ISSN NO. 2320-5407

Journal homepage:http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Water Quality Studies of Bellandur Lake, Urban Bangalore, Karnataka, India

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Manuscript Info *Abstract*

Manuscript History:

Received: 07 May 2013
Final Accepted: 22 May 2013
Published Online: June 2013

Key words:
Water Quality, Bangalore, Lake, physicochemical, Statistical

The pace of urbanization is increasing globally, putting more pressure on local water quality. In addition to discharges of urban and industrial wastewater, urban areas add to poor water quality in a number of ways. The study was conducted to assess the water quality values of Bellandur Lake which is a major tank in Varthur of Bangalore SouthTaluk.Samples were collected in clean and sterilized plastic bottles of 2 litercapacity. The samples were collected to examine the water quality in the month of February 2013 of Bellandur Lake, 30 cm below the surface of water and brought to the laboratory for Physico-chemical parameters analysis.Selected parameters were analyzed by following standard methods APHA, (2005).The obtained results were subjected to Statistical Analysisusing Microsoft offices excel 2010.The water quality of Bellandurlakehas exaggerated due by the consequent changes and urbanization, which indicated the physico-chemical concentrations of lakes found in high levels. Despite of some conservation efforts made by the authorities this lake is threatening immeasurably. Continuous monitoring of lakes should be enacted properly as from the origin point at the end to overcome these situations.

1.0 INTRODUCTION

Water is a prime natural resource, a basic human need and a precious national asset. Planning, development and management of water resources need to be governed by national perspectives.

All life depends on water and exists in nature in many forms like an ocean, river, lake, clouds, rain, snow and fog etc. However, strictly speaking chemically pure water does not exist for any appreciable length of time in nature. A lake is a large body of water surrounded by land, inhabited by various aquatic life forms, for all practical purposes, pure water is considered to that which has low dissolved or suspended solids and obnoxious gases as well low in biological life.

Such high quality of water may be required only for drinking purposes while for other uses like agriculture and industry, the quality of water can be quite flexible and water polluted up to a certain extent in a general sense can be regarded as pure. The health of lakes and their biological diversity are directly related to health of almost every component of the ecosystem. The lakes are also subjected to various natural processes taking place in the environment like the hydrologic cycle, with unprecedented developmental activities; human beings are responsible for choking several lakes to death. Storm water runoff and discharge of sewage into the lakes are a few of the common causes where various nutrients enter the aquatic ecosystems resulting in their death.

Of all the water quality issues facing lakes everywhere, eutrophication is of great concern. Eutrophication is a term used to describe the aging of a lake, resulting due to the accumulation of nutrients, sediments, silt and organic matter in the lake from the surrounding watershed (Sulekh et al., 2012).

The pace of urbanization is increasing globally, putting more pressure on local water quality. In

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addition to discharges untreated sewageofurban and industrial wastewater, urban areas add to poor water quality in a number of ways. The high concentration of impervious surfaces increases runoff from roads and can carry numerous pollutants such as oils, heavy metals, rubber, and other automobile pollution into waterways and streams. The reduction in water percolation into the ground can also affect the quantity and quality of groundwater, and storm water runoff can overwhelm wastewater treatment systems when high volume flows exceed treatment capacities. India is facing a serious problem of natural resource scarcity, especially that of water in view of population growth and economic development. Most of fresh water bodies all over the world are getting polluted, thus decreasing the potability of water. Bangalore city does not have any perennial river. It is dependent on river Cauvery which is about 140 km away to provide water to its residents pumping water is an expensive business as the population of Bangalore increases the demand for water to increase. Leading to depend on ground water which is recharged by lakes (Helen and Paneerselvam, 2008).

2.0 MATERIALS AND METHODS

Study area: The study was conducted in the heavily polluted lake the Bellandur Lake which is a major tank in Varthur of Bangalore SouthTaluk which is located at a $12^0$45'0"N and $77^0$40'0"E. The total catchment area of the lake is 110.94 Sq. miles. The annual rainfall of the catchment area is 32 inches. It has a submerged area of 915 acres. The tank remains full throughout the year since it receives sewage water of about 100 MLD from Bangalore city in addition to its own supply of water of rainfall from its own catchment area.

Sample collection: Samples were collected in clean and sterilized plastic bottles of 2 litercapacity. The samples were collected to examine the water quality in the month of February and the Year 2013 of Bellandur Lake, 30 cm below the surface of water and brought to the laboratory for Physico-chemical parameters selected are pH, EC, Total Dissolved Solids, Dissolved Oxygen, Total Hardness, BOD, COD, Chlorides, Phosphates and Nitrates, analysed by following standard methods of APHA, (2005).

Statistical analysis: The obtained results were subjected to Statistical Analysis, mean, Standard deviation and Pearson Correlation Coefficient to see the correlation between different physicochemical parameters using Microsoft offices excel 2010.

