

Trophic Status of Bhoj Wetland on the Basis of Some Chemical Characteristics

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Abstract

The chemical characteristics of an aquatic ecosystem play key role in defining its trophic status. Bhoj wetland in Bhopal is under trophic evolution as it receives large quantities of agricultural and human wastes from its catchment, resulting in significant change in its environment. The main chemical parameters which are being considered for determination of trophic status of Bhoj wetland are pH, electrical conductivity, total alkalinity, phosphorus and nitrate nitrogen.

The various chemical features revealing that the water body has alkaline pH ($\bar{x}=8.2$ units) and can be categorized among alkaliphilous water bodies. High electrical conductivity value ($\bar{x}=264.2\mu\text{S/cm}$) puts the water body in mesotrophic condition. High total alkalinity value ($\bar{x}=76\text{ mg l}^{-1}$) categorizes water body among nutritionally rich. High phosphorus value ($\bar{x}=0.31\text{ mg l}^{-1}$) puts Bhoj wetland again into the eutrophic category while high nitrate nitrogen value ($\bar{x}=0.67\text{ mg l}^{-1}$) is being associated with accelerated eutrophication of water body. Over all study revealed that Bhoj wetland under eutrophic state.

Keywords: Trophic state; Pollution; Bhoj wetland

Introduction

The trophic status of a water body is an important aspect to be monitored frequently, as it indicates the effect of incoming sewage and other wastes in it. Water bodies enriched with nutrients exhibit excessive growth of phytoplankton [1]. Artificial or natural freshwater bodies have suffered under nutrient contamination, especially nitrogen and phosphorus, originating from point and diffuse sources, mainly municipal sewage and agriculture runoff. The quantity of organic matter in aquatic ecosystems defines their trophic state, which serves as an indicator of the contamination grade of the system [2-4]. The trophic state depends on several biotic and abiotic factors. One of the factors is the wetland total phosphorus concentration, which compared to other water quality parameters, could be considered as the most studied indicator to determine the trophic state in the wetland.

Wetlands are dynamic ecosystems, continually undergoing natural changes due to infilling with sediments and nutrients. They sustain all life and perform some useful functions in the maintenance of overall balance of nature (ecosystem). Rapid urbanization, burgeoning human population and their various activities have contributed to the decline of quality and quantity of wetlands and also socio-economic value of the wetland [5]. Hence, it is imperative to focus on preservation of these endangered habitats to achieve ecological sustainability. This study was undertaken to identify and analyze the qualitative and quantitative impact on wetlands. Integration of water quality and quantity with socio-economic information has aided in appropriate prediction and conservation of the wetland from point and non-point source of pollution.

Study Area

Bhopal, the capital city of the state of Madhya Pradesh, India is famous for its numerous lakes. Of these the most important are the Upper and Lower Lakes, which have commonly been designated as Bhoj Wetland (Figure 1). The Bhoj Wetland is a wetland of international importance. The Upper Lake basin comprises of a submergence area of about 31.0 sq. km and a catchment area of 361 sq. km., whereas the Lower Lake basin comprises of a submergence area of 0.9 sq. km and catchment area of 9.6 sq. km. While Lower Lake is surrounded on all sides by dense urban settlements, only about 40% of the fringe area of Upper Lake has dense human settlement and the rest is sparsely populated having cropping as the major land use. The Upper Lake spread over longitude $77^{\circ}18'00''$ to $77^{\circ}24'00''$ E and latitude $23^{\circ}13'00''$ to $23^{\circ}16'00''$ N, whereas the considerably smaller Lower Lake is spread over $77^{\circ}24'00''$ to $77^{\circ}26'00''$ E and latitude $23^{\circ}14'30''$ to $23^{\circ}15'30''$ N. The Upper Lake was created in the 11th century by constructing an earthen dam across Kolans River, the main feeding channel of the lake with the objective of supplying potable water for the city dwellers. The wetland also supports a wide variety of flora and fauna. Several species of phyto and zooplankton, macrophytes, aquatic insects, amphibians, fishes and birds (resident as well as migratory) are found in these wetlands. Considering its ecological importance, Ramsar site declared by the Government of India in 2002. Increase in anthropogenic activities in the catchment during the second half of the last century resulted in environmental degradation of the lakes.

