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Comparative Water Quality Assessment of Bellandur Lake, Bangalore City, Karnataka Year 2013 and 2017

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Abstract: **The lakes and reservoirs, all over India without exception, are in environmental degradation, might be due to encroachments, eutrophication (from domestic and industrial effluents) and silt. There has been a quantum jump in population during the last century without corresponding expansion of civic facilities resulting in lakes and reservoirs, especially the urban ones, becoming sinks for contaminants. The large density of human population in metropolitan cities like Bangalore, affects the environmental conditions of the city. The wetlands in Bangalore city are now dying, the effect of urbanization has taken some heavy toll on the lakes of Bangalore. and as result, in the heart of the city only 17 good lakes exist as against of 51 healthy lakes in 1985. The remaining lakes of the Bangalore city are facing extinction due to pollution. One such highly polluted lake is 'Bellandur Lake'. It is located at latitude of 12°58' N and longitude of 77°35' E at an elevation of 921 m above the sea level. about 20 km towards the south-east of Bangalore city. A comparative study/work carried out between two years (2013 and 2017) analyzed data with reference to water quality status of Bellandur Lake as per recent years' research papers and analyzed data to generate sufficient comparison. The result showed that the Lake is Polluted and as per CPCB water Quality classification Bellandur Lake comes in class E category and water used for Irrigation, Industrial cooling and Controlled Waste disposal.**

Keywords: **Bellandur Lake, Water Quality, Physico-chemical Parameters, Comparison of Lakes.**

I. INTRODUCTION

Bangalore district is situated in the heart of the South- Deccan plateau of peninsular India to the South-Eastern corner of Karnataka State of India. between the latitudinal parallels of 12°39'N and 13°18'N and longitudinal meridians of 77°22'E and 77°52'E at an average elevation of about 920 m covering an area of land about 2,174 km2 (Bangalore rural and urban districts) (Ravikumar, et al., 2013). Its population is over 13 million and making it a megacity and the third most popular city and fifth populous urban in India. According to recent survey, conducted by the global HR consultancy Mercer, Bangalore was voted the most livable city in India, beating Mumbai, Chennai, New Delhi and Kolkata. In terms of cleanliness, Bangalore ranks 12th in India.

In the 16th century, Kempe Gowda, constructed many lakes meet the town's water requirements, there is no perennial source of water supply to Bangalore city. In the half of 20th century, the Nandi Hills water works was commissioned by Sir Mirza Ismail (Diwan of Mysore, 1926–41 to provide a water supply to the city). Currently, the River Kaveri provides around 80% of the total water supply to the city with the remaining 20% being obtained from the Thippagondanahalli and Hesaraghatta reservoirs of the Arkavathi River. Bangalore receives 800 million liters of water a day, more than any other Indian city. (Rajshekhar Rao, et al., 2009, Chandrashekar, et al., 2012, and Fathima and Rajesh Gopinath 2012).

Climate of Bangalore varies, Winter temperature is 12 °C and summer temperature exceed 34–35 °C. Bangalore receives rainfall from both the northeast and the southwest monsoons and the wettest months are August, September and October. The mean value of rainfall is about 973 mm (Ramesh and Krishnaiah, 2013).

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A. LAKES OF BANGALORE

Lakes in Bangalore are numerous, and there are no rivers close by. Most of the lakes in the Bangalore were constructed in sixteenth century by building the natural dam valley systems by constructing bunds (Figure1). They met the drinking water, irrigation and fishing of the community and have a positive impact on the ecology and microclimate of the city. These water bodies help in replenishing the groundwater resources in the vicinity and prevented flooding, treated wastewater, arrested sediment loads and functioned as a productive ecosystem. (Ramachandra, et al., 2016). The wetlands in the city are now dying slowly by rapid growth and urbanization resulting in encroachment and discharge of sewage and industrial effluents. The effect of urbanization has taken some heavy toll on the lakes of Bangalore. The lakes in the city have been largely encroached for urban infrastructure and as result, in the heart of the city only 17 lakes remain as against of 51 healthy lakes in 1985 (Bhateria Rachna and Disha Jain., 2016) Urban development has caused 19 lakes getting converted to bus stands, Golf courses, playgrounds and residential colonies, and few tanks were breached under the malaria eradication programme.

