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HYDROLOGICAL CHARACTERISTICS OF SOMPURA LAKE, BANGALORE

Environmental Science

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ABSTRACT

The present study assessed the seasonal variations of the selected water quality parameters of Sompura lake from January 2010 to December 2010. The range of the selected water quality parameters were observed to have a seasonal significant difference for temperature (27.5-34.5°C), pH (7.2-8.6), Turbidity (15-63 FAU), Total dissolved solids (400-1100 mg/L), Electrical conductivity(625-1718.75 μmhos/cm), Dissolved oxygen (5.2-9.1mg/L), Biological oxygen demand (2.28-7.34 mg/L), Chemical oxygen demand (5.68-9.82 mg/L), Chloride (58.72-112.6 mg/L), Alkalinity(44.8-112.2 mg/L), Hardness (84-154.4 mg/L), Phosphate(1.23-2.43 mg/L), Nitrate(5.12-8.9 mg/L) and Sulphate (19.8-32.5 mg/L). The results obtained from physico-chemical analysis were compared with WHO standards. In the present study all the parameters were found to be within the permissible limits, while phosphate was found to be beyond the limit. But availability of dissolved oxygen clearly evidenced that Sompura lake is suitable for fisheries. Correlation analysis was made using SPSS software.

KEYWORDS

Water quality parameters, Lake, Seasonal variations, Correlation..

Introduction

Lake water is a source of drinking and domestic use for rural and urban population of India. India is facing a serious problem of natural resource scarcity, especially that of water in view of population growth and economic development (Garg et al., 2009). Most of fresh water bodies all over the world are getting polluted, thus decreasing the potability of water (Gupta et al., 2005). Water quality is the characteristics of water which influence its beneficial use as well as the sustainability of ecosystem. Water resources are of critical importance to both natural ecosystem and human development. The quality of water in any ecosystem provides significant information about the available resources for supporting life in that ecosystem and the suitability for human use. Good quality of water resources depends on a large number of physicochemical parameters and biological characteristics.

Aquatic pollution is a global concern, but even so, huge pollution loads are still producing due to human population growth and unscientific management and the trends are expected to increase. As the aquatic pollution is drastically increasing, it has become essential to assess the water quality parameter of Sompura Lake and identify the various sources of contaminants in order to provide scientific basis for finding appropriate remedies to the situation and to provide good water quality for drinking, irrigation and fisheries. Therefore, the assessment of the variation of water quality parameter is the first and foremost task for the scientific management of lake and to find out the suitability of the water for multipurpose. It is in this light that the present study was undertaken to assess the seasonal variations of water quality parameters of Sompura lake which is located in Bangalore district, Karnataka, India.Many researchers assessed the water quality parameters in order to draw out the baseline information for utilization, management and conservation of water bodies for fisheries,irrigation and drinking purposes (Chavan et al., 2004; Garg et al., 2006; Mustapha, 2008; Narayana et al.,2008; Garg et al., 2009; Prabhakar et al., 2012; Saxena and Saksena, 2012).

MATERIALS AND METHODS

Study area

Sompura lake is situated between $12^0 52^1 27.62^{11}$ N Latitude and $77^0 29^1 56.01^{11}$ E Longitude, and elevation of 2660 ft. The study area is shown in Fig. *1*

Sampling

Water sample was collected monthly for a period of one year from January 2010 to December 2010 to cover three seasons of Pre monsoon (February-May), Monsoon (June-September) and Post monsoon (October-January). Water was collected from 0.5 meter depth with 1 liter plastic bottle. The water samples were brought immediately to the laboratory for analysis.

Analysis of water quality parameters

Temperature and pH were measured in situ, using mercury glass thermometer and portable pH meter respectively. Turbidity, Total dissolved solids , Electrical conductivity, Dissolved oxygen , Biological oxgen demand , Chemical oxygen demand , Chloride , Alkalinity, Hardness, Phosphate, Nitrate and Sulphate were analyzed using standard methods of APHA (2005).

Statistical analysis

Data collected were subjected to SPSS (2008) software and Pearson correlation coefficient was calculated to test the degree of relationship between the water quality parameters.

Figure 1. Showing Sompura lake

Results and Discussion

Seasonal range of variation, mean and standard error of water quality parameters of Sompura Lake are summarized in Table1. Correlation coefficients between different water quality parameters are tabulated in Table 2.