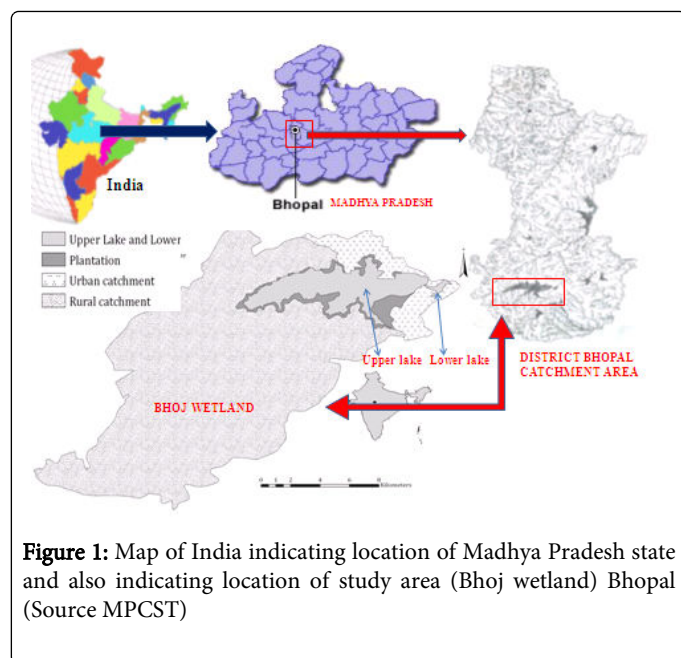


Figure 1: Map of India indicating location of Madhya Pradesh state and also indicating location of study area (Bhoj wetland) Bhopal (Source MPCST)

Materials and Methods

The various physico-chemical characteristics such as temperature, pH, conductivity, TDS, D.O, Free CO₂, total alkalinity, Hardness (total, calcium and magnesium), Chloride, nitrate and phosphate were analysed using the standard APHA [6] and Adoni [7] methods.

Results and Discussion

Thus, the ecological integrity of the Bhoj wetland ecosystem (on which the trophic status is dependent) is influenced by both its physical and chemical characteristics. Annual average values of some chemical parameters of Bhoj wetland are summarized in Table 1. pH of the said waterbody was found to be alkaline (pH: \bar{x} =8.2 units) during the study period. According to Venkateswarlu's classification [8] the Bhoj wetland can be categorized among alkaliphilous waterbodies (where pH ranges from 7.5-9.00 units). The higher values of pH may be due to increased photosynthetic activity, high organic matter and input of nutrients from the sewage.

The average electrical conductivity of Bhoj wetland recorded during the two years period is 246.2 $\mu\text{S}/\text{cm}$ at 25°C, which puts the water body under the mesotrophic condition following the classification of Olsen [9]. The total alkalinity values of more than 60 mg l^{-1} (\bar{x} =76 mg l^{-1}) have been categorized among nutritionally rich waterbody by Spence [10]. Since the present waterbody recorded a range value of 64.25-146.25 mg l^{-1} of alkalinity, it may be put under highly productive water body as suggested by Munawar [11]. The high alkalinity values indicate eutrophic nature of the water body. This eutrophic nature of Bhoj wetland has further been authenticated by high values of nitrate nitrogen (\bar{x} =0.67 mg l^{-1}) Vollenweider [1].

The main nitrogen sources in the wetland are the domestic sewage, agricultural runoff and decomposition of autochthonous matter. In addition, nitrate nitrogen concentrations (0.67 mg l^{-1}) were consistently higher than the critical values associated with accelerated eutrophication (0.3 mg l^{-1}). Total phosphorus on the other hand recorded an average value of 0.31 mg l^{-1} (based on two year study). On the basis of this total phosphorus concentration, the Bhoj wetland again falls in the eutrophic category [12]. This statement is further supported by the findings of Hutchinson who advocated that addition of total phosphorus to natural waters results in greater plant productivity. The phosphate content in Bhoj wetland was well above the eutrophic levels. Phosphates enter the wetland through domestic wastewater and agricultural runoff from the immediate cultivated lands accounting for it's the eutrophic condition.

In the Bhoj wetland the problem of pollution is mainly due to addition of major plant nutrients particularly nitrogen and phosphorus, derived from human wastes, detergents, fertilizers and agricultural activities. The nutrients have been chiefly responsible for an increase in organic production particularly in the form of dense macrophytic growth and the overall deterioration of water quality. The deterioration of water quality and other associated problems as a result of racing eutrophication have reduced the recreational and aesthetic appeal of the wetland, besides other economic benefits.

The ecological stability of wetland is threatened by the impact of both internal and external factors, especially the impact of the wetland regulation and water extraction for domestic usage and agriculture.

Chemical Parameter	Range/Mean	Trophic Status	Reference
pH units	8.1-8.2 (=8.2)	Alkaliphilous	Venkateswarlu [8]
Elect. Conductivity ($\mu\text{S}/\text{cm}$)	248.11-280.34 $\mu\text{S}/\text{cm}$ (\bar{x} =264.2 $\mu\text{S}/\text{cm}$)	Mesotrophic	Lee et al., Olsen [13,9]
Total alkalinity (mg l^{-1})	67-85 mg l^{-1} (\bar{x} =76 mg l^{-1})	Nutrient rich	Spence[10]
Nitrate-nitrogen (mg l^{-1})	0.59-0.75 mg l^{-1} (\bar{x} =0.67 mg l^{-1})	Eutrophic	Vollenweider [1]
Total Phosphorus (mg l^{-1})	0.30-0.32 mg l^{-1} (\bar{x} =0.31 mg l^{-1})	Eutrophic	Lee et al. [12]

Table 1: Trophic status of Bhoj wetland on the basis of some chemical characteristics

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