3.0 RESULTS AND DISCUSSION

Water pollution is on the rise all over the world. Much of it is down to anthropogenic stress /activities. The Lakes has a huge impact on the health of people, plants and animals. The main Key Issues in Bellandur Lake are as follows:

Figure 1&2: Outlets of Bellandur Lake found eutrophic, oil, and Grease deposits

Figure 3&4: Municipal Solid waste dumped in the lakes bed. Unaccounted Sewage entering into the lake

Figure 5&6: Encroachment and Construction activity at lake Beds


Figure 7&8: Improper Fencing around the Bellandur Lake


Figure 9&10: Poultry waste and Construction waste dumped at the outlet of Lake


Figure 11&12: Fodder harvest from the lake using a small boat


Physico chemical analysis:

Table 1: Results of Physico- Chemical analysis of lake water samples

Parameter	Unit	Standard	Bellandur Lake					Mean ± SD
			Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	
pH		6.5 – 8.5*	7.2	7.9	7.5	7.7	7.7	7.6±0.26
EC	µmohs/cm	2250*	1210	1120	1180	1252.5	1191.5	1190.8±48.2
TDS	mg/L	500*	786.5	728	767	814.12	774.47	774.02±31.3
DO	mg/L	4*	0.5	0.7	0.1	0.6	0.2	0.42±0.26
Total hardness as $CaCO_3$	mg/L	300*	138	122	120	140	132	130.4±9.10
BOD	mg/L	3*	1.5	1.9	2.2	1.5	2.4	1.9±0.41
COD	mg/L	250#	21.1	22.4	22.8	21.6	22.5	22.08±0.70
Chloride as Cl^-	mg/L	600*	131	140	138	131.4	142	136.48±5.03
Total Alkalinity as $CaCO_3$	mg/L	200#	145.7	138	139	143	149	142.94±4.59
Phosphate as PO_4^{3-}	mg/L	5#	2.4	2.1	2.2	2.4	2	2.22±0.18
Nitrate as $NO^{3-}N$	mg/L	50*	9.6	9.2	8.5	9.3	8.7	9.06±0.45

*ISI-IS: 2296 – 1982, # IS: 10500 -1992

Table 2: Pearson's correlation coefficient between Physico Chemical Parameters

Parameter	pH	EC	TDS	DO	Total hardness	BOD	COD	Chloride	Total Alkalinity	Phosphates	Nitrate Nitrogen
pH	1										
EC	-0.42	1									
TDS	-0.42	1	1								
DO	0.24	-0.23	-0.23	1							
Total hardness	-0.35	0.82	0.82	-0.52	1						
BOD	0.33	-0.45	-0.45	0.97	-0.62	1					
COD	0.55	-0.58	-0.58	0.84	-0.84	0.88	1				
Chloride	0.59	-0.70	-0.70	0.79	-0.69	0.91	0.87	1			
Total Alkalinity	-0.33	0.51	0.51	0.16	0.68	0.10	-0.36	-0.06	1		
Phosphates	-0.58	0.67	0.67	-0.77	0.61	-0.89	-0.81	-0.99	-0.05	1	
Nitrate Nitrogen	-0.27	0.24	0.24	-0.95	0.64	-0.90	-0.91	-0.72	0.10	0.66	1

The analysis of the water samples is tabulated in the Table 1, the results revealed that pH ranged from 7.2 – 7.9, the water samples analysed results were within the prescribed standard limit.

The three main processes affecting Lake pH are photosynthetic, respiration and nitrogen assimilation. The effect of photosynthesis and respiration depends on carbonate, bicarbonate and carbon dioxide equilibrium. Most of the waters are slightly alkaline due to the presence of carbonates and bicarbonates. Generally the pH of water is influenced by the geology of catchment area and buffering capacity of water. The mean value of pH was 7.6 and SD value was 0.26.

Electrical conductivity ranged between1120 - 1252.5 µmohs/cm, which was within the prescribed limit.

The mean value of Electrical conductivity was 1190 µmohs/cm and SD value was 48.23. Normal surface water is expected to have a range between 50 and 1500 µmhos/cm(Johnson et al., 1985). Laboratory conductivity measurements are used to establish a

degree of mineralization and physiological effects on aquatic biodiversity (APHA, 2005).

Total Dissolved solids Ranged between 814.12 – 728 mg/L, the mean value of Total Dissolved solids (TDS) was 774.02 mg/L and SD value was 31.3, a high level of dissolved solids elevates the density of water which influences osmoregulation of freshwater organisms reducing the solubility of gases like oxygen and utility of water for drinking, irrigation and for industrial purposes. Water can be classified based on the concentration of TDS. Moreover, TDS range up to 3000mg/L are useful for irrigation while anything above 3000mg/L will not be suitable for both drinking and irrigation (Nagaraju et al., 2006).

Dissolved oxygen (DO) was above the prescribed standard against 4 mg/L. The mean value of Dissolved oxygen was 4.82 mg/L and SD value was 0.31. Dissolved Oxygen is the fundamental fuel of life in water. DO in water is of great importance to all aquatic organisms and is considered to be the factor that reflects the biological activity taking place in a water body and determines the biological changes, which are brought about by the aerobic or anaerobic organisms [10]. Fish requires minimum DO of 3mg/L for their survival.

