# Preliminary Investigation of Environmental Status of Bhindawas Bird Sanctuary

A. K. Haritash*, Vandana Shan, Priyanka Singh, S. K. Singh
Department of Environmental Engineering
Delhi Technological University, Bawana Road,
Shahbad, Delhi (110 042)

***Abstract-*** **− Bhindawas wetland is located between 28˚28' to 28˚36' North latitude and between 76˚28' to 76˚38' East longitude in Jhajjar district of Haryana state. It was declared as a bird sanctuary by MoEF in 1986. Due to the dropping water levels at Bharatpur Bird Sanctuary (Rajasthan), the Bhindawas wetland attracts migratory birds during winter season. There have been only a few studies on seasonal variations in quality, contribution from different sources, loading of nutrients by different activities and in depth studies on determination of trophic status and ecological productivity of the wetland. This study is a preliminary investigation of water quality, trophic state index, productivity and proliferation of weeds in the wetland. The growth of weeds is observed to be maximum during summer since the temperature for growth is favourable and photoperiod is longer. The proliferation is restricted during winter since the availability of sunlight and nutrients, alongwith volume of water is less. The investigation reveals fairly high average concentration of total phosphate (5.2 mg/L) and nitrate (48 mg/L) resulting in conditions favourable for eutrophication. Based on the results obtained, the water of Bhindawas wetland was designated as eutrophic with a Trophic State Index value of 127 for TSI-TP and 63.95 as TSI-SD. The gross primary productivity in water was 2.2 mg/L/day (as $O_2$). The average concentration of Dissolved organic carbon (DOC), Biological oxygen demand (BOD), Chemical oxygen demand (COD), and Total Kjeldahl's Nitrogen (TKN) was 17.5 mg/L, 5.2 mg/L, 187.1 mg/L, and 4.2 mg/L, respectively. It was observed that though the water is eutrophic, algal growth is limited possibly due to zooplankton grazing, or excessive growth of macrophytes like water hyacinth, salvinia, vallisneria, hydrilla etc.**

***Keywords: Bhindawas wetland, eutrophic, productivity, nutrients***

## I. INTRODUCTION

Freshwater ecosystems are known as the most important natural resources for survival of variety of organisms, and water quality has become a major global concern due to increasing human development activities near water bodies. Increasing pollution due to overpopulation and unprecedented development create extreme pressure on the ecological health of water bodies [1]. Excess input of nutrients in surface water bodies (lakes, rivers ad ponds) deteriorate the quality of water and interfere with recreational uses of lakes and adversely affect the biodiversity of that region. Nitrates and phosphates are two major nutrients which are responsible for choking several lakes to death due to excess growth of algal blooms and consequently depleting dissolved oxygen level [2]. These constituents also help in the speedy growth of the macrophytes like water hyacinth which is the most troublesome aquatic weed in many parts of the world. Such changes in aquatic ecosystems have resulted in alteration of conditions favourable for maintaining good water quality, maintenance of biodiversity, and conservation of water resources. There have been several reports on deteriorating water quality, reduced biodiversity and fishing, shoreline erosion, and water shrinkage in water bodies around the world [3-6]. Reduced levels of water in Bharatpur bird sanctuary has forced even migratory birds to look for alternate bodies for their nesting. Bhindawas Lake (Haryana) is a preferred alternate site for nesting of migratory birds and endemic avian fauna. It is located at 28˚32' North latitude and 76˚32' East longitude in Jhajjar district with an area of 1074 acres. It is a natural depression with manmade earthen impoundments around to store the stormwater and agricultural runoff. It gets water from rainfall (during monsoon) and mostly from excess spilling over from JLN Canal and drains its water into drain no. 8. Bhindawas wetland also collects water from the vast stretches of agricultural field of twelve villages namely a few Bhindawas, Redhuwas, Chhadwana, Nawada, Bilochpura etc. The water depth in lake actually ranges from 1 foot to 6 feet, and its water holding capacity has been enhanced with construction of earthen embankment all along its boundary. The lake serves as a buffer during floods and lean season/drought. Realizing the environmental significance and ecological services of the lake, MoEF declared it as a bird sanctuary in 1986. Since then the wetland has emerged as an important ecological habitat and place of recreation attracting a good number of tourists. Recently, some of the studies [7-8] have reported the problem of weed infestation in the wetland resulting in reduced sunlight penetration, lower dissolved oxygen levels, mobilization of problematic chemical species like phosphate, eutrophication, and reduced aesthetics. The

present study, therefore aims to study spatial variations of water quality, proliferation of weeds, and identification of major sources/processes resulting in degeneration of water quality.

