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Effect of Lake Sediment Chemistry on Water Quality of Upper Lake in Bhopal (M.P)

Saima Shameem, Vipin Vyas and Ajaz Ahmad Magray

Abstract __The forgoing study was carried out on Upper Lake (Bhoj wetland; a ramsar site) Bhopal (M.P.), India. It is the oldest lake manmade lake of central India. The present study reflects an increase in the pollution status of upper lake. Nitrate and reactive phosphate fluctuations are attributed to diverse land use land cover in catchment area of the lake. Lake was found to be in the hypertonic state in the month of June and August. It was also seen that higher concentration of nutrients was because of release of them from sediments into the water column as it was due to lower oxygen content in lake water. The population living near the lake is the major contributor of pollution to the lake. It was estimated that about 9.82 (mg/l) of sewage enters in the lake daily resulting in the enrichment of the lake and it also promotes its eutrophication and enhance it trophic evolution.

Key words: Ramsar site, Hypertonic, Enrichment, Land use Land cover, Eutrophication**.**

Introduction

Lake sediments are important to study, because of their role in the determination of nutrient levels and productivity in the overlying waters. Sediment texture is a soil property used to describe the relative proportion of different grain size of mineral particles in sediment. Particles are grouped according to their size into what are called soil separates. These separates are typically named as clay, silt, and sand. Sediment texture is a term commonly used to designate the proportionate distribution of the different sizes of mineral particles in a soil. It does not include any organic matter. These mineral particles vary in size from easily seen with the unaided eye to those below the range of a high powered microscope. There are many factors that may affect sediment water exchange reaction shows that there is insufficient knowledge at the present time to predict the extent and, the net direction of exchange for many compounds in most natural waters. Lake sediments contain significant concentrations of many metals and nutrients. The lake sediments act as a buffer system for these elements to control concentrations in the overlying waters. The effect of this buffer system could be to keep the concentrations in the overlying waters relatively constant even though the concentrations of the element in the inflowing waters vary greatly. The chemical composition of the soil affects the aquatic flora and fauna of water bodies. Sediment deposits of lakes can function as either a source or a sink for many of the essential nutrients involved in the eutrophication process. Exchange of nutrients between sediment and overlying water depends upon chemical characteristics of the water and the sediment. Therefore, to assess the nutrient status of a lake it is essential to develop information on seasonal changes in sediment chemistry at the sediment water interface. The present study was conducted on Upper Lake (Ramsar site) in order to know the sediment chemistry of lake and its impact on water quality as aquatic sediment plays an important role in cycling of nutrients in the water body (Moorthy *et al.*,2005). The present study was conducted to grab the two main objectives: to determine the physic-chemical properties of lake sediments and to determine the seasonal variation of lake sediments with respect to water quality.

STUDY AREA

The study area selected for resent investigation, was Upper Lake locally called as Badatalab located in the centre of Bhopal (city of lakes), Madhya Pradesh, India. It is the oldest, man-made lake in the central India. The lake was created in the early 11th century by king Bhoj by construction of an earthen dam across the Kolans River, a rain fed tributary of the Betwa River. The morphological features of lake are given in table 1; Fig. 1.

