CHAPTER 5
CONCLUSIONS

5.1 Major findings

The present work yielded a comprehensive database on the water quality of the Deepor Beel, a Ramsar site in Guwahati, India. The sampling sites were selected after a careful survey such that the water quality data would be the representative of the whole wetland covering all possible differences in location geography and taking into account the inflow and outflow characteristics. For the first time, the variations were studied at three different depths and the euphotic layer has been specifically chosen for water analysis. Despite the wetland being very shallow at many locations, the study of the water column with respect to time, space and depth variations has been undertaken almost in their entirety. Parameters like chlorophyll and water transparency have been documented for the first time with respect to the Deepor Beel wetland system. Some of the important findings of this work are summarized below:

(i) The transparency has a decreasing trend from the summer to the winter (decrease in water volume was the main factor). For most part of the year, the transparency of the Deepor Beel water is much less compared to the total depth, which therefore indicates the highly productive nature of the wetland.

(ii) The air temperature is always higher than the water temperature, the differences being the largest during the summer months of June and August. The water is mostly shallow and the differences in temperature in the water column are quite significant as the day breaks, but these 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.
(iv) The water has an electrical conductivity between 0.02 and 0.46 mS/cm. The values are highest during Feb and April. From these values, the Deepor Beel can be classified as a lake dominated by both carbonate and igneous rocks.

(v) The mean redox potential values are in the range of $-9.2$ to $-58.9$ mV. The values indicate that microbial redox processes dominate the water chemistry of the Beel and overall, the water has a reducing environment.

(vi) Turbidity shows very wide variation from 2 to 310 NTU. The 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.

(vii) As the turbidity indicates, the water is loaded with suspended solids also 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.

(viii) The variations in the TDS are from 57 to 421 mg/L and therefore, the dissolved solid content of the water has no tendency to attain a constant value. Good linear relationship between TDS and Electrical conductivity has been observed.

(ix) The water is only moderately hard with total Hardness in the range of 25 to 80 mg/L. Similarly, the water does not possess a large buffering capacity as the total alkalinity is from 5.0 to 67.5 mg/L only.

(x) The wetland water is generally deficient in dissolved oxygen content and the mean values are $<5$ mg/L throughout the wetland. The wetland has thus ceased to be an ideal habitat for fish and other aquatic life forms. The water has BOD loads significantly large for a freshwater body, and the results have indicated
considerable flow of organic wastes to the wetland significantly jeopardizing its health. BOD and COD loads of the wetland are between 40 to 220 mg/L and from 40 to 280 mg/L.

(xi) The wetland is very rich in Chlorophyll ‘b’ and ‘c’ compared to chlorophyll ‘a’. Thus, the Beel water is full 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.

(xii) 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) Significantly, the wetland water has considerable presence of the metals As, Cd, Co, Cu, Cr, Mn, Hg, Ni, Pb and Zn. It is found that 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. Presence of these toxic metals in higher concentration is likely to add to the chemical toxicity of the water and must have been responsible for the gradually diminishing aquatic life in the wetland. Of the other metals, 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.
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 measured during December, February and April sampling and a maximum content of 1.05 µg/L is observed during this time.

Limited microbiological examination has shown that the wetland water is infested with coliform organisms in all the sites. Faecal contamination is observed in some sites at certain periods which indicate that human and cattle wastes from the neighbouring villages and the agricultural fields have found their way into the wetland.

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. This further demonstrates the state of health of the Deepor Beel water.

### 5.2 Suggestions for further work

In order to strengthen the database, the following have been suggested as follow-up work to be done in future:

(i) A thorough examination of the suspended and bottom sediments should be undertaken to obtain their metal-leaching and uptake capacities,

(ii) Water sampling should be carried out in a few selected sites throughout the day to monitor diurnal changes in important parameters,

(iii) The analysis of aquatic plants (both floating and submerged) should be taken up systematically and nutrient as well as metal accumulation properties of different plant parts should be differentiated, along with their decay properties,

(iv) A similar investigation may be carried out with respect to fish and other species (e.g. mollusca),
(v) A careful analysis of the water with respect to pesticides and their residues may be undertaken since the wetland receives a large amount of agricultural runoff,

(vi) The inlets and the outlets to the wetland should be carefully monitored to compute the pollution loads of the wetland and hence to develop an appropriate wetland management plan, and

(vii) Application of GIS and similar software to the data generated may be taken up for more meaningful data presentation and interpretation.