IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 11, Issue 7 Ver. I (July. 2018), PP 43-47
www.iosrjournals.org

Impact of Urbanization on the Physicochemical Parameters of an Urban Water Body of Bellandur Lake in Bangalore City, Karnataka, India

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***Abstract*:** *Lake Water is a source of drinking and domestic use for rural and urban population of India. The once bountiful Bellandur Lake has gradually transformed into a sewage tank. Bellandur Lake is one of the largest lakes in the Bangalore city. Bellandur Lake flows to Varthur Lake. The physico chemical parameters of Bellandur Lake and Varthur Lake were done in the month of March 2018 to assess the impact of urbanization. Bellandur Lake caught fire in May 2015 and again on February 16, 2018, this made authors curious to study its physicochemical parameters with an objective to assess the quality of water and intended to know the Impact of urbanization on the lake. The various physicochemical parameters of the lake were determined and discussed. The dissolved oxygen of Bellandur Lake water is 4mg/L. The COD of Bellandur Lake was found to be 176mg/L. This indicates that lakes are heavily polluted and they are becoming ecologically inactive.*
Key Words: *COD, DO, Bellandur Lake, physicochemical parameters*

Date of Submission: 25-06-2018 Date of acceptance: 10-07-2018

I. Introduction

Lakes plays a pivotal role in serving the needs of agriculture, irrigation, drinking, domestic uses, industries and other related purposes. Lakes were preserved and maintained to help the man kind at the time of water crisis during long dry periods and draughts. In Bangalore, lakes have played a prominent role serving the needs of agriculture and drinking water. Bellandur Lake is a lake in the suburb of Bellandur in the southeast of the city of Bangalore and is the largest lake in the city. Bellandur lake, which is one of the oldest and largest lakes in Bengaluru, was the lifeline for surrounding 18 villages a few decades ago. Bellandur Lake is part of Varthur Lake series and is one of the highly polluted lakes in Bengaluru now. It has become more or less a sewage tank because of untreated sewage water entering into the lake through various inlets [Fig 1]. Bellandur Lake gets sewage inflow due to two reasons.

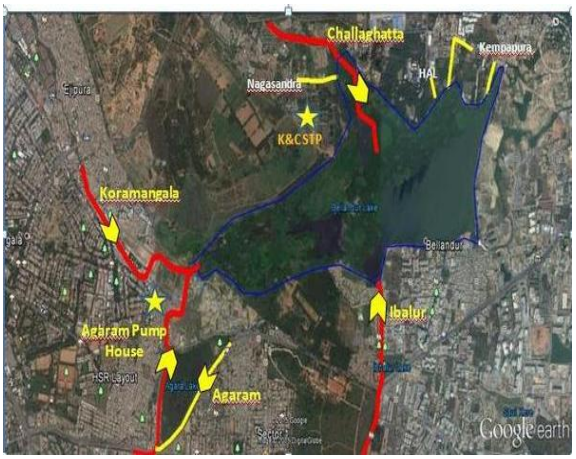
1. Improper sewage system due to which untreated sewage water overflows and joins storm water drains, mixes with rain water, which in turn flows to Bellandur lake via Koramangala and Challaghatta Valley.
2. Lack of effluent treatment plants to treat industrial wastes from small factories which also get into the storm water drains [1].

Water from this lake flows further east to the Varthur Lake. Varthur Lake is situated in the south taluk of Bangalore district. It has a large surface area and is the main irrigation source to the nearby agricultural fields and supports a wide variety of flora and fauna. Due to rapid urbanization the land around the lake is used as a dumping ground by builders and housing societies in the area. Since the early 2000s, nearby areas have been dumping untreated sewage and industrial waste into the lake unchecked. The combination of all these factors has led to a decline in the once robust ecosystem of the lake which now resembles a stinking cesspool. The presence of industrial chemicals in the water causes the lake surface to catch fire regularly and during the rainy season the lakes will be full of foam [Fig.2]. The foam is mainly due to high content of oil and grease substances. This foam forms every year. The stench is so unbearable that residents of buildings near the lake cannot open their windows. Varthur Lake is at the tail end of a network of lakes in the city and sewage that flows into Koramangala or Challaghatta lakes from Puttenahalli in southern Bengaluru and from RT Nagar in north Bengaluru eventually ends up in it. Varthur collects the maximum amount of sewage water, most of it untreated. High levels of Ecoli bacteria found in untreated sewage percolates the groundwater table and causes waterborne diseases [1]. Ramesh N. et.al had done the water quality assessment of Bellandur lake in 2014[2]. A regular monitoring of water quality is required for the determination of extent of pollution in lake. The present