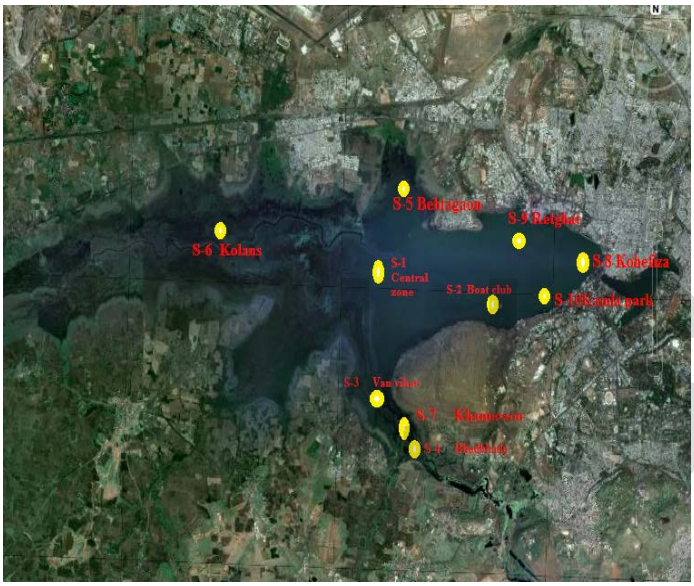


Fig.1 Map of Upper Lake and Sampling Site Location

Table 1 Morphological features of Upper Lake

Country	India
City	Bhopal
Type of Dam	Earthen
Period of construction	11th century A.D
Latitude	23 12′ 0′′N
Longitude	77 18′ 0″ E
Climate region	Warmer humid
Drainage basin type	Open
Age	10,000 years before present
Lake origin	Man made
Catchment area(sq km)	371.00Km2
Surface area (sq Km)	36 km2
Maximum depth	11.7m
Maximum length	10.6km
Maximum width	3.75km
Main use of water	Potable water
Primary inflow	Kolans river
Salinity type	Fresh
Drainage basin area	361 km2
Shore line	24.4km
Total silt load from catchment	0.6M cum/ Annum
Storage capacity	100.8 million cu meter
Maximum water area	3105 hectare
Minimum water area	1360 hectare
Volume	6152cu meter
Source of water	Rain water

Description of sampling stations

Station 1 CENTRAL POINT (S1): This station is the western deeper site of the upper lake, having maximum depth with least human interruption.

Station 2 BOAT CLUB (S2): This site has multi-interference like boating and tourism influxes, national level sporting events are organized by the club at this site.

Station 3 VANVIHAR (S3): This station protected forests cover (VanVihar) and is comparatively free from anthropogenic activities.

Station 4 BHADHBHADA (S6): Higher concentration of human population with profuse growth of algal blooms in water.

Station 5 BEHTAGAON (S5): This sampling station has comparatively more polluted due to nearby urban settlements of Bairagarh village.

Station 6 KOLANS (S6): This sampling station is on the major inflow channel of the lake i.e. Kolans River.

Station 7 KHANOOGAON (S7): The station has high inflow of sewage water from the surrounding human settlement, agricultural activities and cattle population effects. Shoreline consists of stones.

Station 8 KOHE-FIZA (S8): At this station idol immersion is carried out.

Station 9 RETGHAT (S9): This sampling station receives hospital waste of medical college from the Shahid Nagar inlet.

Station 10 KAMLA PARK (S10): This station is situated on eastern end of the lake. It is subjected to maximum anthropogenic pressure.

MATERIAL AND METHODOLOGY

Present study was carried during the month of March 2011 to August 2011 to know the distribution of nutrients, organic matter and sediment texture. Sediment samples were collected on seasonal basics from ten different stations. Sediment samples were collected by Petersons grab, samples were taken to laboratory in polythene bags for further analysis. The physico-chemical analysis was followed from standard methods given in APHA (1998) and A.D. Adoni (1985). For analysis of sediment a suspension were prepared by dilution factor of 10:100w/v ratio i.e.10 gram of soil were dissolved in 100 ml of distilled water, except texture all physical parameter were directly recorded by respective meters as given in the standard books and for chemical parameters the prepared soil water suspension were filtered through whatsmans filter paper (No.50) and the filtrates were analyzed for various physico-chemical parameter.

Results and Discussion

During the present investigation, the value of pH ranged from 7 to 8.3. The maximum value was recorded at Khanugaon during monsoon. Moorthy *et al.*, (2005**)** have also recorded similar values ranged from 7.95 to 9.22 during their study at Madhurantakam Lake, Tamilnadu. Similarly, Oomachan (1981**)** reported a range of 6.4 to 8.1 in Lower Lake Bhopal. Relatively low the pH values may reflect the decreased productivity of the lake as a result of the polluted water discharged into the lake.

