

# Evaluation of Pollutants and Determination of Contaminants in the Bellandur Lake, Bengaluru

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**Abstract:** Environment comprises of living things and non living things such as air, water and land. The destruction of the ecosystem is now a major concern. A steadily increasing population has left India at a critical point and thus the country is facing a massive scarcity in potable water and other necessities. The country has lost about 38% of its wetlands in the past decade. The lakes in the city of Bengaluru were mostly irrigation tanks with high bunds built in the 16th century. Rapid growth of population and urbanization in the city has led to the deterioration of the lakes. Bellandur Lake being a fine example has fallen victim to untreated sewage waste and has been severely neglected in the past years with no systematic environmental study. Hence a study of its characteristics, effects of pollutants and capacity must be undertaken as well as a design plan for restoration is essential.

**Index Terms—** Eutrophication, Bellandur Lake, Physio-Chemical Analysis, Water pollution, Urbanization.

## I. INTRODUCTION

Bengaluru was once known as the ‘City Of Lakes’ with almost 180 lakes. The earliest records indicate that the constructions of artificial catchment areas or tanks were built in the city by the founder ‘Kempegowda’ in the 16th century and the Wodeyars of Mysore. Historically, the several lakes in Bangalore were a result of a genius from our ancestors. Kempegowda started by impounding water catchment areas thus began the journey of Bengaluru which was known as the city of gardens and lakes. For the founder, the monsoon rains became the natural asset in creating the lakes using rain water harvesting. The city having a naturally undulating terrain with its valleys and hills made it easier to develop lakes by storing and capturing rainwater. The valleys with its ridge topography resulted in the birth of several streams. These streams helped form several major watershed system that interconnected several reservoirs that played a major role in recharging the groundwater. The lakes in Bengaluru are scattered and placed in all vantage areas and thus play an important role in recharge of groundwater. The ability of the lakes to trap and store rainwater was enormous. The rainwater that could be harvested through these lakes would partially meet the city's water requirements. A large number of lakes in the vicinity of the city played a vital role in recharging groundwater in its lower command areas and also in the valley portions thus enriching the flora and fauna and forming a green belt around each and every lake. These lakes helped in the prevention of flooding, met the drinking water needs, brought about a positive impact on the cities climatic conditions, replenished the groundwater resources and acted as an efficient ecosystem until they fell prey to the

environmental degradation

### **Causes of pollution:**

The rapid population growth resulted in an increased demand for housing and intensive land use for industries. Due to this quick growth of the city several lakes and irrigation tanks were divested and converted into massive buildings and housing layouts. Illegal violation of the irrigation tanks for development of layouts, factories and industries with a single minded agenda has caused significant damage to the chain of lakes. The inter connectivity which was an integral feature of the watershed systems have been threatened and have lost their characteristics. The invasion of the catchment's area further added to inter connectivity problem. The loss of inter connectivity in the watershed systems resulted in the shrinkage of wetland area and reduction in water holding capacity.

## II. EUTROPHICATION

Eutrophication is derived from the Greek word eutrophos which means ‘well nourished’. Eutrophication or hypertrophication is a process where a body of water undergoes oxygen depletion due to excessive growth of plant and algae. This causes a structural change in the marine ecosystem. Over the centuries this process has been naturally occurring in the lakes, however human activities have accelerated the rate of Eutrophication causing major consequences such as blue green algae and hypoxia.

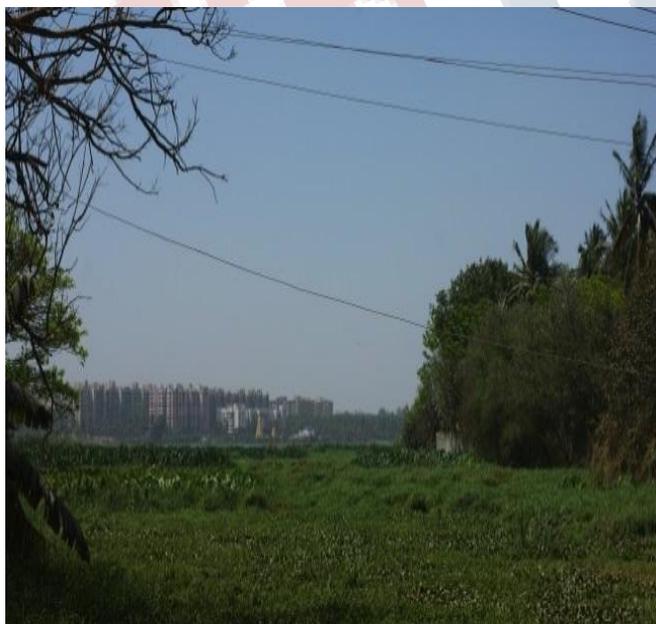
### **Sources of Lake Eutrophication:**

Sewage is the main source causing eutrophication as it contains high levels of nitrogen and phosphate pollutants.