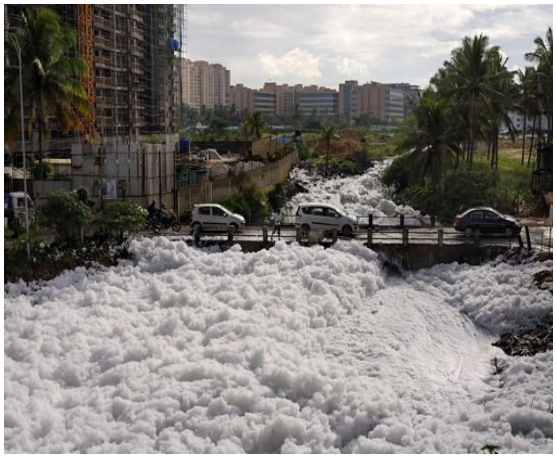
study deals with the present situation and impact of urbanization on the physicochemical parameters of Bellandur Lake. This study is quite significant and will be great help for the lake conservation authorities.

II. Materials And Methods

Water samples for analysis were collected from both Bellandur Lake [inlet Near HAL] in polythene bottles as per standard procedure. The samples were sent for analysis after two days of collection. The analysis was done as per IS3025 standards. The analysed physicochemical parameters and heavy metals were compared with the WHO and ISI Standards.

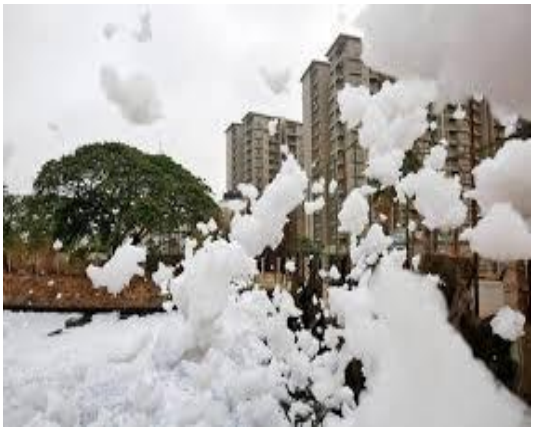


Sewage entering point into lake



During rainy season Bellandur lake filled with foam

Bellandur lake fire



Bellandur lake with foam

Fig.2 Status of Bellandur Lake (source: Facebook)

III. Results And Discussion

The data of physicochemical parameters and heavy metals are tabulated in the Table 1. The temperature of water was 25^0c at the time of analysis. Temperature plays a very important role because it affects the conductivity, solubility of minerals and biochemical reactions in the water. Colour is caused by dissolved organic matter, which originates from soils and decaying vegetations in catchment area. The colour of drinking water should be in 5Hazen units but Bellandur lake water was 50 Hazen units, thus this water is not fit for consumption.

pH: is a measure of acidity of the water. pH of water plays very important role, if the pH is beyond 6.5-8.5 range the water will affect the mucus membrane and water supply system[3].
The pH of Bellandur water is 7.33 [Table 1] which is within the permissible level. The ideal pH of potable water according to WHO is 7 to 8 and by ISI 6.5-8.5.

Alkalinity: is the capacity of water to neutralize an acid. Alkalinity is due to the presence of hydroxide, carbonates and bicarbonate in the water. The alkalinity of Belandur Lake was found to be 440mg/l. Because of

the highly alkaline nature, the taste of the water becomes unpleasant thus is undesirable for domestic as well as household uses. The alkalinity exceeds the permissible level as set by WHO and ISI standards [Table1].

Electrical conductivity [EC]: EC indicates the current carrying capacity of water. EC of water depends on the concentration of dissolved salts present. It depends on the concentration, temperature and mobility of ions. This serves as a tool to assess the water quality. The EC of lake water was found to be 1406µS/cm which exceeds the permissible range [Table1]. Water with such a high increase in conductivity value is not suitable for irrigation and also for human consumption.