## II. MATERIALS AND METHODS

In order to determine the spatial variation of water quality, the wetland was divided into grids of equal size. Twenty (20) representative samples of water were collected from each grid in Polypropylene-grade plastic bottles pre-rinsed with ultrapure (Type-1) grade water. The area under the cover of *Eichhornia* was inaccessible and no sample could be collected from that region (Fig. 1).


Fig. 1. Sampling locations in Bhindawas bird sanctuary

Temperature, pH, Electrical conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), and Oxidation-Reduction Potential (ORP) were measured on the site using Orion make Star A329 model multiparameter meter. The gross primary productivity (GPP), and transparency were determined using DO levels under light and dark conditions, and sechhi-disc depth, respectively. Other parameters were determined within 24 hours after transporting the preserved samples to laboratory using standard methods of APHA [9]. Total phosphate (TP), sulfate ($SO_4^{2-}$), nitrate ($NO_3^-$), and ammonia ($NH_3$) were determined spectrophotometrically, and sodium (Na), potassium (K), calcium (Ca), and lithium (Li) were determined on Systronics make 128 μC model flame photometer. Dissolved Organic Carbon (DOC) was determined on Analytil-Jena make multi N/C2100 model TNC analyzer. The statistical analysis of values obtained was done on MS-Excel software. The eutrophication status of a wetland is usually measured using one of several trophic state indexes (TSI) of algal weight (biomass): water transparency (Secchi Depth, TSI-SD), algal chlorophyll (TSI-Chl), and total phosphorus (TSI-TP) [10]. The following equations can be used to compute the Carlson's TSI.

$$TSI\ (SD) = 60 - 14.41\ \ln(SD)$$
$$TSI\ (CHL) = 9.81\ \ln(Chl) + 30.6$$
$$TSI\ (TP) = 14.42\ \ln(TP) + 4.15$$

Where, SD is sechhi depth (m), Chl is chlorophyll (μg/L), and TP is total phosphorus (μg/L).

## III. RESULTS AND DISCUSSION

Based on the results obtained, spatial variations of nutrients (CNP) and other parameters were observed (Table 1). The measurement of area in a satellite image revealed that 0.98 $Km^2$ of area was under clear water as against 1.344 $Km^2$ under intensive weed growth. Since more than half of the water surface remains covered with weeds, an adverse effect over water quality is very likely. The average pH (8.0) was reported to be slightly alkaline ranging from 7.1 to 9.6. It was observed that the pH of water was less alkaline or near neutral at sampling locations near to weed-cover and shoreline. Similar trend was observed for DO with lower values near to weed cover and shoreline. The probable reasons are restricted penetration of sunlight, limited photosynthesis, and so lower DO levels.

Average DO in the wetland was 8.0 mg/L ranging from 5.3 to 13.3 mg/L. Concurrent values of ORP were observed representing oxidizing conditions in exposed water of the wetland. The mean value of ORP was 92 mV ranging from 30 to 126 mV. The exposed water favors photosynthesis by algae and submerged vegetation resulting in higher ORP levels, thus confirming the earlier observations of higher DO values in sunlight exposed water than in vicinity to weed cover. Average TDS concentration was 234 mg/L with slight variations between 203 and 250 mg/L. It reflects that the water quality *w.r.t.* dissolved solids is almost the same throughout, and there is minimum possibility of different sources to the wetland. Further, the almost constant value of bicarbonate species, and absence of carbonate ions throughout represents uninterrupted cycling of inorganic carbon with no precipitation/fixation of carbonates in sediments. Relatively lower values of chloride and sulphate reveal that there is no input of sewage or domestic wastewater into the wetland since excess of these species is related to domestic activities of cleaning and washing. On the other hand, nutrients like nitrate and phosphate were present in excess with an average concentration of 50.5 and 4.9 mg/L, respectively. The probable source of nutrients in wetland water is agricultural runoff. The agricultural runoff and water-logging is usually pumped into Drain No. 8 and the wetland, adding the nutrients to it. The cations Na, K, Ca, and Mg were present in moderate concentration with average levels of 31.4, 2.4, 18.8, and 17.3 mg/L, respectively.