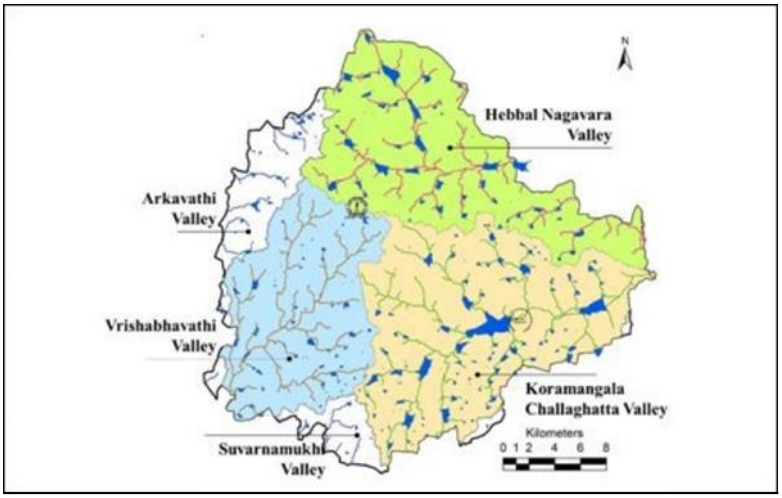

Figure 1. Drainage Pattern of Bangalore

As per recent study on lakes titled ' Wetlands: Treasures of Bangalore (Abused, Polluted, Encroached and Vanishing) ' by Ramachandra T V and others in 2016 a survey of 105 lakes in the Bangalore city. It found that only four seemed to be in a good condition while 25 lakes were in a very bad state fully covered with macrophytes or dumped with solid or liquid wastes and with little or no water. The physical and chemical characteristics of 80 lakes from different 3 valleys such as Vrushabahavthi, Koramanagala-Challaghatta and Hebbal were monitored during all seasons for a period of 2 years.

The study could find that:

- 98% of the lakes were encroached.
- 90% of the lakes converted as sewage due to flow of untreated sewage, industrial effluents, and dumping of solid wastes and building wastes.
- Water quality analysis of 80 lakes, showed that about half of the lakes were highly polluted.
- There was no lake water fit for drinking. according to the standards of Central Pollution Control Board (CPCB).
- 79% of lakes was under Class E category classified by CPCB; suitable for irrigation, industrial cooling or controlled waste disposal.
- 29% of lakes classified under Class E and D suitable for fish culture and wildlife propagation.
- Only one lake Mylasandra 1 and 2, fell under Class A suitable for drinking purposes according to the CPCB classification.
- Competitively The lakes in the Koramanagala-Challaghatta valleys were more polluted than those in the Hebbal and Vrushabahavthi valley.
- Fish deaths were reported in Sankey, Lalbaugh, Jakkur and Munnekolala lakes.

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- Foam formation was seen in lakes in Rampura, Bellandur, Sarakki and Varthur.
- Fire was reported in Bellandur lake.

The report depicts the main reasons for this situation in lakes are: sense of belonging among all the stakeholders, sincerity and poor decision making, Governance and poor implementation of regulatory norms, Coordination between the many para state agencies who were custodians of the lakes leading to their poor maintenance (Ramachandra T V et al., 2016).