Conductivity ranged between 50 µs/cm to 170 µs/cm. The maximum value was recorded at Vanvihar during pre-monsoon and Kamla Park during summer. According to Suneela *et al*., (2007) conductivity ranged between790-1210µmhos/cm. High value of conductivity is due to the high chloride ions, ionized salts and hardness which resulted due to accumulation of these ions at the bottom and due to heavy inflow of agricultural runoff and sewage. TDS value varied from 20ppm to 120ppm. The maximum value was recorded at Vanvihar during summer, Khanugaon during summer and Kamla Park during summer. The variation in TDS is an indication of

the varying contributions of allocthonous and autocthonous inputs to the lake.

Total Alkalinity value varied from 42 mg/l to 88 mg/l. The minimum value was found at Central zone during monsoon and maximum value was recorded at Central zone during pre-monsoon and at Kamla Park during monsoon. Padma *et al.*, (1999), recorded alkalinity during pre monsoon varied from 65.9 -100.0 meq/l, and 229.4 - 275.5 meq/l during post-monsoon. The variations in the results are mainly due to the riverine input during post monsoon. This study shows that heavy rainfall, high run-off and the fresh water input increase the trace metal concentrations in the sediments during post-monsoon, whereas the decrease during pre-monsoon is in response to decrease in clay content and organic carbon.

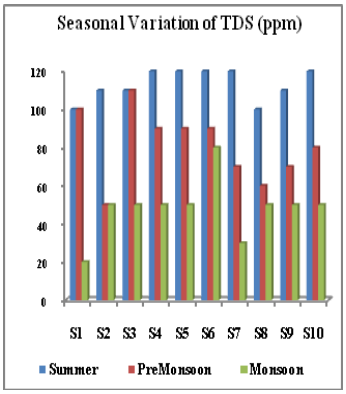
Total hardness ranged from 2 mg/l to78 mg/l. The minimum value was found Vanvihar during pre-monsoon, at Betagaon during pre-monsoon and at Retghat during pre-monsoon and maximum value was recorded at Kolans during summer. Washing of clothes with detergents consisting largely of phosphate also add up the hardness of sediments Suneela *et al.*,(2007). During the present study, calcium hardness ranged from 4.2mg/l to 54.6 mg/l. Kamla Park during pre-monsoon and maximum value was found at Vanvihar during monsoon. Camur-Elipek *et al.*, (2010) recorded the value for calcium hardness ranged from 54.9 to 96.1mg/l during March and Aug. respectively. Magnesium hardness varied from 0.041mg/l to 41.06 mg/l. The minimum value was found at Kohe-fiza during pre-monsoon and maximum value was found at Betagaon during monsoon. Camur-Elipek et al.,(2010) recorded the value for calcium hardness ranged from 41.4 mg/l to 78.0 mg/l during March and Aug. respectively. Chloride varied from 1.99 mg/l to 27.99 mg/l. The maximum value was recorded at Bhadhbhada and Kohe-fiza during monsoon**.** Bajpai, (1994) The higher values may be due to input of organic matter of animal origin during their study at Shahpura Lake, Bhopal. Similarly Rainfall leaches salt out of soil, that may be the reason of lowest value of chloride during monsoon and highest in pre-monsoon De,S (2009).

