



Studies on physico-chemical properties of water in some selected sites of Deepor Beel (Ramsar site), Assam, India.

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Abstract

Deepor beel (Ramsar Site) is a natural, permanent wetland, in a former channel of Brahmaputra river having both biological and environmental importance and richer in floral and faunal diversity. The Deepor beel ecosystem harbours large number of migratory waterfowl each year. But in recent decades several threats introduced in the area like construction, industrial development, large scale encroachment, etc. within the peiphery of the beel. Hence by studying the water quality of the beel the health of the beel could be understood and corresponding measurements could be taken. In the present study physico-chemical variables of the water like, Water temperature (WT), Colour, Odour, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Alkalinity (TA), pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Solids (TS), turbidity (T), Total Hardness (TH), Chloride, Calcium and Magnesium had been studied. The result of water variables varies with location, Turbidity found high, i.e., 12.6 TNU at site 7, where DO was very low at site 6 (1.4 mg/l). The BOD ranges (>2 mg/l) of water indicated that the water was moderately polluted at all the sites except site 6 and site 10. TDS shown the upper range of values (150 mg/l - 725 mg/l), which was unsuitable for drink. The outcome of ANOVA shown that water variables differ with location (F ration=1.83, p-value<< 0.06). Bray-Curtis Cluster analysis had been performed to find out the similarity among the sites. Where site 1 and site 4 shown highest similarity percentage (96.45%) than other sites. Hence the present study showed that more or less all the sites of the beel were contaminated and a quick action is required to sustain the health of the wetland.

Keywords: Physico-chemical properties, Deepor Beel, wetland.

1. Introduction

Wetlands are widely recognized as fragile ecosystems with diverse attributes including distinct avifauna (Burger, 1985). It has been estimated that freshwater wetlands hold more than 40% of bird species of the entire world and 12% of all animal species (Kirsten and Brander, 2004).

Wetlands are a vital line of defense between the nonpoint source pollutants and water quality of streams, rivers and lakes. Because of their position between dry land and water, wetlands protect the most biologically productive ecosystems in the world. Their strategic position within the landscape, wetlands can

provide a wide variety of ecosystem services such as (i) improving water quality by filtering sediment, nutrients, and pollutants, (ii) reducing flood damage, (iii) preventing bank and shoreline erosion, (iv) recharging ground and surface water supplies, (v) providing vital fish and wildlife habitat, (vi) offering opportunities for recreation, education, and research, (vii) producing food, forest, and fuel products, etc. and also functioning as important nutrient cycling mechanism for maintaining water quality (Huiping, *et al.*, 2011).

Deepor beel is a large natural wetland having great biological and environmental importance (Deka

& Goswami, 1992). Deepor Beel is a large natural wetland having great biological and environmental importance (Deka and Goswami, 1992). This large water body is a great food source and breeding ground for a variety of migratory birds, amphibians, reptiles, insects, micro and macrophytes, terrestrial weeds and important taxa of ecological and economic importance (Bera *et al.*, 2008). Deepor Beel has been designated as a Ramsar Site (No. 1207) on November, 2002. Although the original area of Deepor Beel was 4000 ha, due to large scale encroachment and other activities, the area has shrunk considerably and the present area of the actual wetland has been estimated at around 700 ha (Kapil and Bhattacharya 2013). Again, considering the varieties of bird species found in the *Beel*, Birdlife International has also declared Deepor Beel as an Important Bird Area (IBA).

The Beel is reported to provide, directly or indirectly, its natural resources for the livelihood of fourteen indigenous villages (1,200 families) located in its precincts. Freshwater fish is a vital protein and source of income for these communities; the health of these people is stated to be directly dependent on the health of this wetland ecosystem.