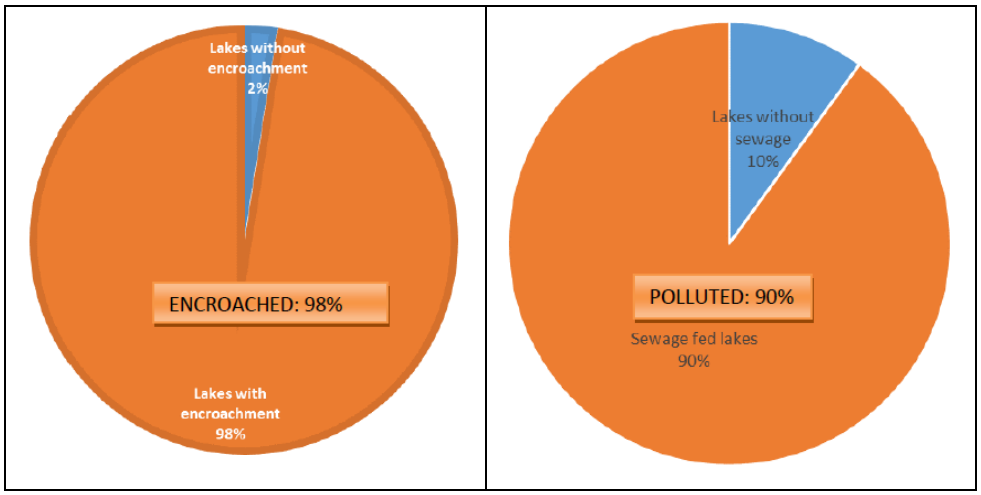

Figure 2. Encroached and Polluted Lakes in Bangalore

Source: ENVIS Technical Report (2016)

II. STUDY AREA

A. BELLANDUR LAKE

The lakes of the Bangalore city are facing extinction due to pollution. One such highly polluted lake is 'Bellandur Lake'. It is located at latitude of 12°58' N and longitude of 77°35' E at an elevation of 921 m above the sea level. About 20 km towards the south-east of Bangalore city. has a catchment area of 287.33 km2. One of the largest Lake in Bangalore city. being 3 km in length and 2.75 km in width (Pattusamy V et al., 2013).

The lake catchment has been subjected to extreme environmental stress mainly due to lush unplanned developmental activities in the catchment in recent years. The development plans of the region ignore the integrated planning approaches considering all the components of the ecosystem. This lake is scattered throughout the region (Parvathi K S et al.2018). The Bellandur lake spreads across six villages.

TABLE 1. Bellandur lake, break up and extent in each village

Taluk	Hobli	Villages	Survey number	Area	
				Acre	Gunta
Bangalore East	Varthur	Ammanikere Bellandur Khane	1	284	2
Bangalore South	Begur	Ibbaluru	12	399	14
Bangalore South	Begur	Agara	43 (A)	166	15
Bangalore East	Varthur	Kempapura	6	13	15
Bangalore East	Varthur	Belur	2	40	15
Bangalore East	Varthur	Yamalur	62	3	4
			Total Area	906	25
As per the RTC, WWW.bhoomi-karnataka.gov.in					
Spatial analysis using remote sensing data with geo-informatics (367.34 hectares)				907	28.4

Source: (Ramachandra T V et al. 2017, ENVIS technical report)

