

Trophic Status in Freshwater Lentic Ecosystem of Halali Reservoir (Vidisha-MP, India) with Special Focus on Nitrate and Phosphate

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Abstract

Nitrate and phosphate are the two key nutrients required by plants and animals to perform certain necessary functions. Accelerated anthropogenic activities (via use of nitrate and phosphate based compounds) and processes like runoff from sewerage, agricultural and construction sites; septic tank leachate; runoff and infiltration from animal feedlots etc. brings large quantities of such nutrients into the nearby water bodies and support the luxurious growth of algae and other aquatic plants like *Hydrilla*, *Ceratophyllum*, *Vallisneria spiralis* etc. which alternately make the water eutrophic and cause the gradual shrinking of the water body. The excessive growth of these aquatic plants causes some more complicated conditions like reduced light penetration, low DO and also snatches the aesthetic value of the aquatic system and ultimately reduces its life span to a large extent.

Keywords: Halali reservoir; Seasonal variation; Physico-chemical parameters; Runoff; Nutrient uptake; Nitrate; Phosphate

Introduction

Reservoirs are not only a significant source of precious water but also provide a valuable habitat to the aquatic world. Madhya Pradesh has 3.0 lakh ha of water area in the form of reservoirs and ponds out of which 2.50 lakh ha are in the form of reservoirs and 0.50 lakh ha is in the form of village ponds [1]. The contamination of water bodies with excessive amount of inorganic nitrogen and phosphorus from fertilizer runoff is a pressing concern, though they give the prevalence of agriculture but alternately results in large proliferation of algae which have detrimental effects on the aquatic biota [2].

Nitrate is final product of mineralization process [3] which is colourless, odourless and tasteless compound. Phosphorus is present in different forms among which orthophosphate is the soluble reactive form of phosphorus which is also termed as inorganic phosphate. It plays a dynamic role in aquatic ecosystem which is taken up widely by phytoplankton [4].

Materials and Methods

The present study was carried out on Halali reservoir (Vidisha, India) which is a source of different fish varieties (*Catla catla*, *Rohu*, *Mrigal*, *Wallago attu*, *Mystus* and *Chitala*). It is built on the river Halali which is 40 kms away from the Bhopal City.

The reservoir was constructed in 1976, with catchment and water spread area of 699 km² and 5959 ha, shoreline 65 kms and maximum depth of 29.5 m.

Water samples were collected seasonally during the morning hours (9 to 11 am) from surface and bottom in winter (January), summer (April), monsoon (July) and post-monsoon (October) 2011 at Patra Nala that was selected as sampling station through which the drainage waste of Bhopal city enters the reservoir. Besides domestic discharge, the Nala also receives wastes from textile, distillery and straw product factories of Bhopal. Water samples were analysed as per APHA [5] and A.D Adoni [6] (Figures 1 and 2).

Results and Discussion

The results about nine physico-chemical parameters of water are listed in Table 1. During the period of study the nitrate concentration

was recorded maximum in monsoon which may be due to heavy downpour and subsequent runoff from surrounding agricultural fields but this level is below the USEPA's [7] Maximum Contaminant Level (MCL) of 10 mg/l, and minimum value of nitrate was recorded in winter which may be due to very minimum runoff from surrounding fertilizer fed agricultural fields which drains everything into the nearby water body. Nitrate (NO₃) is not dangerous for the health unless it is changed to nitrite (NO₂). Hannan and Young [8] has shown that early monsoon runoff is an important contributor of nitrate-nitrogen to the reservoir.

High concentration of phosphorus in an aquatic system is an alarm of turning the system towards the eutrophic state. USEPA [7] has



Sampling station

Figure 1: Sampling station.

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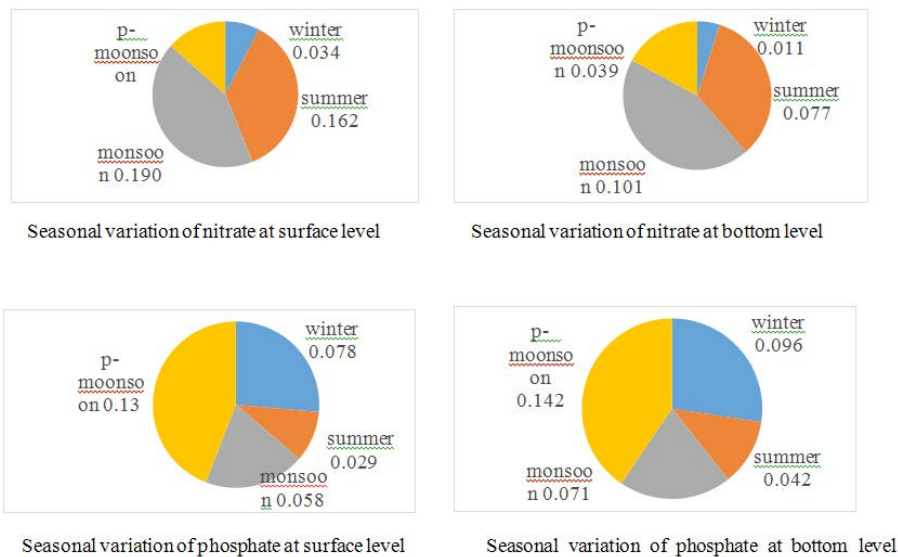


Figure 2: Seasonal variations at different levels.

