*International Research Journal of Environmental Sciences*_____ ISSN 2319–1414
Vol. **10(3),** 47-49, July **(2021)** *Int. Res. J. Environmental Sci.*

Short Communication

Trophic status of freshwater lentic ecosystem-Halali reservoir (Vidisha, MP, India) with special reference to Nitrate and Phosphate

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Available online at: www.isca.in, www.isca.me
Received 9th February 2021, revised 11th April 2021, accepted 12th June 2021

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, Ceratophylum, Vallisneriaspiralis 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, Nitrate, Phosphate.

Introduction

Reservoirs simultaneously provide the important freshwater source as well as a dwelling place for the flora and fauna inhabiting inside them. 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].

As the runoff from nitrogen and phosphorus based fertilizer fed areas enters the aquatic system, the chances of the receiving system to turn towards eutrophic condition and become unsuitable habitat to live in for fishes and other species are more by favouring the luxurious growth of nuisance algae and other macrophytes which alternately lowers the DO of the water body[2].

Organic nitrogen upon oxidation by bacteria present in water and soil gets converted nitrates. In water nitrogen exists in a few unique forms such as nitrate, nitrite, area or amino acids that are captured by the aquatic species[3]. Phosphorus is the primary initiating factor responsible for turning a water body into eutrophic type.

The accumulation of phosphorus in a water body is limited due to the busy schedule of plants in picking it up. The rich source of phosphorus for an aquatic ecosystem are the rocks which act as a reservoir of phosphorus that upon weathering and subsequent disintegration release it into the nearby water body. Besides the rich source of rocks, the soils are also a significant contributor of phosphorus for an aquatic ecosystem[4].

Materials and methods

This paper reveals the trophic position of Halali reservoir (Vidisha, India) by making the analysis of physic-chemical parameters of water, which is a source of different fish varieties (*catlacatla, rohu, mrigal, wallagoattu, mystus* and *chitala*). It is built on the river Halali which is 40 kms away from the Bhopal. The reservoir was constructed in 1976, with catchment and water spread area of 699 km^2 and 5959 ha, shoreline 65kms and maximum depth of 29.5m.

To carry out the proposed work water samples have been collected on seasonal basis during 09 to 11am from surface and bottom in winter (January), summer (April), monsoon (July) and post-monsoon (October) 2011 at PatraNala that was selected as sampling station through which the drainage waste of Bhopal city enters the reservoir. The wastes released from the textile industries, distillery industries and straw product factories also enters the Nala which finally drains it into the reservoir. Water samples were analysed as per APHA[5] and A. D. Adoni[6].

Results and discussion

During the study period, 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 10mg/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.

Table-1: Seasonal data about the physical and chemical parameters of Halali Reservoir.

Season	Parameter								
	Water temperature (^oC)	Transp. (cm)	Free CO_2 (mg/l)	pH (0-14)	DO (mg/l)	Phosphorus Alkalinity (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	Air temp (^oC)
Winter	S 23.6	124	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	S Nil	S 8.2	S 6.8	S 24.1	S 0.162	S 0.029	37.6
	B 22.7		B Nil	B 7.8	B 4.4	B 19.7	B 0.077	B 0.042	
Monsoon	S 26.1	46	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	
Post monsoon	S 19.4	67	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	

S means surface and B means bottom.

Nitrate (NO_3) is not dangerous for the health unless it is changed to nitrite (NO_2). 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 suggested 0.08ppm as a threshold level at which the eutrophic status in a water body can be observed 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.

There is an active involvement of phosphorus in the continuous and successful growth of algae that subsequently turns an aquatic system into the eutrophic form[9]. The maximum value of 0.130mg/l at surface and 0.142mg/l at bottom were recorded in post-monsoon which could be because of large amount of sewage from nearby domestic areas, dung especially of cattle, organic wastes of plant–animal origin, phosphate based detergents and NPK fertilizers. The level of phosphate was recorded lower in summer than the winter, 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 recorded from values of 6.05 to 9.21ppm and 2.02 to 15.22ppm[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.

Eutrophication signifies the ageing of a water body. Nutrient enrichment causes variations in aquatic systems which gives the birth of primary production to nuisance level[11].

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: i. Aquatic vegetation can be due to increasing load of nutrients which enhances the growth of macrophytes like-*Vallisneria, Potamogeton, Ipomoea, Ceratopylum* etc. ii. Low D.O. content of water body creates anaerobic condition, suitable for growth of pathogenic microbes that makes water unfit for different utilities. iii. Nutrient rich water requires efficient machinery (high cost) for removal of nutrients to make it suitable for different uses. iv. Concentration of nitrates above 10mg/L (USEPA-MCL) cause methaemo globinemia, also known as 'blue baby syndrome', v. Decomposition of nutrients like nitrate and phosphate cause foul smell. vi. The higher levels of nitrate and phosphate in an aquatic ecosystem is believed to be the factor responsible for luxurious growth of *Microcystis aerogenosa* that cause the water bloom and subsequently lowers the DO level of water.

The toxins and chemicals released by it can kill the inhabited fishes, migratory birds and other aquatic animals of the very aquatic ecosystem.

Conclusion

On the basis of physic-chemical analysis, it has been observed that the trophic status of the reservoir is far away from the eutrophic level, but we cannot deny the accelerated agricultural and other such practices, being carried out near its vicinity that could be the cause for the reservoir to tune to eutrophic mode. So, the necessary measures should be taken to protect the water body as it is a source of fish income for a large human population by inhabiting the species like Catla, Rohu, Mrigal, Wallagoattu, Mystus and Chitala.

Acknowledgement

The author of the manuscript is happy to acknowledge all the members that have been an integral part of the work especially a very humble and helpful Associate Professor Dr. Vipin Vyas of the department of Environmental Science, Barkatullah University, Bhopal, MP, India the Boat Association of Halali Reservoir and many more.

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