Agriculture is the main contributor, as up to half of nitrogen in the sewage water is from fertilizers. The phosphorous found in the sewage is due to human and animal excretion. The urban runoff carries detergents that also accelerates eutrophication and cause the death of Lake Biodiversity

***Effect of Eutrophication:***

The most crucial effect of eutrophication is the formation of dense blooms of algae which causes reduction in water clarity and harms the water quality due to limited light penetration. This causes accelerated rates of photosynthesis which causes elevated pH values which blinds the marine life. The dense algae blooms eventually die and under decomposition which severely decreases the dissolved oxygen thus creating the dead zones that lack sufficient oxygen to support organisms. The abundance of organic substances gives the water disagreeable odours or taste and prevents the natural purification process. The toxic algae will also cause in the dead of animal and may pose a threat to humans. Due to the high concentration of the organisms there is a high degree of competition which causes physical stress and struggle for survival in eutrophic system. Increases nutrients levels may also stimulate other forms of macrophyte growth in addition to algae and cyanobacteria. From a purely aesthetic point of view excessive growth of macroscopic plants reduces the value of water body as a recreational resource.



***Fig1: Eutrophication of the Bellandur Lake***

**III. MATERIALS AND METHODS**

***Study Area:***

The test was conducted for a heavily polluted lake known as Bellandur Lake in the South East Taluk of Bengaluru. The lake is located at 12°45'0"N and 77 ° 40'0"E with an annual rainfall of 32 inches in the catchment area of the lake is said to be 110.94sqmiles. The water quality of Bellandur wet lands due to unplanned urbanization is the serious threat to the public health.

***Water and sediment sampling:***

Samples of sediment and water from the lake as well as surrounding area were collected by following the standard sampling protocol. The samples were collected in clean and sterilized plastic bottles of 2ltr capacity. The samples to be examined for water quality were collected in the month of March in the year 2018. The samples from the lake were collected 30cm below the water and the 30 number of fresh ground water sample were collected from the surrounding area ().These samples were brought to the laboratory and tested for physical and chemical parameters such as Ph, acidity, alkalinity, chlorides, turbidity, dissolved oxygen, BOD, COD, phosphates and nitrates. Approximately 1kg of sediments was collected at the depth of 0 to 20cm from each of the location. The above collected samples were all analysed by following the standard protocol of APHA (2005).

**IV. RESULT AND DISCUSSION**

Water pollution is one of the most paramount concerns all over the world. The lake has a huge impact on the health of people, plants and animals as well as on recharging ground water. The largest water body in the city is a cause of huge concern due to the formation of foam. The improper functioning of the sewage treatment plants and 40% of untreated sewage water largely contributes to Bellandur lake pollution. The increased urbanization and more apartments in the city is also one of the major causes of pollution. The pollution of the lake as also caused pollution of ground water table in the surrounding areas.

Temperature of the lake water is important as it effects biochemical reactions in aquatic organisms and a rise in temperature leads to the acceleration of chemical reactions in water, reduces the solubility of gases. Temperature of water was found in the range of 27.8 to 29.5 0C, the color of the

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lake water is also Greyish black to Dark blue due to the green algal population.. In the present study the turbidity found in the range between 14 to 30.9 NTU thus exceeding the permissible limit of 5 NTU. The value of Electrical Conductivity was found in the range 1120 to 1220 $\mu$ s/cm above the maximum permissible limit of 500 $\mu$ s/cm, in drinking waters as recommended by WHO. Total Dissolved solids (TDS) develop a particular taste to the water and at higher concentration reduce its potability. High TDS levels also indicate hard water, which can cause scaling in pipes, valves and filters. During the present study the value of TDS was found in the range 594 to 827mg/l which is permissible limit as per BIS standard but above the desirable limit. In this study pH values were found in the range of 7.01 to 8.09 in the water samples which is permissible limit as per BIS standard. The total hardness found at all the locations was within the desirable limit as per BIS standard except sampling point 3.

