air temperature, WT = Water temperature, Turb. = Turbidity, DO = Dissolved oxygen, TA = Total alkalinity, TH = Total hardness, TDS = Total dissolved solids, SC = Specific conductivity, NO_3-N = Nitrate- nitrogen and PO_4-P = Phosphate- phosphorous.

4. Conclusion

From the above findings, it is clear that a distinct monthly variations in selected physico-chemical parameters of the *beel* water. The correlation coefficient indicates positive and negative correlation of physico-chemical parameters of water with each other. This study may be helpful in optimum utilization and sustainable management of the *beel*. Removal of aquatic weed (water hyacinth) should be practiced at regular intervals to control the nutrients level and silt deposition.

5. Acknowledgement

The authors are thankful to the Head of the Department of Aquatic Environment Management, College of Fisheries, Assam Agricultural University, Raha for providing laboratory facilities.

6. References

1. Mitsch WI, Gosselink IG. *Wetlands*, Van Nostard Reinhold, New York, 1986.
2. Pramod A, Kumara V, Gowda RA. Study on Physico-Chemical Characteristics of Water in Wetlands of Hebbe Range in Bhadra Wildlife Sanctuary, Mid- Western ghat Region, India. J of Exp. Sci. 2011; 2(10):9-15.
3. Sugunan VV. Floodplain wetlands, small water bodies, culture-based fisheries and enhancement-conceptual framework and definitions. *In*: Fisheries Enhancement of small Reservoirs and Floodplain Lakes in India. (ed. Sugunan, V.V. and Sinha, M.).Bull.No.75, Central Inland Capture Fisheries Research Institue, Barrackpore. 1997; 13-21.
4. Smitha Ajay D, Shivashankar P. Physico-chemical Analysis of the Freshwater at River Kapila, Nanjangudu Indrustrial Area, Mysore, India, J Env. Sc. 2013; 2(8):59-65.
5. Bhuyan JR, Gupta SA. comparative hydrobiological study of a few ponds of Barak Valley, Assam and their role as sustainable water resources. J of Env. Biol. 2007; 28(4):799-802.
6. Bhattacharyya KG, Kapil N. Impact of urbanization on the quality of water in a natural reservoir: A case study with the Deepor *Beel* in Guwahati city, India. Water and Env. J. 2010; 24:83-96.
7. Dutta T. Zooplankton diversity and physico-chemical conditions of two wetlands of Jalpaiguri district, India. Int. J. of Applied Biol. and Pharma. Tech. 2011; 2(3):576-583.
8. Suravi Islam, Md S, Ali MA, Meghla NT, Sultan N. Seasonal Variations of Physicochemical Parameters of Water in the Pungli River, Tangail, Bangladesh. Int. J Curr. Microbiol. App. Sci. 2013; 2(5):155-167.
9. Hussain BA, Chandra BR, Amalesh D. A study of the Limnology and Icthyology of Dhir *Beel* at Dhuburi, Assam, India. Int. Res. J Biological Sci. 2015; 4(8):40-48.
10. Abir S. Seasonal Variations in Physico-Chemical Characteristics of Rudrasagar Wetland- A Ramsar Site, Tripura, North East, India. Res. J Chem. Sci. 2014; 4(1):31-41.
11. Sugunan VV, Vinci GK, Bhattacharjya BK, Hassan MA. Ecology and Fisheries of *Beels* in West Bengal. Bull. No. 103, Central Inland Capture Fisheries Research Institue, Barrackpore, 2000, 53.
12. CIFRI. Ecology and fisheries in beels of Assam, Bulletin, Central Inland Fisheries Research Institue, Barrackpore, India. 2000; 48:104.
13. Chandra G. Management Regimes and Institutional Arrangement in Floodplain Wetlands Fisheries of Assam: An Evaluation, Ind. J. of Extn. Edu. 2011; 47(1-2):27-33.
14. APHA. Standard methods for the examination of water and wastewater, 21st ed. Eaton, A.D.,Clesceri, L.S., Rice, E. W. and Greenberg, A. E. Americacan Public Health Association, Washington, D C, 2005.
15. Boyd CE. Water Quality Management in Aquaculture. Special Publ. No. 22, Cent. Mar. Fish. Res. Inst., Kochi, India, 1984, 98.
16. Bhat BV. Studies on the Meroplanktonic Larve with Reference to Hydrography of Nethravati-Gurupur Estuary, Mangalore, Dakshina Kannada. Unpublished M.F. Sc. Thesis, Univ. Agric. Sc., Bangalore, 1979, 214.
17. Bhattacharyya HC, Borkakati K, Saikia RS. Agricultural profile in Assam. *In*: Agriculture in Assam (ed. Thakur, A. C.M Bhattacharyya, A. and Sarma, D. K.). Assam Agricultural University, Jorhat (Assam), 2001, 1-17.
18. Yadava YS, Singh RK, Choudhury M, Kolekar V. Limnology and productivity of Dighali *beel* (Assam). Trop. Eco. 1987; 28(2):137-146.
19. Gupta T, Dey M. Hydro Biological Characteristics of Some Semi- intensive Fish Culture Ponds of Lumding Town of Nagaon District, Assam. Curr. World Environ. 2012; 8(1):107-115.
20. Bordoloi R. Comparative study on fish and fisheries of a closed and an open type wetland of the Brahmaputra valley. Int. J of Sci. and Res. Publ. 2012; 4(2):1-11.
21. Alam T, Hussain A, Sultana S, Hasan T, Simon KD, Mazlan AG, *et al.* Sediment properties of two important *beels* of Rajshahi, Bangladesh. Chinese J of Oceanology and Limnol. 2015; 7(1):50-62.
22. Bordoloi D, Baruah PP. Composition and seasonality of phytoplankton in a crude oil effluent holding pond of Digboi oil field, Assam (India). Bull. Env. Pharmacol. Life Sci. 2015; 4(8):76-82.
23. Sivalingam P, Swamy M, Reddy RT. Zooplankton Diversity with Reference to the Physico-Chemical Parameters of Kaijjarla Lake, Adilabad District, AP, India. Int. Res. J of Biol. Sci. 2013; 2(11):24-28.
24. Bhattacharyya BK. Trophic Structure and Fishery Potential of Selected Floodplain Wetlands (*Beels*) of Brahmaputra Valley. Ph. D. Thesis, Central Institute of Fisheries Education, Mumbai 2002, 1-244.
25. Welch PS. Limnology. McGraw Hill Book Co., New York 1935, 471.
26. Goswami MM. Limnological Investigations of a Tectonic Lake of Assam, India and Their Bearing on Fish Production. Unpublished Ph. D. Thesis, Gauahati University, Assam 1985, 395.
27. Pahwa DV, Melhotra SN. Observations on fluctuation in the abundance of plankton in relation to certain hydrobiological conditions of river Ganga. Proc. Nat. Acad. Sci. India. 1966; 36B (2):157-189.
28. Kannan K. Fundamentals of Environmental Pollutions, S. Chand and Company Ltd., New Delhi 1991, 189.
29. Hart JS. The circulation and respiratory tolerance of some Florida freshwater fishes. Proc. Fla. Acad. Sci. 1944; 7:221-246.
30. Chakravarty RD, Roy P, Singh BA. quantitative study of the plankton and physico-chemical condition of the river

