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# Distribution of A Few Heavy Metals in The Water of A Freshwater Wetland in Barpeta District, Assam, India

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**ABSTRACT**

With the rapid growth of urbanization, industrialization and modern agricultural practices, heavy metals toxicity has gained importance as one of the essential health related issue. In recent times the topic has become a matter of great concern due to deposition of industrial waste products in the food, water and air and thus heavy metals toxicity is regarded as a subject matter of particular interest within the outline of environmental exploration. Sorbhog Beel situated in the Barpeta district of Assam is recognized as one of the most important wetland of the district because of its faunal composition. The wetland is famous for its fisheries resource. Moreover, it is a breeding and feeding ground for numerous migratory birds. The wetland also serves as a source for irrigation of the nearby agricultural fields. Presently the Sorbhog Beel is under tremendous pressure from waste disposal and encroachment. It has turned into a degraded wetland. Among various problems witnessed by the Sorbhog beel, one of the major problems is of pollution of water by the heavy metals. Out of the 8 (eight) metals analysed, Lead (Pb) and Nickel (Ni) were found in the water of Sorbhog beel at considerable higher level. The level of mercury (Hg) and chromium (Cr) were comparatively lower. The level of arsenic (As) was found to be below the permissible safe level of BIS, safe drinking water standards and World Health Organization (WHO).

**KEYWORDS** water quality, heavy metals, toxicity, pollutants, Sorbhog Beel

## Introduction

Sorbhog Beel is one of the most significant riverine wetland in Barpeta district of Assam. The wetland apart from supporting highly concentrated and diverse indigenous freshwater fish population, it is a major feeding and breeding ground for a wide verity of resident and migratory birds. Most of the agricultural fields in the vicinity of the wetland are supplied with water for irrigation purposes from this wetland. With the rapid increase of population in the surrounding areas, coupled with different unplanned developmental activities in the nearby landscape, the wetland has been suffering from environmental dilapidation. Due to dumping of waste materials, unscientific fishing practices, irrigation return flows from the nearby agricultural fields, non-point source pollution occurring from surface and subsurface runoff and rapid encroachment, the Sorbhog beel has transformed in to a degraded wetland. The wetlands are transitional lands between terrestrial and aquatic system covered by standing water. Wetlands due to their strategic position between dry land and water act as an important line of defense between nonpoint source pollution and water quality of rivers and streams. Moreover wetlands check bank and shoreline erosion, filter pollutants, nutrients and sediments thereby maintain water quality, reduce flood damage, recharge ground and surface water and function as nutrient cycling unit for improvement of water quality (Agarwal, 2008; Huiping, ***et al***., 2011). Wetlands are important habitat for fish and wild life and supply large numbers of food, fuel and forest products. The wetlands trap suspended solids and attached nutrients, apart from mitigating flood during the period of flooding (Prasad ***et al***., 2002).Thus it is imperative to monitor wetland health for its protection. The continuous addition of undesirable chemicals has led to deterioration of water quality day by day (Ali and Jain, 2001). Loss of biodiversity, alteration of species composition and deterioration of water quality have been noticed in wetland system due to contribution of pollutants such as suspended solids, fertilizers, pesticides, nutrients and other organic and inorganic wastes (Durell ***et al***., 2001; Ouyang ***et*** al., 2002; Ouyang, 2005). Water in the wetland system has become vulnerable to contamination from industrial and urban effluent. Industrialization and urbanization have lead to the increase in the addition of metallic substances in the aquatic medium due to increase in the use of trace metals in different products. Among various water pollutants, metal ions are of harmful, toxic and dangerous nature because of non-degradable status (Jumbe and Nandini, 2009). Metals enter aquatic ecosystems via directly exposed surface water, soils, rocks, atmospheric particulate matter, various anthropogenic activities such as discharge of different treated and untreated liquid waste in to the aquatic medium and decomposition of dead organic matter (Akoto ***et al***., 2008).Toxic metals need close monitoring because of bioaccumulative, relatively stable and carcinogenic nature (Ali and Jain, 2001). Although presence of several metals such as Cr, Ni, Cu, Fe, and Zn in trace amount in aquatic environment is essential for life processes of aquatic plants and animals but at high concentration they become toxic (Akoto ***et al***., 2008). Increased concentration of metals in many natural aquatic ecosystems has raised concern regarding human health hazard (Iqbal ***et al***., 2006). Trace metals can check growth and damage kidneys and are linked to circulatory and central nervous system disease, rheumatoid arthritis, different types of cancer etc. ( Roy and Kalita, 2013) Based on various ongoing anthropogenic activities around the Sorbhog Beel, major heavy metals such as Pb, Hg, As, Cr, Cu, Fe, Zn and Ni were analyzed in the surface water of the wetland to investigate the pollution level.