Table 1: Seasonal variation of Physico-chemical parameters of Halali Reservoir.

Season	Parameter								
	Water temp (°C)	Transp.	Free Co ₂	pH	DO	P alkalinity	Nitrate	Phosphate	Air temp (°C)
Winter	S 23.6	124 cm	S 3.41	S 7.5	S 7.14	Nil	S 0.034	S 0.078	26.2
	B 17.3		B 2.77	B 7.1	B 7.9	Nil	B 0.011	B 0.096	
Summer	S 29.4	78 cm	Nil	S 8.2	S 6.8	S 24.1	S 0.162	S 0.029	37.6
	B 22.7		Nil	B 7.8	B 4.4	B 19.7	B 0.077	B 0.042	
Monsoon	S 26.1	46 cm	S 2.67	S 7.3	S 8.1	Nil	S 0.190	S 0.058	31.5
	B 18.6		B 1.48	B 6.7	B 6.4	Nil	B 0.101	B 0.071	
P-monsoon	S 19.4	67 cm	S 3.97	S 7.1	S 8.8	Nil	S 0.060	S 0.130	22.9
	B 16.1		B 2.71	B 6.9	B 7.1	Nil	B 0.039	B 0.142	

suggested 0.08 ppm as a critical level for the occurrence of eutrophication in a water body which is less than the mean value found during the present study. The amount of phosphate in the Halali reservoir may be because of the presence of certain macrophytes (*Ipomoea*, *Vallisneria*, *Potamogeton*, *Hydrilla* etc.) and sediments drained by surface runoff to the reservoir.

The role of phosphorus in algal growth and eutrophication has been studied by Peterson [9]. The maximum value of 0.130 mg/L at surface and 0.142 mg/L at bottom were recorded in post-monsoon which could be due to huge quantity of domestic sewage, cattle dung, detergents, organic wastes of plant-animal origin, phosphate based detergents and NPK fertilizers. The lower values of phosphate was recorded in summer which may be because of minimum surface runoff and higher temperature that increases the metabolic activity of microbes picking up more and more nutrients from water body. Another reason may be huge quantity of nutrient uptake by inhabited macrophytes (*Ipomoea*, *Vallisneria*, *Potamogeton*, *Hydrilla* etc.) in the reservoir. The phosphate and nitrate content of Shahpura lake (Bhopal) was found in the range of 6.05 to 9.21 ppm and 2.02 to 15.22 ppm [10]. Enrichment of water body with phosphate may be attributed to the cumulative action of disintegration of phosphate bearing rocks and their subsequent washing and from surrounding catchments making use of phosphate based compounds (e.g., fertilizers) during rainy season. Phosphates also get released by the rocks lying at the bottom and by the death of plants and animals present in the reservoir by various hydrological processes. Phosphate is considered to be the most significant among

the nutrients responsible for eutrophication- a condition characterized by growth of algae and weeds in a water body.

Eutrophication signifies the ageing of a water body. Nutrient enrichment causes variations in aquatic systems which results in the growth of primary production to nuisance properties [11]. The main cause is excessive loading of phosphorus and nitrogen into the system resulting in high algal biomass, dominance by cyanobacteria and loss of macrophytes [12].

Entrance of nutrients in a water body and the subsequent aftermath:

Increasing load of nutrients in an aquatic system can lead to the following consequences:

1. Aquatic vegetation can be due to increasing load of nutrients which enhances the growth of macrophytes like- *Vallisneria*, *Potamogeton*, *Ipomoea*, *Ceratophyllum* etc.
2. Low DO content of water body creates anaerobic condition, suitable for growth of pathogenic microbes that makes water unfit for different utilities.
3. Nutrient rich water requires efficient machinery (high cost) for removal of nutrients to make it suitable for different uses.
4. Concentration of nitrates above 10 mg/L (USEPA-MCL) cause methaemoglobinemia, also known as 'blue baby syndrome'.

5. Decomposition of nutrients like nitrate and phosphate cause foul smell.

6. The higher levels of nitrate and phosphate in an aquatic ecosystem might be responsible for the development of water bloom by *Microcystis aerogenosa*. The toxins and chemicals released by it can kill the inhabited fishes, migratory birds and other aquatic animals of the very aquatic ecosystem.

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