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Temporal rhythms in physico-chemical characteristics of Gangondanahalli Lake, Bengaluru, Karnataka

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ABSTRACT

Water bodies in urban Bangalore cover about 5% of the land. These lakes form a unique, irreplaceable system. The present study was carried out from January 2014 to December 2014 in Gangondanahalli Lake and the water samples were collected seasonally and analysed for physico chemical factors following standard methods (APHA 2005). It was observed that the Lake is under tremendous anthropogenic pressures pumping heavy loads of domestic sewage and dumping of solid material leading to rapid tropic evolution in the form of eutrophication.

Keywords: Lake, pollution, water quality, environment, season, variation

1. Introduction

Water is the elixir of life, a precious gift of nature to mankind and millions of other species living on the earth. (EPA-PWD, 2001). Wetland constitutes 6.4% of the earth's surface and serves various functions as flood control, nutrient absorption, sediment retention, soil erosion control and provide habitat to various flora and fauna. Lakes are vital parts of freshwater ecosystems of any country. A freshwater lake when maintained free from pollution can offer many beneficial uses in an urban area. The present scenario of increasing urbanization, industrial as well as pollution of water courses due to discharge of effluents without conforming to the environmental norms and standards, the environmental quality and lake rejuvenation has become an issue of concern (Nandini et al., 2009). The quality of life is linked with the quality of the environment. Hence, the Biological components of fresh water depend solely on physico-chemical conditions. Several works on water quality have focused on the physico-chemical characteristics of waters (Waziri et al., 2009; Haiti et al., 2008; Izonfuo and Bareweni, 2001).

2. Material and methods

The present work has been conducted on Gangondanahalli Lake, located in the Northern part of Bangalore having an area of 43.62 acres and lies within geographical coordinates of 13°01'08"N and 77°28'21"E. The Lake receives water through surface runoff during monsoon from surrounding upland and has a regular inlet of sewage canal. Samples were collected in clean and sterilized plastic bottles of 2 liter capacity. The samples were collected 30 cm below the surface of water and brought to the laboratory for the analysis of Physico-chemical parameters like pH, Electrical Conductivity, Total Dissolved Solids, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Hardness, Chlorides, Nitrates, Sulphates, Phosphates, Sodium and Potassium analysed by following standard methods of American Public Health Association (APHA) 2005. The analysed test results

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were equated with the standards of IS 2296-1982 for Inland waters and IS10500:2012 for the current trend of lake.

3. Result and discussion

Water quality is affected by a wide range of natural and human influences. The most important of the natural influences are geological, hydrological and climatic, since these affect the quantity and the quality of water available.

Table 1: Seasonal Variations of Physico-chemical characteristics of Gangondanahalli Lake

Parameters	Standards IS 2296-1982, 10500:2012	Pre monsoon	Monsoon	Winter	Mean ± S.D
Water temperature, °C	-	27.4	25.6	24.3	25.8 ±1.6
pH	6.5-8.5	8.02	7.45	7.74	7.7 ±0.3
Electrical Conductivity EC (µS/cm)	2250	3560	2680	2250	3120 ±622.3
Total Dissolved Solids (mg/L)	500	2225	1675	1406	1950 ±388.9
Turbidity (NTU)	10	3.35	6.65	2.17	4.1 ±2.3
Dissolved Oxygen (mg/L)	>4	6.8	5.6	6.2	6.2 ±0.6
Biological Oxygen Demand (mg/L)	3	4.2	2.8	3.2	3.4 ±0.7
Chemical Oxygen Demand (mg/L)	250	256	192	224	224.0 ±32.0
Total alkalinity as $CaCO_3$ (mg/L)	200	56	68	62	62±6.0
Total Hardness as $CaCO_3$ (mg/L)	300	676	532	408	538.7 ±134.1
Chlorides as Cl^- (mg/L)	600	669	557	603	609.7 ±56.3
Nitrates, (NO_3^-) mg/L	45	22.3	16.6	21.2	20 ±3.0
Fluorides as F^- (mg/L)	1.5	1.2	0.9	1.0	1 ±0.2
Sulphates as SO_4^{2-}(mg/L)	400	288	169	208	221.7 ±60.7
Phosphates as PO_4^{3-} (mg/L)	5	3.8	3.1	2.4	3.1 ±0.7
Sodium as Na (mg/L)	200	142	116	134	130.7 ± 13.3
Potassium as K (mg/L)	12	2.3	1.2	1.7	1.7 ± 0.6