TABLE I. RANGE, MEAN (N = 20), AND STANDARD DEVIATION OF PARAMETERS MONITORED IN WATER OF BHINDAWAS BIRD SANCTUARY

| Parameter | Range | | Mean | SD (±) |
|---|---|---|---|---|
| | Min. | Max. | | |
| **pH** | 7.1 | 9.6 | 8.0 | 0.6 |
| **EC (µS/cm)** | 403.0 | 508.0 | 472.5 | 26.2 |
| **Temp (˚C)** | 32.3 | 33.9 | 33.0 | 0.5 |
| **DO (mg/L)** | 5.3 | 13.3 | 8.0 | 2.1 |
| **ORP (mV)** | 29.7 | 126 | 92.1 | 23.3 |
| **TDS (mg/L)** | 203 | 250 | 234.3 | 9.6 |
| **$HCO_3^-$ (mg/L)** | 92.7 | 117.1 | 105.6 | 6.3 |
| **$Cl^-$ (mg/L)** | 52.0 | 88.0 | 58.2 | 7.6 |
| **$SO_4^{2-}$ (mg/L)** | 26.8 | 239.9 | 85.2 | 51.0 |
| **$PO_4^{3-}$ (mg/L)** | 0.4 | 10.6 | 4.7 | 2.9 |
| **$NO_3^-$ (mg/L)** | BDL | 380.1 | 48.0 | 107.4 |
| **Na (mg/L)** | 29.8 | 34.3 | 31.4 | 1.3 |
| **K (mg/L)** | 1.1 | 3.0 | 2.4 | 0.4 |
| **Ca (mg/L)** | 15.4 | 20.2 | 18.8 | 1.0 |
| **Mg (mg/L)** | 6.8 | 28.3 | 17.3 | 6.2 |
| **BOD (mg/L)** | 3.0 | 10.0 | 5.0 | 1.5 |
| **COD (mg/L)** | 186.0 | 190.0 | 187.0 | 2.0 |
| **DOC (mg/L)** | 8.7 | 38.8 | 17.5 | 5.5 |
| **$NH_3$ (mg/L)** | 0.2 | 1.4 | 0.5 | 0.3 |
| **TKN (mg/L)** | 1.4 | 22.4 | 4.2 | 4.6 |

Lower levels of the cations also confirm to the speculation of absence of domestic wastewater as source. Mean $BOD_5$ in the lake water was 5.0 mg/L ranging from 3.0 to 10.0 mg/L classifying Bhindawas lake as moderately polluted *w.r.t.* organic pollution. The death and decay of phytoplanktons and macrophytes in eutrophic lakes has been identified as major contributor of organic pollution. It, inturn, scavenges dissolved oxygen of water thereby affecting fish and other sensitive organisms. COD values varied between 186 to 190 mg/L with an average of 187 mg/L signifying that the oxygen demand of water is almost the same throughout the region studied. The dissolved organic carbon content varied between 8.7 and 38.8 mg/L with most of the values around the mean value of 17.5. The concentration of dissolved ammonia in water was also high with an average of 0.5 mg/L, ranging from 0.2 to 1.4 mg/L. Most of the fish and aquatic organisms are reported to be sensitive to dissolved ammonia levels higher than 0.2 mg/L in water. Toxic levels are both pH and temperature dependent, and it increases as pH decreases and as temperature decreases. Plants are more tolerant of ammonia than animals, and invertebrates are more tolerant than fish. Hatching and growth rates of fishes may be affected by higher dissolved ammonia [11]. Similarly high concentration of total Kjeldahl's nitrogen (TKN) was observed with an average of 4.2 mg/L ranging from 1.4 to 22.4 mg/L. Very high levels of TKN, nitrate, and phosphate are a testimony to eutrophicated status of Bhindawas.