Total Dissolved Salts[TDS]: TDS comprising of inorganic salts such as calcium, magnesium, potassium, sodium, bicarbonates, chlorides, sulfates and some small amounts of organic matter that are dissolved in water. Some of the salts are essential for life but harmful when taken more than the desired level. TDS present in water are one of the leading causes of turbidity and sediments in drinking water. When left unfiltered TDS can be the cause of many diseases. TDS in drinking water comes from natural water sources, sewage, urban run-off, industrial wastewater and chemicals used in water treatment process, and the hardware or piping used to distribute water. The TDS was found to be 910mg/L[Table 1.] which is within the permissible level of WHO but high according to ISI standards. Beyond 500mg/L of TDS, the palatability of water decreases and may cause gastrointestinal irritation [3].

Total Hardness: Total hardness is sum of temporary hardness and permanent hardness. Water Hardness is a measure of the capacity of water to precipitate soap. The two most common elements contribute to hardness are Ca and Mg. Total hardness is particularly important when spawning fish and raising fry because calcium is critical to egg, bone and tissue development. The total hardness was found to be 240mg/L which is in the permissible level as set by ISI but exceeds the permissible level according to WHO [Table 1].when hardness exceeds the permissible limit it leads to encrustation in water supply structure and adverse effects on domestic use [3].

Calcium and Magnesium: Calcium is most abundant ions in fresh water and is important in shell construction, bone building and plant precipitation of lime. Magnesium is often associated with calcium in all kinds of waters, but its concentration remains generally lower than the calcium. Magnesium is essential for chlorophyll growth and acts as a limiting factor for the growth of phytoplankton [4]. The amount of calcium and magnesium was found to be 60mg/L and 21.8mg/L respectively which are within the permissible level.

Dissolved oxygen (DO): It is the amount of oxygen dissolved in the water. Oxygen enters the water by direct absorption from the atmosphere, by rapid movement, or as a waste product of plant photosynthesis. Water temperature and the volume of moving water can affect the dissolved oxygen level. Adequate dissolved oxygen is important for good water quality and necessary to all forms of life. Dissolved oxygen level that drops below 5.0 mg/L cause stress to aquatic life. Lower concentrations cause greater stress. Oxygen levels that go below 1-2 mg/L for a few hours may result in large fish kills. Dissolved oxygen is a major indicator of water quality. DO indicate the degree of pollution in the water body. The amount of dissolved oxygen in the lake water sample is found to be 4mg/L, is may be due to Decay of organic material in water caused by either chemical processes or microbial action or untreated sewage or dead vegetation.

Biological oxygen demand (BOD): BOD is the amount of dissolved oxygen required by the microorganisms for the oxidation of biologically oxidisable impurities present in water sample. It serves as a sum parameter for the assessment of pollution of sewage. The BOD in the lake water was found to be 36mg/L. The high level of BOD indicates high level contamination of organic matter in the water.

Chemical oxygen demand (COD): It is a measure of water and waste water quality. COD is the amount of oxygen required for the oxidation of organic and inorganic matter present in the water sample. It is a measure of the oxidisable pollutants present in the water sample. The COD for the studied water sample was found to be 176mg/L. The higher value of COD indicates the presence of high level of organic matter.

Chloride: Chloride is one of the most common anions found in surface water and ground water. Chlorides are mainly come from inorganic salts like NaCl, KCl and CaCl2 etc. which are generally provided by soil, natural layers of chloride salts, municipal and industrial sewage and animal wastes [5]. Chloride is not harmful to humans but high concentration of chloride increase the corrosive property of water. Although chlorides are harmless at low levels, water high in sodium chloride can damage plants if used for gardening or irrigation, and give drinking water an unpleasant taste. Over time, sodium chloride's high corrosivity will also damage

plumbing, appliances, and water heaters, causing toxic metals to leach into your water. The studied lake water had 180mg/L Cl^- which is within the desirable level.