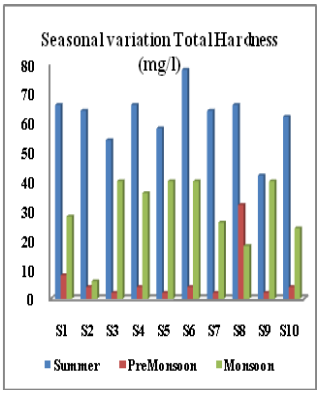
During the present study, the orthophosphate value varied from 0.068 mg/l to 1.554 mg/l. The maximum value was found at Kohe-fiza during monsoon. The soluble phosphate extracted by water represents the fraction that is easily available for algal growth Psenner *et al.* (1984). After aqueous and acid extraction, the remaining phosphate in the sediment is mainly organic and inorganic phosphate Psenner *et al.* (1984); Phosphate exchange between sediment and water has been studied in the past primarily in highly eutrophic lakes in which the hypolimnion remains reduced for the major part of the year (Moore *et al.* 1991; Reddy *et al.* 1996). Gerhardt *et al.*, (2010) also found that the sediment is disturbed by mechanical mixing. Obviously, phosphate released by the sediment is stimulated in summer by enhanced sediment temperature, probably through enhanced microbial activities. The highest phosphate values recorded during monsoon season may be attributed to heavy rainfall, land runoff, its autochthonous origin and weathering of rocks liberating soluble alkali metal phosphates, the bulk of which are carried into the mangrove waters (Das *et al.*, 1997; Gowda *et al.*, 2001). Phosphorous is an important element which controls the reproduction and growth aquatic organisms. The TP concentration of sediments can give an indication of recent P loading to aquatic systems Reddy et al., (2007). During the present study, the total phosphorus value ranged from 0.081 mg/l to 1.085 mg/l. The minimum value was found at Bhadhbhada during monsoon and maximum value was found at Betagaon during summer. It is generally accepted that the bottom sediments contain on average from 0.5 to 6.0 g/kg of total phosphorus (Murphy *et al.*

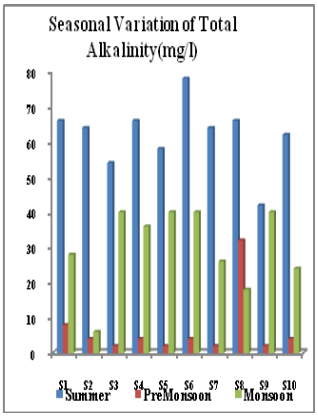
2001; Horvatincic *et al.* 2006). Nevertheless, higher contents were observed elsewhere – 7.32 g/kg (Lake Hollingsworth – Florida) (Brenner *et al.*1999) and even higher – 8.5 g/kg (Ogorelec *et al.* 2006). Phosphorus contents, for lakes with a forest catchment without any presence of sewerage or waste water inflow, ranged from 0.6 to 1.2 g/kg. High Levels of phosphate can lead to eutrophication, which increases algae growth and ultimately reduces dissolved oxygen Adeyemo et al.,(2008).

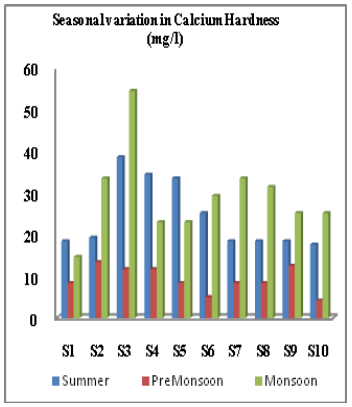
Nitrate is a form of nitrogen and a vital nutrient for growth, reproduction, and the survival of organisms. High nitrate levels (>1 mg l-1) are not good for aquatic life (Johnson *et al.*, 2000). During the present study, the nitrate value ranged from0.225 mg/l to 2.781 mg/l. The minimum value was found at Betagaon during monsoon and maximum value was found at same station during pre- monsoon. The nitrate rate also reflects the seasonal fluctuations in the deposition of liable organic substrates from the water column (Canavan *et al.*,2006). The presence of denitrifying organism and high potential NO^{3-} reduction rates well below the depth of NO^{3-} from the overlying bottom water. Nitrate accumulation can be due to excessive growth of aquatic plant which on death and decomposition release organic nitrate under the mineralization process by microbial action in soil sediment. The quantity of organic material in the surficial sediment of lakes determines the sediment nitrogen content, which is because the nitrogen deposited in sediment is primarily in the organic form (Zdanowski, B 1983) High Levels of nitrate can lead to eutrophication, which increases algae growth and ultimately reduces dissolved oxygen Adeyemo *et al.*,(2008).