Temperature of a water body depends upon the time of collection, season, water depth and has both direct and indirect effect on the water body. In the present study, surface water temperature ranged between the lowest value of 27.5°C in January 2010 and the highest of 34.5°C in May. Water temperature was varying from 27.8^0C to 34.5^0C with mean of 30.5 ± 1.52^0C in pre monsoon, 28.6^0C to 32.2^0C with mean of 29.87 ± 0.79^0C in monsoon and 27.5^0C to 28.6^0C with mean of 28.0 ± 0.23^0C in post monsoon season. The temperature value was maximum during summer and minimum during winter. Low temperature recorded in winter was due to lesser solar radiation and low atmospheric temperature. Similar pattern of temperature fluctuation was observed by (Prabhakar et al., 2012).

The **pH** indicates the intensity of the acidic or basic character of a solution and is controlled by the dissolved chemical compounds and biochemical processes in the solution. In the present study, the study lake has shown an alkaline pH ranged between the lowest value 7.2 in June and the highest of 8.6 in May. pH was varying from 7.6 to 8.6 with mean of 7.97 ± 0.21 in pre monsoon, 7.2 to 8.1 with mean of 7.7 ± 0.23 in monsoon and 7.6 to 8.2 with mean of 7.95 ± 0.15 in post monsoon

season. The pH of Sompura lake water was high in summer season and low in monsoon and post monsoon season. Kumar et al. (2009) and Sinha & Biswas (2011) has also observed similar pH variation in Keenjhar lake and Kalyani lake respectively The high pH values during summer are due to high photosynthetic activity of phytoplankton and macrophytes resulting in high production of free carbon dioxide shifting the equilibrium towards alkaline.

Table 1: Seasonal range of variations, mean and standard error of water quality parameters of Sompura Lake (January, 2010 to December, 2010)

Parameter	Pre Monsoon			Monsoon			Post Monsoon		
	Min.	Max.	Mean ± SE	Min.	Max.	Mean ± SE	Min.	Max.	Mean ± SE
Water temp	27.8	34.5	30.5 ± 1.52	28.6	32.2	29.87 ± 0.79	27.5	28.6	28.0 ± 0.23
pH	7.6	8.6	7.97 ± 0.21	7.2	8.1	7.7 ± 0.23	7.6	8.2	7.95 ± 0.15
Turbidity	15.0	24	18 ± 2.04	37.0	63	51 ± 5.58	18	28.0	23.5 ± 2.21
TDS	800	1100	950 ± 64.54	500	800	650 ± 64.54	400	900.0	675 ± 110.86
EC	1250	1718.75	1484.38 ± 100.85	781.25	1250	1015.63 ± 100.859	625	1406.25	976.56 ± 205.46
DO	5.2	8.42	6.49 ± 0.69	6.5	7.8	7.14 ± 0.26	5.85	9.1	7.47 ± 0.77
BOD	2.28	7.34	5.31 ± 1.09	5.81	7.26	6.29 ± 0.34	3.98	4.89	4.38 ± 0.19
COD	5.68	9.82	7.76 ± 0.95	8.9	9.6	9.20 ± 0.14	6.38	8.23	7.63 ± 0.42
Chloride	58.72	72.4	64.12 ± 2.93	73.6	112.6	91.8 ± 8.04	76.2	96.2	84.75 ± 4.65
Alkalinity	58.2	89.0	73.55 ± 6.55	44.8	112.2	85.5 ± 14.44	66.8	96.2	80.3 ± 7.36
Hardness	84.0	98.2	91.8 ± 2.93	103.2	154.4	130.25 ± 11.17	89.0	141.1	126.62 ± 12.57
Phosphate	1.34	1.94	1.575 ± 0.12	1.82	2.43	2.11 ± 0.13	1.23	1.76	1.61 ± 0.12
Nitrate	6.24	7.34	6.73 ± 0.22	6.14	8.9	7.55 ± 0.63	5.12	7.12	6.18 ± 0.44
Sulphate	24.8	29.2	27.05 ± 0.90	26.3	32.5	29.27 ± 1.27	19.8	28.6	23.77 ± 1.85

Water Temp – Water temperature, TDS – Total dissolved solids, EC – Electrical conductivity, DO – Dissolved oxygen, BOD – Biological oxygen demand, COD – Chemical oxygen demand.