Nitrate NO_3^- : Inorganic nitrogen that present in water as Nitrate (NO_3^-) is the main nutrient that accelerates the growth of hydrophytes and algae. Nitrate occurs in water from various natural sources and due to human activities like food production, agriculture and manure disposal of domestic and industrial sewage. In urban areas sewage water rich in nitrates contaminate surface water thus increases the nitrate amount. The Nitrate content in lake water was found to be 10.7mg/L though which is within the desirable limit, excess concentration of nitrates leads to Lake Eutrophication. If the concentration of nitrate exceeds 45mg/L in water it leads to blue baby syndrome.

Phosphate (PO_4^{2-}): Phosphate will stimulate the growth of plankton and aquatic plants which provide food for larger organisms, including zooplankton, fish, humans, and other mammals. But as the concentration of phosphate increases it leads to Lake Eutrophication resulting in reduced stability of ecosystem. The value of Phosphate recorded in the water sample was 3.4mg/L. The increased amount of phosphate in the lake is due to the discharge of municipality sewage and dumping of domestic waste and untreated industrial waste.

Ammoniacal nitrogen: It is a measure for the amount of ammonia, a toxic pollutant present in the waste water. It indicates the quality of water. Ammonia can directly poison humans and upset the equilibrium of water systems. The ammoniacal nitrogen present in the tested sample was found to be 7mg/L, such a high level evidently signifies the contamination of lake water by sewage waste and organic load.

Table 1. Physicochemical parameters of the Bellandur Lake

Parameters	Observed values	WHO Standard	ISI Standard
Temperature ^oC	25^oC	30-32^oC	…
pH	7.33	7.0 – 8.0	6.5 – 8.5
Color (Hazen unit)	50.0		5
odour	Disagreeable	….	…
Conductivity(µS/cm)	1406.0	1400	---
Turbidity (NTU)	58.2	5	5
Total dissolved solids (TDS)(mg/L)	910.0	…	500
Total suspended solids(mg/L)	92.0	…	…
Total Hardness as $CaCO_3$ (mg/L)	240.0	100	300
Calcium as Ca (mg/L)	60.0	75	75
Magnesium as Mg (mg/L)	21.8	150	30
Chloride as Cl^- (mg/L)	180.0		250
Total Alkalinity as $CaCO_3$ (mg/L)	400.0	120	120
Sulphate as SO_4^{2-} (mg/L)	37.2	500	200
Nitrate as NO_3^- (mg/L)	10.7	50	45
Nitrite as NO_2^- (mg/L)	0.2	3	
Iron as Fe (mg/L)	0.4	--	0.3
Fluoride as F^- (mg/L)	1.0	--	1.0
Ammoniacal nitrogen (mg/L)	7.0	---	---
Total Kjeldal Nitrogen (mg/L)	18.2	--	--
COD (mg/L)	176.0	--	--
BOD(3days at 27^oC) (mg/L)	36.0	--	2(CPCB)
Dissolved oxygen (mg/L)	4.0	---	6(CPCB)
Residual free chlorine (mg/L)	<0.1	--	--
Copper as Cu (mg/L)	<0.1	--	0.05
Zinc as Zn (mg/L)	<0.5	3	
Chromium as Cr^{6+} (mg/L)	<0.1	--	0.05
Manganese as Mn (mg/L)	<0.1	--	0.1
Oil and greases (mg/L)	<1	--	--
Total phosphate as PO_4^{2-}(mg/L)	3.4	5	--

IV. Conclusion

The Statistical data obtained from the physicochemical parameter analysis of the Bellandur Lake clearly indicates that most of the important parameters such as conductivity, turbidity, Total dissolved solids, Total alkalinity and BOD exceeds the permissible level as set by the ISI and WHO. This present situation drastically affects the aquatic and terrestrial ecosystem. To sustain the ecology and aquatic life in the lake, CPCB has to take adequate measures by not allowing the untreated sewage waste and industrial effluent in to the Bellandur Lake.

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IOSR Journal of Applied Chemistry (IOSR-JAC) is UGC approved Journal with Sl. No. 4031, Journal no. 44190.

Prathibha B S "Impact of Urbanization on the Physicochemical Parameters of an Urban Water Body of Bellandur Lake in Bangalore City, Karnataka, IndiaElectrode in Aqueous Solution." IOSR Journal of Applied Chemistry (IOSR-JAC) 11.7 (2018): 43-47.