The analysis of water quality is important as the anthropological influence as well as natural processes

changes and degraded the water surface quality and impairs its use in drinking, agricultural, industrial, recreational and other purposes. Rapid growth of urbanization and industrialization results pollutions of land, air and water. The wetland is now facing a number of challenges, both natural and manmade. Illegal settlements and industries cropping up around the wetland are exacerbating the waste and pollution problems of the beel. Deepor beel receives a fair amount of waste water from different parts of the city and the adjoining areas. Neglect and mismanagement threaten to convert a vibrant, productive ecosystem into a massive garbage dump. The rich biodiversity of the beel has been on the declining line. Degradation of the water body has reached a critical state.

By studying the physico-chemical properties of the water of the beel, the status of water quality will be understood and subsequent management measurements can be undertaken.

2. Materials and methods

Study area

Deepor Beel (a Ramsar site), is located to the south-west of Guwahati city, in Kamrup district of Assam (Fig. 1). Located between Latitude: 26° 05' - 26° 11' N and Longitude: 91° 35' - 91° 43' E, it covers

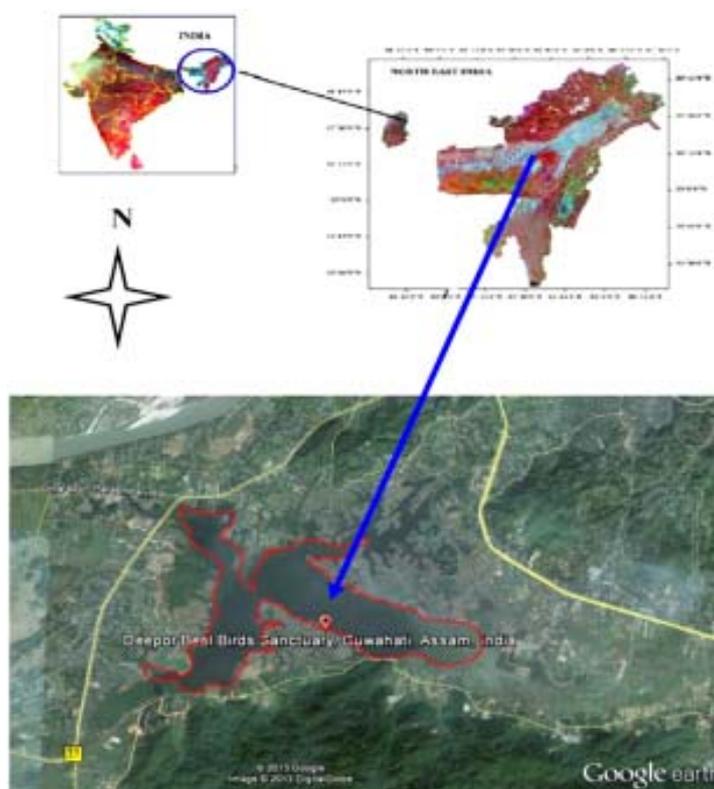


Fig.1: Map of Deepor Beel.

an area of 40.14 sq km and varies in depth from approximately 4 m in monsoon to 1 m in dry seasons. It is a permanent freshwater wetland in a former channel of Brahmaputra River.

The Beel, is a habitat to a large number of migratory waterfowl each year in addition to a huge congregation of residential water birds. Saikia and Bhattacharjee (1987) reported 219 species of birds including more than 70 migratory species in and around the beel. The lake supports globally threatened species of birds like Spotbilled Pelican (*Pelecanus*

philippensis), Lesser Adjutant Stork (*Leptoptilos javanicus*), Baer's Pochard (*Aythya baeri*), Pallas' Sea Eagle (*Haliaeetus leucogaster*), Greater Adjutant Stork (*Leptoptilos dubius*), Blacknecked Stork, and large Whistling Teal. It also supports 50 fish species belonging to 19 families (Saikia and Bhattacharjee, 1987).

Sampling sites

Ten sampling stations were selected throughout the wetland area (Table 1). The sampling points were

Table 1: Geographical description and G.P.S. location of study sites.