## IV. TRANSPARENCY, PRODUCTIVITY, AND EUTROPHIC STATUS

Secchi depth transparency is the simplest, most extensive and appropriate parameter for determination of ecosystem health. In present study, average (n = 5) secchi depth was recorded as 0.76 metres. As per Nurnberg (1996) [11], lakes with sechhi transparency depth <1 metres are classified as hypereutrophic lakes. Bhindawas lake is classified as a highly eutrophic lake based on sechhi disc transparency. The trophic state index was calculated as 63.95 based on sechhi depth (TSI-SD), and 127 based on total phosphate (TSI-TP). Since TSI-TP>TSI-SD, it may be concluded that overgrazing by zooplanktons and excessive growth of macrophytes limits the growth of algae.

## V. CONCLUSION

Based on the results obtained, it is observed that water in Bhindawas lake has high concentration of nitrogen and phosphorus and is eutrophic in nature. Despite excess of nutrients, overgazing by zooplanktons complemented by excessive growth of macrophyte weeds is assumed to be associated with limited growth of algae. Based on the values of cations and anions, it is observed that pumping from water-logged areas and agricultural runoff around the wetland is major source of nutrients (nitrogen and phosphorus). The water of lake is slightly alkaline and there is no precipitation/deposition of inorganic carbon in the form of carbonates. The organic carbon resulted in moderate organic pollution, but was autochthonous since death and decay of algae and weeds resulted in addition of organic carbon to the lake. The DO levels were sufficiently good to support normal growth of aquatic life forms.

## VI. REFRENCES

[1] R. Chandra, K.A. Nishdh, P.A. Azeez, "Monitoring water quality of Coimbatore wetlands, TamilNadu, India," Envciron. Monit. Assess., Vol. 169, pp. 671-676, 2010.
[2] R. Upadhyay, A.K. Pandey, S.K. Upadhyay, "Assessment of lake water quality by using Palmer and Trophic State Index- a case study of upper Lake, Bhopal, india," International Research journal of Environmental Sciences, Vol. 2(5), pp. 1-8, 2013.
[3] A.A. Ayoade, N. aggarwal, "Preliminary analyses of physical and chemical parameters of Tehri dam reservoir, Garhwal himalaya, India," Zoology and Ecology. Vol. 22(1), pp. 72-77, 2012.
[4] O. Singh, C.K. Jain, "Assessment of water quality and eutrophication of lakes," Journal of Environmental and Nanotechnology, Vol. 2, pp. 46-52, 2013.

[5] J.A. Shah, A.K. Pandit, "Physico-chemical characteristics of water in Wular lake-A Ramsar site in Kashmir Himalaya," International Journal of Geology, vol. 2, pp. 257-265, 2012.
[6] S. Singh, R. Kumar, "Changes in land use pattern of Bhindawas wetland in Haryana," International journal of Informative & Futuristic Research, vol. 2, pp. 346-349, 2014.
[7] S. Kumar, R. Dhankhar, "Trophic State Index and assessment of water quality for domestic and agriculture purpose of Bhindawas wetland, Jhajjhar, Haryana (India)," Annals of Biology, vol. 28, pp. 144-151, 2012.
[8] R. Saluja, J. K. Garg, "Surface water quality assessment of Bhindawas Lake (Haryana, India) using Multivariate Statistical Techniques," Journal of Global Ecology and Environment, vol. 2, pp. 2454-2644, 2014.
[9] American Public Health Association: Standard Methods for the Examination of Water and Wastewater, 21st Edn. APHA-AWWA, Washington DC, USA, 2005.
[10] R.E. Carlson, "A trophic state index for lakes," Limnology and Oceanography, vol.2, pp. 361-369, 1977.
[11] G.K. Nurnberg, "Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish," J. Lake and Reservoir Management, vol. 12, pp. 432-447, 1996.