Water temperature: It is well known fact that the water temperature influences directly as well as indirectly biotic and abiotic components of the aquatic ecosystem. In the present

investigation minimum water temperature recorded during winter 24.3^{0}C and maximum in pre monsoon 27.4^{0}C. It also reflects the dynamics of the living organisms such as metabolic and physiological behavior of aquatic ecosystem. Desai (1995) diagnostic about water temperature may be depending on the season, geographic location and sampling time.

pH: pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions. The pH values during the pre monsoon, monsoon and winter seasons were 8.02, 7.54 and 7.74 respectively. The highest value of pH was recorded during the pre monsoon season and the lowest was recorded during monsoon season. The lowest value of pH measured during monsoon may be due to dilution of rain water. A fall in pH value in monsoon season was also recorded by Siddhartha et al., (2013). The concentrations of pH were within in the standard range as prescribed by Indian Standards of IS 2296-1982 for Inland waters. pH affects taste and corrode water supply system.

Electrical Conductivity (EC): Conductivity can be regarded as a crude indicator of water quality for many purposes, since it is related to the sum of all ionised solutes or total dissolved solid (TDS) content. The EC value in the present study ranged between 2250 to 3560 umhos/cm being maximum 3560 umhos/cm in pre monsoon season and minimum 2250umhos/cm in the winter season. The fluctuations in EC are due to fluctuation in total dissolved solids and salinity (Pandey and Pandey, 2003). Seasonal variation in the EC may be due to increased levels of salt due to evaporation. Electrical conductivity values of the samples falls in very high salinity zone as exceeded their standard limits.

Total Dissolved Solids: Total dissolved solids (TDS) indicates the general trend of the surface quality or salinity of the surface water bodies. In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium and other particles. In the present study, minimum values of TDS were recorded during pre monsoon at 1406 mg /L and maximum during winter as 2225 mg/L. This may be due to natural sources and urban runoff from the sampling sites. Maximum concentration of TDS exceeding 2000 mg/L means that, the water also has an equally high amount of Chlorides and Sulphates.

Turbidity: Turbidity is an important parameter in water analysis because it helps in determining the condition and productivity of that water system. The lake water turbidity values ranged between 2.17 to 6.65 NTU. Dagaonkar and Saksena (1992) and Garg *et al.,* (2006) have also reported high turbidity during rainy season. During rainy season silt, clay and other suspended particles contributed to the turbidity values, while during winter and pre monsoon seasons settlement of silt, clay resulted in low turbidity. Turbidity concentrations showed well within the limits in all seasons.

Dissolved Oxygen (DO): Dissolved oxygen is to describe the amount of oxygen dissolved in a unit volume of water. DO is essential for the maintenance of healthy lakes and rivers. In Lake Water the amount of dissolved oxygen recorded ranged from 5.6 mg/L to 6.8 mg/L. The maximum value of dissolved oxygen was recorded during pre-monsoon season and minimum during monsoon season. The maximum DO in pre monsoon may be due to increase in temperature and duration of bright sunlight which has influenced on the % of soluble gases like O_2 & Co_2. Analytical results of DO revealed that, the lake water is well capable of productivity. The dissolved oxygen level in water is constantly changing and Organic waste may overload a natural system causing a serious depletion of the oxygen supply in the water.

Biochemical Oxygen Demand: BOD is a measure of organic pollution to both waste and surface water. The BOD recorded in the lake water ranged between 2.8 mg/L to 4.2 mg/L. The maximum values were recorded during pre-monsoon season and minimum levels during monsoon season. Sankar et al., (2002) suggested that high BOD levels may be due to increasing demand of oxygen for the degradation of the organic wastes dumped into the water. Similar findings of Bhattaraj et al., (2008) that values of BOD clearly showed higher concentration during pre-monsoon and comparatively low during winter and monsoon respectively.

Chemical Oxygen Demand: COD is a measure of the oxidation of reduced chemicals in water. It is commonly used to indirectly measure the amount of organic compounds in water. The maximum COD of 256 mg/L was recorded during pre-monsoon and minimum of 192 mg/L in rainy season. The increase in COD during hot season is mainly attributed to the increase in the air and water temperatures, facilitating the decomposition and oxidation of organic matter Abdo (2002).