Sr. No.	Site No.	Location of sampling point	G.P.S. Point	
			Latitude	Longitude
1	S1	Near bird watching tower	26°07'05.25"N	91°39'02.83"E
2	S2	Near culvert	26°07'00.33"N	91°40'11.64"E
3	S3	Near the Railway Bridge	26°06'50.10"N	91°39'26.53"E
4	S4	Inlet (Garchuk)	26°08'05.39"N	91°39'49.77"E
5	S5	Deochotal	26°06'41.91"N	91°38'01.74"E
6	S6	Boragaon	26°07'48.22"N	91°39'13.31"E
7	S7	Near Khanamukh	26°07'19.57"N	91°38'03.11"E
8	S8	Middle of Deepar Beel	26°07'21.62"N	91°38'48.69"E
9	S9	In front of Engineering College	26°07'44.54"N	91°38'38.21"E
10	S10	Outlet (Near Azara)	26°07'38.39"N	91°38'00.38"E

selected keeping in view of some factors like – industrial effluents deposition, agricultural field's wash off, garbage dumping sites, outlets and inlets of water, etc.

Collection and pre-treatment of samples

Samples of water were collected from the study sites during two seasons, pre-monsoon and monsoons of 2009 and 2010. The water samples were collected in a plastic water gallon and BOD bottles from the respective study sites with three replicates and brought to laboratory for further analysis. The samples were collected from 4-6 inch beneath the water surface at the different sampling points. The temperature was measured for each sample on the spot at the time of collection. Whereas the other parameters like Total Alkalinity (TA), pH, Total Dissolved Solids (TDS), turbidity (T), chloride etc. were estimated within 24

hours of collection by applying suitable analytical methods. For Dissolved oxygen (DO) and Biological Oxygen Demand (BOD), the samples were collected in 300 ml BOD bottles very carefully, for BOD analysis samples were collected and preserved for 3 days at 27°C.

Analytical methods

Analyses of water were done following the methods of American Public Health Association (APHA, 2005). Colour visual method, odour by smelling, the temperature was measured with the help of mercury thermometer, graduated between 0° - 100° C at the time of collection of the samples. Turbidity was measured with the help of Nephelometer (ELCO CL 52D). DO by Winkler's method, BOD by titrimetric method, pH by electrical method using digital pH meter, Total Hardness (TH) by EDTA titration method,

TA by titrating with standard sulphuric acid (0.02N) at room temperature using phenolphthalein and methyl orange indicator, Cl⁻ by Silver nitrate method, Ca²⁺ and Mg²⁺ by titrimetric method .

Data analysis

The generated data were subjected to basic statistical analysis and pair-wise linear regression. Analysis of variance (ANOVA) of water variables in the surface layers for the 10 sampling sites was carried out using one way ANOVA model which relies on an additive decomposition of the data into grand mean, main effects, possible interactions, and an error term (Gelman, 2005). This analysis tests the validity of the 'null' hypothesis that water variables concentrations did not differ with location and time (Cooper & Gillespie, 2001). The differences are considered significant if F-ratio \gg 1.0 and the p-

value \ll 1.0, when the null hypothesis is invalid and the measured values within a group have valid correlation. F-ratio is approximately 1.0 if the corresponding effects are zero; otherwise F-ratio $>$ 1.0. If F-ratio is $<$ 1, there is negative correlation within a group. If F-ratio is $<$ 1.0 and p-value is $H^*1.0$, the measured values have a 'chance' element that cannot be neglected.

Bray-Curtis Cluster analysis was performed taking water variables as parameters to evaluate similarity among the sites.

3. Results and discussion

Surface water quality helps in evaluating the impacts of natural or anthropogenic point and non-point sources of pollution on ecosystem health (Ouyang, 2005). The values of the water variables estimated were listed in Table no. 2.

Table 2 : Variation of ranges of water variables in different stations of Deepor beel.