The present work was undertaken with the objective of estimating a few heavy metals of health importance in the surface water of Sorbhog Beel.

## Materials and Methods

**Study area.** The Sorbhog Beel is located at a distance of 35 km in the northwestern side of the district head quarter, Barpeta town. It is situated within Chakchaka development block under Barnagar revenue circle of Barpeta sub-division, in the district of Barpeta, Assam. The geographical coordinates of the study area is between $26^0\,30^{/}\,45^{//}$ N latitude and $90^0\,53^{/}22^{//}$ E longitude. The climate of the area is warm and humid with hot summer followed by monsoon of heavy rainfall and relatively cool and dry winter. Periodic dry spells occurs during October to March. The area receives annual rainfall of 1800 to 2000mm. with heaviest precipitation during May to July. The total number of rainy days per year varies from 118 days to 141 days. The minimum temperature is about 12$^0$C during December and January and maximum temperature is 33$^0$C to 38$^0$C during July and August. Relative humidity is minimum 72% and maximum 75%.

**Sampling procedure**. Sampling was done in dry seasons and wet seasons during 2013. Dry season was taken from December to March and the wet season was from July to September. Water samples were collected from four different corners of the wetland representing four different directions and a composite mixture of the sample was analysed for estimation of trace metals. Water samples were collected in thoroughly cleaned plastic bottles. Before used, the bottles were cleaned with chromic acid solution and rinsed several times with distilled water. At the sampling site, the bottles were rinsed 3 to 4 times with sample water.

**Sample preparations for heavy metal analysis.** For heavy metal analysis the samples were acidified with HCL to make the pH<2 (APHA, 1995). The bottles were then stored in refrigerators at ~4$^0$C. Each sample was digested before analysis under Atomic Absorption Spectrophotometer (AAS). To each 50 ml. of the sample 5 ml. conc.$HNO_3$ is added. It was than allowed to evaporate slowly on a hot plate and the volume was reduced to about 25 ml. The digested samples were cooled to room temperature. After cooling samples were filtered through Whatman no.40 filter paper and the volume of each sample were made up to 50 ml with double distilled water and stored for analysis. The heavy metals such as Pb, As, Ni, Cr, Cu, Fe and Zn were estimated using Flame Atomic Spectrophotometer (Agilent Technologies Spectra-240AA) with Air Acetylene Flame but for estimation of Hg, $N_2O$-$C_2H_2$ flame was used. The standard solution calibration curves were prepared separately for each metal by running suitable concentration of the standard solutions. The concentrations of the metals were determined from the calibration curves. The average values of minimum three replicates were taken for determination of each concentration. Protocols outlined in APHA (2005) were used for all analysis.

## Results and Discussion

Distribution of trace metals in the natural environment are primarily contributed by the weathering of rock minerals and soils (O'Neil, 1993). Monitoring of the eight important trace metals in the surface water of Sorbhog Beel revealed concentration of some metals above the permissible limits as prescribed by BIS, 2009 and WHO, 2003 (Table 1 and Fig. 1 ). This certainly reflects influence of human activities in the wetland ecosystem.

**Arsenic.** Arsenic has both natural and anthropogenic origin and it is known to be toxic and carcinogenic. The concentration of Arsenic was found to be 0.016 mg/l in dry season and 0.018 mg/l in wet season suggesting no adverse effect from As-content. The level of concentration is well within the safe limit for drinking water (BIS, 2009;WHO, 2003) and Irrigation water standard (Ayers and Westcot, 1994).

**Copper.** The concentration of Copper was found at below detectable limit (BDL) during both dry and wet seasons, suggesting no adverse effect from Cu-content. Cu concentration at 0.1 to 1.0 mg/l is toxic to a number of plants in nutrient solutions (Ayers and Westcot, 1994).

**Chromium.** The concentration of Chromium was found at below detectable limit (BDL) during both dry and wet seasons, suggesting no adverse effect from Cr-content.

**Iron.** Iron contributes a lot to the increase of soil acidification. The concentration of Iron was found to be 2.32 mg/l in dry season and 1.71 mg/l in wet season. The level exceeded the permissible limits as prescribed by BIS, 2009 and WHO, 2003 but it is safe for irrigation purpose.