	Temp	pH	Turbidity	TDS	EC	DO	BOD	COD	Chloride	Alkalinity	Hardness	Phosphate	Nitrate	Sulphate
Temp	1	0.073	0.204	0.282	0.307	-0.599*	0.816**	0.513	-0.199	-0.620*	-0.280	0.291	0.525	0.497
pH		1	-0.424	-0.127	-0.059	0.080	-0.104	-0.066	0.202	0.062	-0.081	-0.618*	-0.406	-0.254
Turbidity			1	-0.430	-0.367	0.026	0.520	0.524	0.476	0.147	0.527	0.845**	0.737**	0.562
TDS				1	0.969**	-0.166	-0.050	0.031	-0.853**	-0.086	-0.717**	-0.288	-0.126	0.023
EC					1	-0.245	0.015	0.137	-0.815**	-0.031	-0.729**	-0.256	-0.104	0.120
DO						1	-0.627*	-0.417	0.249	0.435	0.079	-0.346	-0.168	-0.174
BOD							1	0.666*	0.095	-0.394	0.035	0.621*	0.614*	0.519
COD								1	0.313	0.040	0.221	0.637*	0.369	0.513
Chloride									1	0.260	0.698*	0.323	0.052	0.013
Alkalinity										1	0.317	0.011	-0.187	-0.252
Hardness											1	0.532	0.115	-0.113
Phosphate												1	0.714*	0.547
Nitrate													1	0.762**
Sulphate														1

** Correlation is significant at the 0.01 level;* Correlation is significant at the 0.05 level

Temp – Temperature, TDS – Total dissolved solids, EC – Electrical conductivity, DO – Dissolved oxygen, BOD – Biological oxygen demand, COD – Chemical oxygen demand.

Table 2: Correlation matrix of the water quality parameters of Sompura Lake.

Turbidity is a measurement of cloudiness of water. In the present study, turbidity ranged between the lowest value of 15 FAU in April and the highest of 63 FAU in July.Turbidity was varying from 15.0 FAU to 24.0 FAU with mean of 18 ± 2.04 in pre monsoon, 37.0 FAU to 63.0 FAU with mean of 51 ± 5.58 in monsoon and 18.0 FAU to 28.0 FAU with mean of 23.5 ± 2.21 FAU in post monsoon season and the highest turbidity was noted during monsoon season. Similar observation was made by Krishnamoorthi et al. (2011).

Total dissolved solids are affected by the geographical location of the water body, drainage, rainfall, deposit organic material at the bottom level, incoming water and nature of biota. The excess amount of total dissolved solids in water disturbed the ecological balance due to osmotic regulation and suffocation caused in aquatic fauna. In the present study, total dissolved solids ranged between the lowest value of 400 mg/L in October and the highest of 1100 m/L in April. TDS was varying from 800 mg/L to 1100 mg/L with mean of 950 ± 64.54 mg/L

in pre monsoon, 500 mg/L to 800 mg/L with mean of 650 ± 64.54 mg/L in monsoon and 400 mg/L to 900 mg/L with mean of 675 ± 110.86 mg/L in post monsoon season. Lower values of total dissolved solids were recorded in winter season and higher in summer season. High values of total dissolved solids during summer season may be attributed to increased evaporation due to high temperature and decrease in water volume. Similar results have also been observed by Chinnaiah & Rao, 2011 and Kalwale & Savale, 2012.

Electrical conductivity could be due to variations in the rate of decomposition of organic matter, low level of water caused by evaporation, influx of seepage and nutrients from the drainage basin and also the presence of higher concentration of inorganic salts. In the present study, Electrical conductivity ranged between the lowest value of 625 µmhos/cm in October and the highest of 1718.75 µmhos/cm in April, 2010. Electrical conductivity was varying from 1250 µmhos/cm to 1718.75 µmhos/cm with mean of 1484.38 ± 100.85 µmhos/cm in

pre monsoon, 781.25 µmhos/cm to 1250 µmhos/cm with mean of 1015.63 ± 100.859 µmhos/cm in monsoon and 625 µmhos/cm to 1406.25 µmhos/cm with mean of 976.56 ± 205.46 µmhos/cm in post monsoon season. It was higher in summer season and lower in winter season. The present findings in relation to electrical conductivity are in conformity with the work of Chaurasia & Pandey (2007) and Verma et al. (2012).

Dissolved Oxygen is a very important parameter of water quality and is an index of physical and biochemical processes occurs in water. It may be present in water due to direct diffusion from air and photosynthetic activity of autotrophs. In the present study the dissolved oxygen ranged between the lowest value of 5.2 mg/L in April and the highest of 9.1 mg/L in January. Dissolved oxygen was varying from 5.2 mg/L to 8.42 mg/L with mean of 6.49 ± 0.69 mg/L in Pre monsoon, 6.5 mg/L to 7.8 mg/L with mean of 7.14 ± 0.26 mg/L in monsoon and 5.85 mg/L to 9.1 mg/L with mean of 7.47 ± 0.77 mg/L in post monsoon season. In Sompura lake, higher values of dissolved oxygen was recorded in winter, this was due to the good aeration caused by rain water. During summer the level of dissolved oxygen was quite satisfactory, perhaps due to photosynthetic activities resulting into liberation of oxygen. Gonjari & Patil (2008) and Singh et al. (2010) studied about seasonal variation of dissolved oxygen.