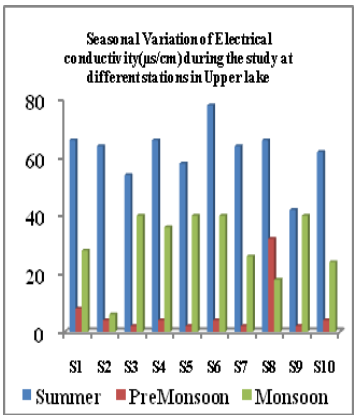
During the present study, the organic matter varied from 0.089 mg/l to 7.682 mg/l. The minimum value was found at Vanvihar during monsoon and maximum value was found at same station during summer. Shoreline urbanization has a variety of impacts on lake ecosystems, including eutrophication and altered littoral habitat structure, vegetation community composition, and fish growth and behavior (Schindler and others 2000); (Scheuerell and Schindler 2004); Marburg and others (2006). Our results demonstrate two additional consequences of shoreline urbanization: changes in the composition and distribution of organic sediments. Previous studies in recent lacustrine systems have shown that compositional variations in the sedimentary organic matter, deduced from bulk parameters such as the Hydrogen Index (HI), can provide valuable information about environmental changes (Ariztegui et al. 1996a, 1996b).

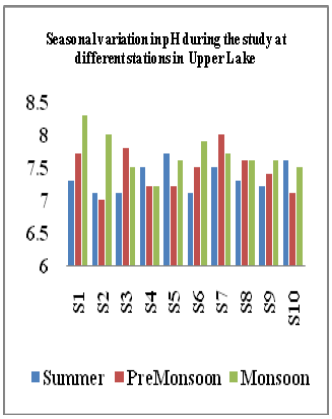


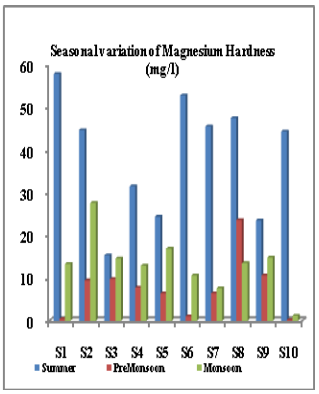


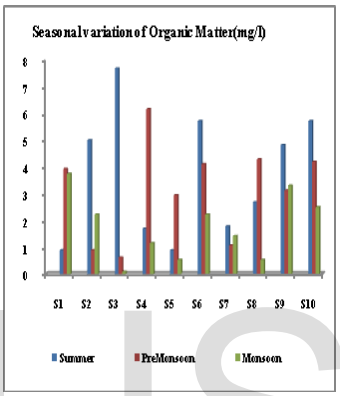


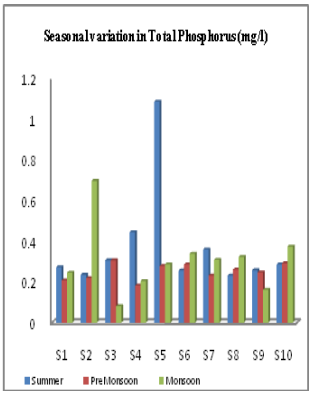


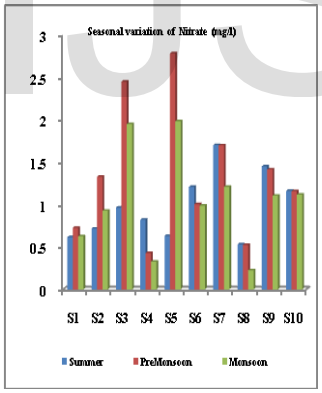












Conclusion

Lake showed distinct organic matter composition that can be attributed to both climate and anthropogenic as a major source. The present study reflects an increase in the pollution status of upper lake. Nitrate and reactive phosphate fluctuations may be attributed to varying agricultural inflows as catchment of the lake is enriched with phosphate and nitrate compounds. The study further showed that the lake was found to be in the hypertonic state in the month of June and August. With the addition of anthropogenic nutrients, algal growth accelerates and the lake becomes over productive biologically. It was also seen that higher nutrient concentration of nutrients were released from sediments to water column it was due to lower oxygen content and higher salinities of water in lake. The population living near lake is the major contributor of the pollution to the lake. It is estimated that 9.82(mg/l) of sewage enters Upper lake daily resulting in the enrichment of the lake and promoting the eutrophication.

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