**Table 1. Heavy metal concentration (mg/l) in surface water of Sorbhog Beel, Barpeta, Assam**

| Metals | Recorded mean values at Sorbhog Beel (mg/l) | | Permissible limits for drinking water (BIS,2009 & WHO,2003) | Irrigation water standard (Ayers and Wescot, 1994) |
|---|---|---|---|---|
| | Dry season | Wet season | | |
| Copper (Cu) | BDL | BDL | 0.05 | 0.20 |
| Iron (Fe) | 2.32 | 1.71 | 0.05 | 5.0 |
| Lead (Pb) | 0.47 | 0.53 | 0.01 | 5.0 |
| Nickel (Ni) | 0.21 | 0.58 | 0.05 | 0.20 |
| Zinc (Zn) | 0.49 | 0.23 | NA* | 2.0 |
| Chromium (Cr) | BDL | BDL | 0.05 | 0.10 |
| Arsenic (As) | 0.016 | 0.018 | 0.05 | 0.10 |
| Mercury (Hg) | 0.001 | 0.003 | 0.001 | NA |

**NA Not Assessed; BDL Blow Detection Level**

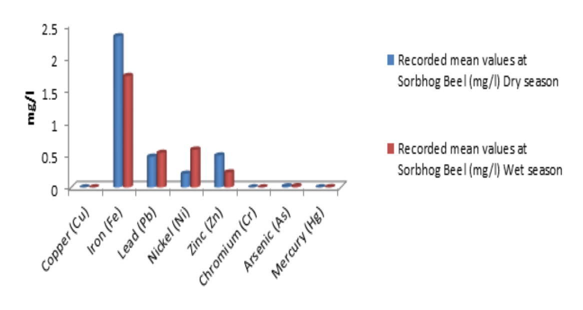


**Figure 1. Concentration (mg/l) of heavy metals in Sorbhog beel,Barpeta, Assam.**

Lead. Lead is a relatively abundant metal in nature, occurring in lead minerals. But anthropogenic activities have lead to its entry through automobile exhaust, used dry cell batteries waste and sewage deposition. The concentration of Lead was found to be 0.47 mg/l in dry season and 0.53 mg/l in wet season. The level exceeded the permissible limits as prescribed by BIS, 2009 and WHO, 2003 but it is safe for irrigation purpose. Lead can inhibit plant cell growth at very high concentration (Ayers and Westcot, 1994). According to United States Environmental Protection Agency Pb is toxic to most life forms and potentially hazardous to human beings, causing many ailments such as chronic neurological disorders, especially in fetuses and children.

Mercury. Compounds of Mercury are highly toxic to human beings and causes brain and kidney diseases. The concentration of Mercury was found to be 0.001 mg/l in dry season and 0.003 mg/l in wet season. Although in dry season its concentration is within permissible limits as prescribed by BIS, 2009 and WHO, 2003 but during wet season its level exceeded the permissible limit. In agricultural sector mercury is widely used as fungicides for seed dressings (De, 1995).The increased concentration of mercury in Sorbhog beel during wet season is due to runoff from agricultural fields.

Nickel. The concentration of Nickel was found to be 0.21 mg/l in dry season and 0.58 mg/l in wet season. The level exceeded the permissible limits as prescribed by BIS, 2009 and WHO, 2003 and Irrigation water standard of Ayers and Wescot, 1994. Its presence in higher concentration in Sorbhog beel is a matter of great concern. IARC, 1990 classified Ni as carcinogenic to humans. Various sources contribute to the increase of concentration of Ni in surface water. The major sources are from anthropogenic activities, used battery waste, old coins, components of automobiles, many items containing stainless steel and other Ni alloys (Kapil and Bhattacharyya, 2013). Presence of Ni in Sorbhog beel can be linked to similar sources.

Zinc. The concentration of Zinc was found to be 0.49 mg/l in dry season and 0.23 mg/l in wet season suggesting no adverse effect from Zn-content. It is toxic to many plants at widely varying concentration (Ayers and Westcot, 1994). Zn enters the domestic water supply from the deterioration of galvanized iron and dezincification of brass and industrial waste (De, 1995).

In the present study it was found that among the heavy metals analysed in the surface water of Sorbhog beel, Iron (Fe), Lead (Pb) and Nickel (Ni) were found in the water of Sorbhog Beel at considerable higher level as prescribed by BIS, 2009 and WHO, 2003 but only Ni was found to exceed the prescribed limit for irrigation water standard of Ayers and Wescot, 1994 . The occurrence of heavy metals in the Sorbhog beel is a matter of great concern. The agricultural areas and other life forms in and around the wetland are vulnerable to contamination by heavy metals. Thus, adequate conservation and restoration measures should be taken through effective watershed management practices. Constant monitoring and reducing human interference to the natural ecosystem of the wetland is the key to sustainable utilization of its resources.

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