Biochemical oxygen demand is the amount of oxygen required by the living organisms engaged in the utilization and ultimate destruction or stabilization of organic water. It also indicates the presence of microbial activities and dead organic matter on which microbes can feed. In the present study, BOD ranged between the lowest value of 2.28 mg/L in February and the highest of 7.34 mg/L in May. BOD was varying from 2.28 mg/L to 7.34 mg/L with mean of 5.31 ± 1.09 mg/L in pre monsoon, 5.81 mg/L to 7.26 mg/L with mean of 6.29 ± 0.34 mg/L in monsoon and 3.98 mg/L to 4.89 mg/L with mean of 4.38 ± 0.19 mg/L in post monsoon season.The higher biochemical oxygen demand were recorded during summer season, this may be due to presence of high amount of organic matter and entry of other allocthonous materials thereby increasing the respiratory activity of the heterotrophic organisms. In winter season, the biochemical oxygen demand values were low which may be due to lesser quantity of organic material in the form of solids and decreased microbial population. Similar observations have been made by Karne & Kulkarni (2009).

Chemical oxygen demand is the oxygen consumed by the chemical break down of organic and inorganic substances in water. It is also a measure of the oxygen equivalent to the organic matter content of water that is susceptible to oxidation by a strong chemical oxidant and thus, is a reliable parameter for interpreting the extent of pollution in water or evaluating the pollution load. Therefore, chemical oxygen demand of water increases with increasing organic matter concentration. In the present study, COD ranged between the lowest value of 5.68 mg/L in March and the highest of 9.82 mg/L in April. COD was varying from 5.68 mg/L to 9.82 mg/L with mean of 7.76 ± 0.95 mg/L in pre monsoon, 8.9 mg/L to 9.6 mg/L with mean of 9.20 ± 0.14 mg/L in monsoon and 6.38 mg/L to 8.23 mg/L with mean of 7.63 ± 0.42 mg/L in post monsoon season.The chemical oxygen demand was with lower values in winter season and higher values during summer and rainy seasons. Similar observations was made by Sharma & Capoor (2010).

Chloride is always regarded as an indicator of eutrophication and pollution due to sewage and other organic materials. The high chloride contents might be attributed to the presence of large amount of organic matter. In the present study, chloride ranged between the lowest value of 58.72 mg/L in March and the highest of 112.6 mg/L in September. Chloride was varying from 58.72 mg/L to 72.4 mg/L with mean of 64.12 ± 2.93 mg/L in pre monsoon, 73.6 mg/L to 112.6 mg/L with mean of 91.8 ± 8.04 mg/L in monsoon and 76.2 mg/L to 96.2 mg/L with mean of 84.75 ± 4.65 mg/L in post monsoon season. High chloride contents were observed during monsoon months which were due to increased runoff water brought salts from catchment area in monsoon. Similar reason have given by Sharma et al. (2010).

Alkalinity of water is a measure of its capacity to neutralized acids and the total alkalinity is the total sum of carbonate and bicarbonate alkalinities. In the present study, alkalinity ranged between the lowest value of 44.8 mg/L in June and the highest of 112.2 mg/L in July. Alkalinity was varying from 58.2 mg/L to 89.0 mg/L with mean of

73.55 ± 6.55 mg/L in pre monsoon, 44.8 mg/L to 112.2 mg/L with mean of 85.5 ± 14.44 mg/L in monsoon and 66.8 mg/L to 96.2 mg/L with mean of 80.3 ± 7.36 mg/L in post monsoon season. Garg et al. (2006 & 2009) in Harsi and Ramsagar reservoirs, have found seasonal variation of alkalinity.

Hardness of water is mainly governed by the cations of calcium and magnesium. In the present study, hardness ranged between the lowest value of 84 mg/L in March and the highest of 154.4 mg/L in August. Hardness was varying from 84.0 mg/L to 98.2 mg/L with mean of 91.8 ± 2.93 mg/L in pre monsoon, 103.2 mg/L to 154.4 mg/L with mean of 130.25 ± 11.17 mg/L in monsoon and 89.0 mg/L to 141.1 mg/L with mean of 126.62 ± 12.57 mg/L in post monsoon season.