Total Alkalinity: It is an important parameter in the detection of water pollution. In the present investigation total alkalinity ranged from 56 to 68 mg/L. It was higher in winter, moderate in monsoon and lower in pre monsoon season. Similar findings were observed by Pandhe et.al., (1995) and Singh D.N. (2000). Alkalinity of the water is the power to neutralize strong acids that give mainly a function of carbonate, bicarbonate and hydroxide content, and formed due to the dissolution of carbon dioxide in water, Wankhade et.al., (2012). The values of Total alkalinity were within standard limits during all seasons.

Total Hardness: It is defined as the sum of calcium and magnesium hardness and is an indicator of Hydrogeology also with aesthetic quality of water. The hardness ranged from 676mg/L (maximum in pre monsoon) to 220mg/L (minimum in winter). The limits were exceeded in all seasons. Similar findings were also observed by Sehgal (2003) and Das (2003) in their studies. Total hardness is imparted mainly by the calcium and magnesium ions, which apart from sulphate, chloride and nitrates are found in combination with carbonates.

Chlorides: Chloride concentration was used as an important parameter for the detection of contamination by sewage. Freeda et al., (2006) reported that chlorides usually occur as NaCl, $CaCl_2$, $MgCl_2$, and in widely varying concentration in all natural water. Chloride values in the present study reports maximum of 669 mg/L in pre monsoon and a minimum of 557 mg/L in monsoon season. The highest concentration of chloride is considered to be an indicator of higher pollution due to high organic waste from animal origin. Sahu et. al., (2007) observed that the higher concentration of chloride in the pre monsoon may be due to increase in temperature, low level of water and sewage mixing. The concentrations of chlorides were fluctuates near to the standard maximum limits during all seasons.

Nitrates: Nitrate ions (NO_3^-) found in freshwater samples resulted from a variety of natural and man-made sources. Nitrate concentrations in the present recorded higher value as 22.3 mg/L in pre monsoon season while lower value was recorded 16.6 mg/L in winter season. The low levels of Nitrates were observed against the standard limits reveled in indication of organically not as much of pollution.

Fluoride: Fluoride is beneficial for human health, if it is taken in controlled quantity. According to WHO (1997), permissible limit for fluoride in drinking water is 1.0 mg/L. In the present study, the values of fluoride varied between 0.9 mg/L to 1.2 mg/L. Fluoride content was recorded maximum value during pre-monsoon and gradually decreased during

rainy and winter season. Sulphates: Sulphates concentrations are widely distributed in nature and may be present in the natural waters ranging from a few to several thousand milligrams per liter. Concentration of sulphate ion was minimum in Monsoon 169 mg/L and maximum 288 mg/L in pre monsoon. Sulphate concentration is within the desirable limit of IS in all the season.

Phosphates: The phosphates are present in natural waters as soluble phosphates and organic phosphates. During the present investigation the phosphate concentration was reported to the higher as 3.8 mg/L in pre monsoon season and lower as 2.4 mg/L in winter season. The concentration of phosphate was higher in pre monsoon during which the algal blooms were observed, while minimum value in winter months was possibly due to its immediate utilization by the overgrowth of phytoplankton. Higher concentration of phosphate in dry seasons may be due to low level of water and pollution. Similar findings were observed by Kamal et. al., (2007) observed the similar findings in their study. The concentrations were within the standard limits and correlates with nitrates.

Sodium: The sodium concentration recorded in Gangondanahalli lake water was ranged between 20.8 mg/L to 28.8 mg/L. The high concentration of sodium was recorded during the pre-monsoon season and the lowest concentration was recorded during winter season. According to Solanki (2001) the highest volume of sodium during pre-monsoon is due to reducing in volume of water in the lake. Potassium: The major source of potassium in natural fresh water is due to weathering of rocks, but the quantities increase in the polluted water due to disposal of waste water. Potassium content in the water samples varied from 1.2 mg/L to 2.3 mg/L.

4. Conclusion

The Analytical data of Physico-chemical parameters in Gangondanahalli Lake water samples showed well above the desirable limits during all the three seasons. Thus the result shows that the Gangondanahalli Lake receives a very high amount of inorganic pollutants. Data suggested there is need of attention through environmental monitoring system.

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