Jamuna at Allahabad in 1954 & 1955. Indian J Fish. 1959; 6:186-203.
31. Gonjalves JG, Joshi DB. The seasonal succession of the algae in a tank at Bandra. J Bombay Nat. Hist. Soc. 1956; 46(1):187-206.
32. Varduin J. Primary production in lakes. Limnol. Oceanogr. 1956; 6:68-78.
33. Acharjee B. Ecological Status and Productivity Potential of Some *Beels* in Lower Brahmaputra Basin, Assam. Unpublished Ph. D. Thesis, Gauhati University, Assam 1997, 206.
34. Northcote TG, Larkin PA. Indices of productivity in British Columbia lakes, J Fish. Res. Bd. Canada 1956; 13(4a):515-540.
35. Goldman CR, Horne AJ. Limnology. McGraw Hill International Book Co., Japan 1983, 464.
36. Yadavi P, Yadavi VK, Yadavi AK, Khare PK. Physico-Chemical Characteristics of a Fresh Water Pond of Orai, U.P., Central India. Octa J. Biosci. 2013; 1(2):177-184.
37. Pathak NB, Mankodi P. C.Hydrobiogical status of Danteshwar pond, Vadodara, Gujarat, India, Int. Res. J Environ. Sci. 2013; 2(1):43-48.
38. Barman D, Roy B, Roy S. Seasonal Variation of Physico-Chemical character stics of Wetlands in the West Garo Hill, Meghalaya, India. Int. Res, J Biol. Sci. 2015; 4(1):60-65.
39. Jhingran VG. Fish and Fisheries of India, 3rd edition. Hindustan Publishing Corporation (India), Delhi 1991, 727.