ABSTRACT

Water pollution is not endemic to any particular region or country and all countries, whether developed, developing or under-developed are affected by water pollution by different degrees. The impact of pollution is felt even in countries with disordered economic growth associated with the exploration of virgin natural resources.

The sources of contaminants generally recognized as responsible for surface water quality degradation are the surface runoff generated from urban, rural, and agricultural lands; discharge from ditches and creeks; groundwater seepage from malfunctioning septic tank systems; chemicals used for aquatic weed control and naturally occurring inorganic inputs; and atmospheric deposition.

Wetlands are a vital line of defense between the non-point source pollutants and the degradation of water quality in the streams, rivers and lakes. Because of their position between dry land and water, wetlands act as giant natural filters and provide a wide variety of ecosystem services. Factors which determine the wetland water quality are physical and aggregate properties, inorganic non-metallic constituents, organic constituents and microbiological constituents.

The Deepor Beel is a permanent, freshwater wetland in the southern bank of the Brahmaputra River, India receiving a large amount of runoff from the surrounding agricultural land as well as from the Guwahati city. The Beel received international recognition as a Ramsar site (No. 1207) in 2002. With the broad objective of evaluating the present status of water quality of the Beel, the following specific objectives were formulated for the present study:

i) To study the quality of water with respect to temporal, spatial and depth variations,

ii) To estimate input of pollutants from major inflows into the Beel and their impacts on water quality, aquatic plants and fish, and

iii) To derive appropriate conclusions about the state of water in the Beel from statistical computations.
The thesis, reporting the results of the investigation, is organized into six chapters, viz., (1) Introduction, (2) Study area (3) Experimental methodology, (4) Results and discussion (5) Conclusion (6) References.

Chapter 1 (Introduction) starts with a general description of the water quality, the environmental role of a wetland, factors which determine the quality of the water and the national and international standards. Available relevant literature from other parts of the world has been reviewed to highlight the type of studies being carried out and the nature of results obtained. The chapter also reviews important water quality parameters and how they are being affected by pollution and other factors.

Chapter 2 (Study Area) gives a brief description of Guwahati and its suburbs, the important geographical features, such as climate, weather and drainage characteristics of the city. The Deepor Beel wetland system along with its surroundings have also been described giving clear ideas of the general features, physiography, climate and location, economic significance, land use, biological diversity present, aquatic plants and animals, etc.

Chapter 3 (Experimental Methodology) discusses the methodology followed in the present study. After a thorough survey of the Deepor Beel and its adjoining areas, locations for collection of water samples were chosen. Initially, samples were collected on monthly basis from February to July, 2004. Later, three sets of water samples were collected only from the surface layer at 13 locations in December 2004, February 2005 and April 2005. These 13 locations were further investigated by collecting water samples from three depths on bimonthly basis from June 2005 to April 2006. The three depths were the surface layer, the middle layer (euphotic zone) and the bottom layer (euphotic zone x 1.5). Euphotic zone was found with the help of a Secchi disk. The plant species and the fish species were collected from several sites. The water quality parameters monitored in this study could be grouped into 5 categories:

(i) Physical and aggregate properties: Turbidity, Alkalinity, Hardness, Conductivity, pH, Total solids dried at 103 – 105oC, Total dissolved solids
(ii) Metals: Major metallic constituents such as calcium, magnesium, sodium, potassium, iron, and manganese, and trace metallic constituents such as arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, and zinc.

(iii) Inorganic non-metallic constituents: Bicarbonate, chloride, fluoride, nitrate, phosphate and sulphate, as well as boron.

(iv) Organic constituents: Oil and grease, phenol.

(v) Microbiological quality: MPN of Total Coliform and Faecal Coliform.

Chapter 4 (Results and Discussion) is the most important part of the thesis, as it gives and analyses the results of the study. The first phase of sampling and analysis was exploratory in nature that helped in acquiring a preliminary understanding of the water quality status of the wetland and in identifying an appropriate strategy for monitoring water quality. The spatial, temporal and depth variation studies with respect to each of the parameters was undertaken in the second phase to identify factors responsible for considerable impact on water quality, and to obtain a comprehensive picture about the overall status of the wetland’s water quality. The overall findings of the study are:

(i) For most part of the year, the transparency of the Deepor Beel water is much less compared to the total depth, which therefore indicates highly productive nature of the wetland.