Phosphate is considered to be the most significant component among the nutrients responsible for eutrophication of a water body, as it is the primary initiating factor. In the present study, phosphate ranged between the lowest value of 1.23 mg/L in January and the highest of 2.43 mg/L in July. Phosphate was varying from 1.34 mg/L to 1.94 mg/L with mean of 1.575 ± 0.12 mg/L in pre monsoon, 1.82 mg/L to 2.43 mg/L with mean of 2.11 ± 0.13 mg/L in monsoon and 1.23 mg/L to 1.76 mg/L with mean of 1.61 ± 0.12 mg/L in post monsoon season. High concentrations of phosphates can indicate the presence of pollution and are largely responsible for eutrophic conditions. Low values of phosphates during the winter season are due to its utilization by microphytes and macrophytes in their growth. Surface runoff from washings of agricultural fields and mixing with the incoming water to the lake made higher values of phosphorous in the lake. Similar reason have been projected by Ganesan & Sultan (2009).

Nitrate are products of oxidation of organic nitrogen by the bacteria present in soil and water where sufficient oxygen is present. In the present study, Nitrate ranged between the lowest value of 5.12 mg/L in December and the highest of 8.9mg/L in July. Nitrate was varying from 6.24 mg/L to 7.34 mg/L with mean of 6.73 ± 0.22 mg/L in pre monsoon, 6.14 mg/L to 8.9 mg/L with mean of 7.55 ± 0.63 mg/L in monsoon and 5.12 mg/L to 7.12 mg/L with mean of 6.18 ± 0.44 mg/L in post monsoon season. High concentration of nitrates are useful in irrigation but their entry into water resources increase the growth of nuisance algae, macrophytes and trigger eutrophication and pollution (Trivedy & Goel 1986). Nitrates were present in higher concentration during summer and monsoon while lowest in winter season. Similar opinions were also expressed by workers working on different water bodies (Sinha & Biswas 2011, Prabhakar et al. 2012).

Sulphate are naturally occurring anion present in all kinds of natural waters. It is one of the key nutrients in the aquatic environment. In the present study, sulphate ranged between the lowest value of 19.8 mg/L in December and the highest of 32.5 mg/L in June. Sulphate was varying from 24.8 mg/L to 29.2 mg/L with mean of 27.05 ± 0.90 mg/L in pre monsoon, 26.3 mg/L to 32.5 mg/L with mean of 29.27 ± 1.27 mg/L in monsoon and 19.8mg/L to 28.6 mg/L with mean of 23.77 ± 1.85 mg/L in post monsoon season. The high values of sulphates may be due to decay of phytoplankton and aquatic macrophytes or due to oxidation of sulphide or sulphite into sulphate in the presence of photosynthetic sulphur bacteria. The relatively low values of sulphates were measured during winter mainly because of its uptake and accumulation by plankton and aquatic macrophytes as well as bacteria. These results are in conformity with Kirubavathy et al. (2005).

Correlation among physico-chemical characteristics
It has been pointed out in several studies that the physico-chemical characteristics influence each other and biological features of the water body. In the present study, during 2010, in Sompura lake the following pair of parameters like Temperature – BOD (r = 0.816), Turbidity – Phosphate (r = 0.845), Turbidity – Nitrate (r = 0.737), TDS – EC (r = 0.969), Phosphate – Nitrate (r = 0.714), Nitrate – Sulphate (r = 0.762) shows good positive correlation and BOD – COD (r = 0.666), BOD – Phosphate (r = 0.621), BOD – Nitrate (r = 0.614), COD – Phosphate (r = 0.637) shows moderate correlation. However, a good negative correlation is shown by the pairs Temperature – DO (r = -0.599), Temperature – Alkalinity (r = -0.620), pH – Phosphate (r = -0.618), TDS – Chloride (r = -0.853), TDS – TH (r = -0.717), EC – Chloride (r = -0.815), EC – TH (r = -0.729), DO – BOD (r = -0.627) (Table – 2).

Conclusion
The present investigation of water quality of Sompura lake indicates that the physico-chemical parameters are within the permissible limits

of WHO standards except for phosphate. The present study clearly indicated that most of the selected water quality parameters are significant to water quality variations throughout the seasons of the year. Correlation coefficient analysis of the water quality parameters in the present study clearly showed degree of relationship of the water quality parameters which are the baseline information for the management of the lakes.

Most of the water quality parameters were in the permissible range for fisheries and irrigation The findings clearly proved that the lake water is suitable for multipurpose.

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