Calcium hardness and Magnesium hardness found within the desirable limit as per BIS standard except for a few sample points. The Alkalinity exceeds the desirable limit which leads to unpleasant taste. Sulphate concentration ranges from 32.0 mg/l to 63.2 mg/l, at all the sampling points is within the required limit as per BIS standard. Nitrate concentration depends on the activity of nitrifying bacteria which in turn get influenced by presence of dissolved oxygen and in the present study the values of nitrate exceeds according to the BIS standard. This may be due to decaying macrophytes, the higher phytoplanktonic production and concentration of nutrients which subsequently increases the nitrate concentration. Chloride, Fluoride and Phosphate found to be inside the limit as per BIS standard. Dissolved oxygen found in the range of 1.9mg/l to 4.8 mg/l, this can be attributed to the process of eutrophication. The DO values obtained in the present study are said to be low compared to ICMR standards. Biochemical oxygen demand (BOD) found in the range of 26.4 mg/l to 86.9 mg/l, the BOD values obtained in the present study are higher than the ICMR standards of 5.0mg/l. Chemical oxygen demand (COD) value found in the range of 73.92mg/l to 241.58mg/l. COD is a reliable parameter for judging the extent of pollution in water. Accumulation of heavy metals in sediment and macrophyte samples of the lake was investigated to reveal high heavy metal concentrations in the sediment samples collected at inlet regions and shoreline. All the metals exceeded the standard values of metals in sediment.



**Fig2: Satellite view of the lake and its surroundings**



**Fig3: Outlets of Bellandur Lake.**

**Table 1: Physical and Chemical analysis of the lake water**

Sampling points Parameters	1	2	3	4	5	6	7	8	9	10	11	12
Temperature, °C	28	27.8	28.4	28	28.4	28.1	28.3	28.6	28.1	29.3	29.5	29.4
Colour (Visible)	Greaysh black										Dark blue	
Turbidity, NTU	16.5	18.3	26.8	20.1	21.2	19.7	23.4	30.9	25.6	16.2	15.1	14.0
EC, $\mu$ s/cm	1128	1150	1190	1170	1190	1120	1220	1200	1190	1220	1180	1170
TDS, mg/l	617	746	594	641	723	827	735	722	789	735	607	732
pH	7.34	7.35	8.09	7.40	7.42	7.30	7.46	7.12	7.26	7.78	7.16	7.01
Total Hardness, mg/l	280.2	240.1	320.4	284.6	244.3	248.5	284.6	292.2	200.7	300.9	276.2	288.4
Calcium, mg/l	56.4	64.1	67.3	72.5	64.1	67.3	64.1	80.7	72.6	76.9	56.6	73.8
Magnesium, mg/l	34.0	18.4	39.8	24.3	19.4	20.5	29.1	22.3	14.8	30.1	14.8	25.6
Alkalinity, mg/l	550.1	450.3	600.0	550.4	500.0	600.7	610.1	560.8	550.0	550.5	480.0	510.2
Sulphate, mg/l	51.3	54.4	56.4	50.9	39.2	32.0	50.3	41.7	63.2	42.5	56.1	51.2
Nitrate, mg/l	14.6	70.5	50.0	15.4	49.8	12.1	27.9	85.4	24.1	21.3	36.7	79.2
Chloride, mg/l	213.9	160.3	199.5	231.6	163.9	178.2	217.4	201.4	194.5	196.0	181.7	142.5
Phosphate, mg/l	9.2	1.5	1.49	2.48	2.35	3.05	1.56	2.76	3.14	3.12	2.59	6.08
Fluoride, mg/l	1.3	1.4	1.2	1.1	1.5	1.2	1.8	1.2	1.4	1.3	1.4	1.6
DO, mg/l	4.8	4.6	2.5	3.5	3.2	1.9	2.8	2.4	2.4	2.8	2.5	2.7
BOD, mg/l	26.4	28.6	72.3	31.5	86.9	64.6	62.0	70.5	69.7	41.8	39.4	55.0
COD, mg/l	73.92	80.05	206.5	87.57	241.58	187.34	155.5	186.82	201.43	121.22	101.41	156.75

### CONCLUSION

Most of the fresh water bodies are getting polluted due to urbanization and industrialization causing a scare city of water. Lack of treatment of sewage water before dumping into the rivers and lakes as caused a major drawback in the ecosystem. Lakes being an important feature of earth's landscape are not only the source of precious water, but also a home to large populace of plants and animals, moderate hydrological cycle, influences micro climate and enhances the aesthetic duty of landscape. The Bengaluru metropolitan city must realize there states and improve their perspectives on pollution by carrying out a set of systematic environmental study on the lake and also issue a restoration and management program on the lake. The water quality of the lake deteriorated extensively due to urbanization which was indicated by the high levels of physio-chemical concentration of the lake The total dissolved solids, phosphates, nitrogen, turbidity, hardness and nitrate concentration exceed the desirable limit as per bureau of India standards BOD and COD values were found to be higher in the lake water sample. The increased levels of various heavy metal concentrations in the sediments necessitates immediate and appropriate measures to reduce the disposal of pollutants into the Bellandur wet lands. These measures may also include treatment of industrial and Municipal waste water with a full-fledged treatment set up. Continuous monitoring of the lake should also be carried out preferable using bio indicators.

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