Water parameters (mean)	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Colour	Clear	Clear	Yellowish	Black	Clear to Black	Yellowish	Clear to Black	Clear	Black to Clear	Clear
Odour	No smell	No smell	Bad Smell	Bad Smell	Bad Smell	Bad Smell	Bad Smell	No Smell	Bad to No Smell	No Smell
WT(°C)	29.93	26.73	27.45	27.23	27.55	27.98	26.7	27.82	27.33	30.4
T(NTU)	7	5.28	5.18	3.5	4.55	4.3	12.6	6	4.44	5.26
pH	7.45	7.63	8.01	8.27	7.71	7.68	7.2	7.57	7.3	7.95
DO(mg/L)	7.45	2.69	3.54	7.88	8.9	1.4	8.55	8.76	7.45	6.3
BOD(mg/L)	2.3	2.08	2.03	3.82	3.93	0.34	5.13	5.72	4.81	1.58
TA(mg/L)	35	45.5	36.5	38	30.75	43.25	37.5	39.25	41.75	41.5
TDS(mg/L)	7200	4450	2525	6900	4975	2975	2950	1500	1350	6975
TS(mg/L)	9700	5825	3475	9975	7925	4450	5000	3450	2400	7950
TSS(mg/L)	2700	1500	1000	2925	2975	1500	1950	1475	1075	1000
TH(mg/L)	47.75	43.5	54.4	47	51.63	62.5	45	49	44	57.25
Ca(mg/L)	11.63	11	14.3	13.4	16.03	17.33	13.55	16.14	5.62	15
Mg(mg/L)	8.35	7.53	9.14	11.76	9.16	8.61	8.63	10.49	8.63	7.92
Cl(mg/L)	31.05	28.56	30.07	27.38	28.54	31.92	27.5	29.64	24.78	26.91

Pure water has no colour. The presence of humic acids, fulvic acids, metallic ions, suspended matter, phytoplankton, weeds and industrial effluents may cause colour in natural water. Odour of water some extent indicate the pollution status as bad odour was caused by chemical agents like H_2S , alcohol, phenols, ammonia etc. and colour may prevent sunlight from preventing into deep water. At sites S1, S2, S8, and at S10 the water appears to be cleared colour with no odour, where S3, S6 was found yellowish and S4, blackish water with bad smell during the study period. S9 had black to clear water and S5, S7 had clear to black water.

Water Temperature (WT) showed a range of 26.7 °C to 30.4 °C during the study period. Certain taste and odour producing organism grow more readily at a temperature range of 16 to 20°C. Hence recommendation for any acceptable limit should be guided by the temperature requirement at a specific locality necessary to preserve normal species diversity and prevent undesirable growth of nuisance organism (WHO, 1971; Patra and Azadi, 1985; Umeham, 1989; Jonnalagadda and Mhere, 2001). Turbidity caused by the hydrous oxides of Fe and Mn is objectionable in domestic water and may require special treatment for removal (Krenkel, 1974). Turbidity was found between 3.5 TNU (site4) - 12.6 (site7). Turbidity less than 10 TNU indicates excellent quality of water where more than 10 indicate fair quality. Turbidity is not necessarily harmful to fish (Ayodele and Ajani, 1991); however, the resulting reduction of sunlight intensity in the water decreases the productivity of a water body. Freshwaters with a pH range of 6.0 to 9.0 have been noted to be productive and thus recommended for fish culture (Adeniji, 1986). pH value of water found within the permissible limit. DO was found high in all the sites except site 2, 3 and 6. Where site 6 had 1.4 mg/l DO. DO increase the palatability of water because of its ability to remove undesirable taste. A dissolved oxygen concentration of not less than 5.0mg/l is required to sustain fish and other aquatic life in water bodies (Adeniji, 1986; Ayodele and Ajani, 1991; Adakole, 2000). BOD was found lowest at site 6 (0.34) and highest at site 8 (5.78). BOD values indicate the extent of organic pollution in an aquatic system, which adversely affect the water quality (Jonnalagadda and Mhere, 2001). The BOD of unpolluted waters is less than 1.00 mg/l; moderately polluted (BOD 2.0– 9.0mg/l) while heavily polluted waters have BOD more than 10.0 mg/l (Adakole, 2000). In the study except site 6 and 10, all sites had BOD more than 2, which indicates

moderately polluted water. TA was found within range of 30.75 mg/l (Site5)-45.5 mg/l (site2).