(ii) The differences between air temperature and water temperature are quite significant as the day breaks, but these differences gradually disappear as the water heats up from the top and the activities (such as fishing, rowing, etc.) create turbulence after the morning hours resulting in better mixing and elimination of the temperature differences between the layers.

(iii) The pH is in the range of 6.5 to 7.6 for the surface layer and 6.4 to 7.6 for the bottom layer. In several of the sites, the surface layer has a higher pH than the bottom layer.
The water has an electrical conductivity between 0.02 and 0.46 mS/cm. The values are highest during Feb and April. The Deepor Beel is a lake dominated by both carbonate and igneous rocks.

The mean redox potential values are in the range of – 9.2 to – 58.9 mV. The microbial redox processes dominate the water chemistry of the Beel and overall, the water has a reducing environment.

Turbidity reaches high values during the month of December onward. Water volume, runoff inflow, activities like fishing, submerged vegetation and other factors together determine the turbidity of the Deepor Beel water.

The water is loaded with suspended solids in a wide range of 14 to 111 mg/L. The average TSS values are highest during the months of June, August and October owing to the runoff bringing in more mud and vegetation debris from the banks as well as resuspension of bottom deposits due to fishing and other activities.

TDS varies from 57 to 421 mg/L and the values show linear dependence on Electrical conductivity.

Total Hardness varies from 25 to 80 mg/L and the water does not possess a large buffering capacity due to low total alkalinity of 5.0 to 67.5 mg/L.

The wetland water is generally deficient in dissolved oxygen with mean DO < 5 mg/L throughout the wetland. BOD loads are significantly large for a freshwater system and considerable flow of organic wastes to the wetland is indicated. BOD and COD loads of the wetland are between 40 to 220 mg/L and from 40 to 280 mg/L.

The wetland is very rich in Chlorophyll 'b' and 'c' compared to chlorophyll 'a' showing that the Beel water carries a large load of dead plants and algal matter. Chlorophyll 'a' varies from 16.3 to 22.8 % in the surface layer, and 16.1 to 50.0 % in the bottom layer.

The wetland water is sufficiently rich in nutrients - nitrate, phosphate, potassium and boron, which have the ranges of 0.01 to 8.20 mg/L, BDL to 0.86 mg/L, 0.2 to 22.3 mg/L and BDL to 868.0 mg/L respectively. The trophic state index (TSI) is > 70 for the water column from top to bottom and the wetland has reached eutrophication level.
(xiii) The cationic constituents, Ca, Mg, Na and Fe, have their presence in the water in ranges of 1.0 to 24.0 mg/L, 1.0 to 13.4 mg/L, 1.1 mg/L to 68.5 mg/L and 0.02 to 47.63 mg/L respectively. The anionic constituents - chloride, sulphate, and fluoride, are present in the concentrations of 7.10 to 49.70 mg/L, 0.5 to 122.0 mg/L, BDL to 3.41 mg/L respectively.

(xiv) Considerable presence of the metals As, Cd, Co, Cu, Cr, Mn, Hg, Ni, Pb and Zn has been recorded. As exceeds the WHO limit for drinking water in 1.5 % of the measurements, Cd in 63.8 % of the measurements, Cr in 67.8 %, Mn 24.2 %, Hg in 72.2%, Ni in 42.0%, and Pb in 78.7 % of the measurements. Co could be detected only in 42.6% of the water samples, Cu in 27.8%, and Zn in 81.7% of the samples. While no permissible limit has been prescribed for Co, the contents of Cu and Zn are found to be much below their maximum permissible limits for drinking water.

(xv) Due to large water volume, no petroleum hydrocarbons could be detected in the wetland from June to December, but small quantities are found during February to April when the water volume recedes to the minimum. During this period, oil and grease up to 8.58 mg/L can be found in the Beel water. This must have entered the wetland along with the city’s garbage. The toxic organic contaminant, phenol is found during December, February and April sampling and a maximum content of 1.05 μg/L is observed during this time.

(xvi) Microbiological examination shows the wetland water to be infested with coliform organisms in all the sites. Faecal contamination is observed in some sites at certain periods indicating flow of human and cattle wastes into the wetland.

(xvii) Analysis of a few common plant species growing at different locations of the wetland and also a few fish species has shown that all the species have accumulated considerable amounts of the heavy metals in them.

Chapter 5 (Conclusions) summarizes the overall results from the study and Chapter 6 (References) presents the complete list of references, consulted and found useful in interpreting the results of the study.