Total hardness (TH) ranged from 120 to 138 mg/L. The mean value of Total Hardness was 130.4 mg/L and SD value was 9.10. (Manivasakam, 2003) and(APHA, 2005)Water hardness basically a measure of the capacity of water precipitate soap. Calcium and magnesium are the principal cations causing hardness. Other elements such as Iron Aluminium, Manganese strontium and zinc are also responsible in contributing the Hardness of the water. The principle anions are Carbonates and Bicarbonates.Measurement of carbonates and bicarbonates below 300mg/L are harmless to fish in the water medium. Higher levels of hardness indicate a serious pollution of that water body system by elements other than calcium and magnesium (Johnson et al., 1985).

Biological Oxygen Demand (BOD) ranged from 1.5–2.4 mg/L. The mean value of Biological oxygen demand was 2.8 and SD value was 1.00 BOD determines the strength of organic waste (sewage, effluents and other pollutants) in water and provides data on the pollution load in all natural waters. Reason of high values of the BOD may be due to agricultural and domestic discharge in the water (Mullar et al., 2012).

Chemical Oxygen Demand (COD) ranged from 21.1 to 22.8 mg/L. The mean value of Chemical Oxygen Demand was 22.08mg/L and SD value was 0.70. The increase in COD is mainly attributed to the increase in the air and water temperatures, facilitating the decomposition and oxidation of organic matter and higher the COD is the Indication of increased organic loads due to increased household wastewater and waste discharges (Mullar et al., 2012).

Chlorides ranged between 21.1–22.8 mg/L. The mean value of Chlorides was 136.48 mg/L and SD value was 5.03. Chlorine in the form of chloride ion (Cl^-) is one of the major anions in water and wastewater. Presence of chloride in water could be due to various sources like, natural weathering of rocks, domestic waste and through artificial or natural chemical reactions. Salty taste of water is produced by Cl^- ions but the chemical composition and the abundance of some cations like Na^+, Ca^{++} and Mg^{++} in water generally govern the taste.

Total Alkalinity (TA) ranged between 131.4-149 mg/L. The mean value of Total Alkalinity was 142.94 mg/L and SD value was 4.59. The higher value is due to the relative amounts of carbonates and bicarbonates.

Phosphates ranged between 2 – 2.4 mg/L. The mean value of Phosphate was 2.22 mg/L and SD value was 0.18. Phosphorus occurs in the natural waters as phosphates and exceeds lake Phosphate standard limit of 30µg/L. These are classified as Orthophosphates, condensed Phosphates and organically bound Phosphates. . They occur in solution, in the piratical detritus, or in the bodies of an aquaticorganism primarily, they arise from a variety of sources such as raw sewages from domestic and industrial effluents; and also from Agrochemicals and fertilizers in the form of run – offs and storm waters (APHA, 2005).

Nitrate Nitrogen ranged between 8.5 – 9.6 mg/L. The mean value of Nitrate nitrogen was 9.06 mg/L and SD value was 0.45. Nitrate nitrogen exceeds lake water standard limit of 1.5 mg/L. Nitrate is the oxidized form of nitrogen and end product of aerobic decomposition of organic nitrogenous matter. The presence of nitrate in fresh water bodies depends mostly upon the activity of nitrifying bacteria, domestic and agricultural source.

Statistical analysis:

The statistical analysis (Table 2)showed pH, moderately correlated with BOD, COD and Chlorides. Negatively moderately correlated with EC, TDS, Total Alkalinity, Phosphates and Nitrates. EC showed Positive strongly correlated with Total Hardness, Phosphates and Total Alkalinity and Negative strongly correlated with Chlorides. TDS showed strongly correlated with Total Hardness, Phosphates and Total Alkalinity and Negative strongly correlated with Chlorides. DO showPositive strongly correlated BOD, COD and Chlorides, Negative strongly with Phosphates and Nitrates. Total hardness showed Positive moderately correlated with Total Alkalinity, Phosphates and

Nitrates. Chloride showed strongly correlated with Total alkalinity. Phosphates showed strongly correlated with Nitrate.

4.0 CONCLUSION

The water quality of BellandurLakehas exaggerated due by the consequent changes and urbanization, which indicated the physico-chemical concentrations of lakes found in high levels. Total Dissolved Solids, Phosphates and Nitrogen have found to be exceeding their limits prescribed by the Bureau of Indian Standards showed the demanding pollution load on the lake. Despite of some conservation efforts made by the authorities this lake is threatening immeasurably. Water treatment is available in Bellandur Lake but inadequate treatment; however full-fledged treatment should be set up. Continuous monitoring of lakes should be enacted properly as from the origin point at the end to overcome these situations. This monitoring also helps in keeping the connectivity of lakes conscious.

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