TDS was found between 150 mg/l (site 8) - 725 mg/l (site 1). Solids are found in streams and lakes in two forms, suspended and dissolved. Suspended solids include silt, stirred up bottom sediment, decaying plant matter, or sewage treatment effluent. Suspended solids will not pass through a filter, whereas dissolved solids will. Total Suspended Solids (TSS) had shown concentration within 100 mg/l (site3 and site 10) - 300 mg/l (site 4 and site 5). Dissolved solids in freshwater include soluble salts that yield ions such as Na^+ , Ca^{2+} , Mg^{2+} , HCO_3^- , SO_4^{2-} , or Cl^- . TDS levels in lakes and streams are typically found in the range of 50 to 250 mg/L. In areas of especially hard water or high salinity, TDS may be as high as 500 mg/L. Drinking water tends to be 25 to 500 mg/L.

In the study TS had shown ranges from 240 mg/l (site9) - 1050 mg/l (site 1). TH result showed that the water was soft as all the sites had TH within 60 mg/l except site 6 which was in medium category with TH 62.5 mg/l. Calcium dissolves out of almost all rocks and is, consequently, detected in many waters. Waters associated with granite or siliceous sand will usually contain less than 10 mg of calcium per litre. Many waters from limestone areas may contain 30-100 mg/l and those associated with gypsiferous shale may contain several hundred milligrams per litre. The concentration of Ca^{2+} in freshwater is generally in the range of 0 to 100 mg/l. The recommended upper level for drinking water is 50mg/L but higher levels do not cause health risks. If the calcium ion concentration in freshwater drops below 5mg/L, the ability of the water to support life is dramatically decreased, resulting in oligotrophic condition. The entire study site showed Ca^{2+} concentration more than 10 with highest value 17.33 at site 6 but site 9 only had a lowest Ca^{2+} , i.e., 5.62 mg/l. Magnesium is a component of chlorophyll in plants and therefore an essential nutrient. Mg^{2+} was found between 7.53 mg/l (site 2) - 11.76 mg/l (site 4). Magnesium is a relatively abundant element in the earth's crust and hence a common constituent of natural water. Waters associated with granite or siliceous sand may contain less than 5 mg of magnesium per litre. Water in contact with dolomite or magnesium-rich limestone may contain 10-50 mg l^{-1} and several hundred milligrams per litre may be present in water that has been in contact with deposits containing sulphates and chlorides of magnesium. Cl^- 24.78 mg/l (site 9)-31.92 mg/l (site 6). Chloride anions are usually present in natural waters. A high

4. Conclusion

Deepor Beel is one of the largest and most important beels in the Brahmaputra valley of lower Assam and is a representative wetland type found within the Biogeographic province (Burma Monsoon Forest). But in recent decades several threats introduced like construction of railway line along the southern boundary of the Deepor beel; Industrial development within the peiphery of the beel; Large scale encroachment and government as well as private settlement within the Deepor beel area; Allotting the government vacant land to private party by Government settlement department; Brick making

factory and soil cutting within the beel ecosystem; Hunting, trapping and killing of wild birds and mammals within and in the adjoining areas of Deepor beel; Unplanned fishing practice without controlling mesh size and using water pump, etc. the result of the present study showed that at all the location some water variables show within the permissible limit and some variables show upper the limit. Hence we can conclude that proper embankment to stop illegal encroachment should be undertaken, municipality solid waste dumping near at Deepor Beel should be replaced, the water hyacinth partially should be cleaned, etc.

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