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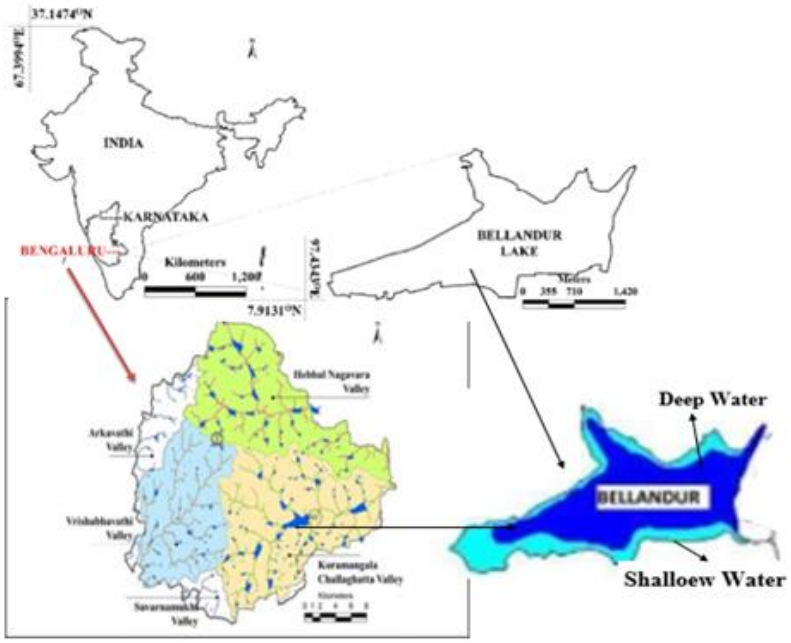

III. METHODOLOGY

One of the major metropolitan city of India (Bangalore) selected for the study, An attempt has been made to study the present status of surface water resources mainly the Lakes in the city by using secondary data which are already exist in research papers, Journals, reports and other internet resources and open websites. The selected Lake was Bellandur Lake (one of the largest Lake in Bangalore city, Karnataka). A comparative study/work carried out between two years 2013 and 2017 analyzed data with reference to water quality status as per recent years' research papers and analyzed data to generate sufficient comparison.

IV. RESULT AND CONCLUSION

As per study of Ramesh. and Krishnaiah, 2014, the assessment of Physico-Chemical parameters of Bellandur Lake, Bangalore. The samples were collected during March, 2013 and the study carried out by the Parvathi et al., 2018, samples collected from different point of Bellandur Lake during February, March and April 2017. The samples were brought to the laboratory to analyzed for the parameters like: Temperature, Turbidity, Electrical Conductivity, Total Dissolved Solids, pH, Total Hardness, Calcium, Magnesium, Alkalinity, Sulphate, Nitrate, Chloride, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The analyzed data has shown in the Table 2 below.

TABLE 2. Values of physico-chemical parameters of Bellandur Lake 2013 and 2017 along BIS Standards.

S. No	Parameters	Bellandur Lake 2013			Bellandur Lake 2017			BIS limits (1998)	
		S1	S2	S3	S 1	S2	S3	Desirable	Permissible
1	Temperature C°	28	27.8	28.4	28.11	29.8	26.2	NA	NA
2	Turbidity NTU	16.5	18.3	26.8	16	18.43	19.2	5	10
3	Electrical Conductivity µmohs/cm	1128	1150	1190	1196.6	1158	1062	2,000	3,000
4	TDS mg/L	617	746	594	776.62	751.94	689.61	1,000	2,000
5	pH	7.34	7.35	8.09	7.29	7.63	7.2	6.5-8.5	6.5-8.5
6	Total Hardness mg/L	280.2	240.1	320.4	269.68	288.4	336	300	600
7	Calcium mg/L	56.4	64.1	67.3	76	92	140	75	200
8	Magnesium mg/L	34.0	18.4	39.8	193.68	196.4	196	30	100
9	Sulphates mg/L	51.3	54.4	56.4	47.36	50.83	46.814	200	400

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10	Nitrates mg/L	14.6	70.5	50.0	47.767	49.767	47.27	45	45
11	Chlorides mg/L	213.9	160.3	199.5	190.27	188.8	178.26	250	1,000
12	Alkalinity	550.1	450.3	600.0	541.9	562.77	577.30	200	600
13	DO mg/L	4.8	4.6	2.5	2.4	2.85	2.76	6.0	NA
14	BOD mg/L	26.4	28.6	72.3	56.4	51.72	54.82	3.0	6.0
15	COD mg/L	73.92	80.05	106.5	153.85	146.16	149.26	NA	NA

Sources:(Ramesh and Krishnaiah, 2014 and Parvathi, et al., 2018)

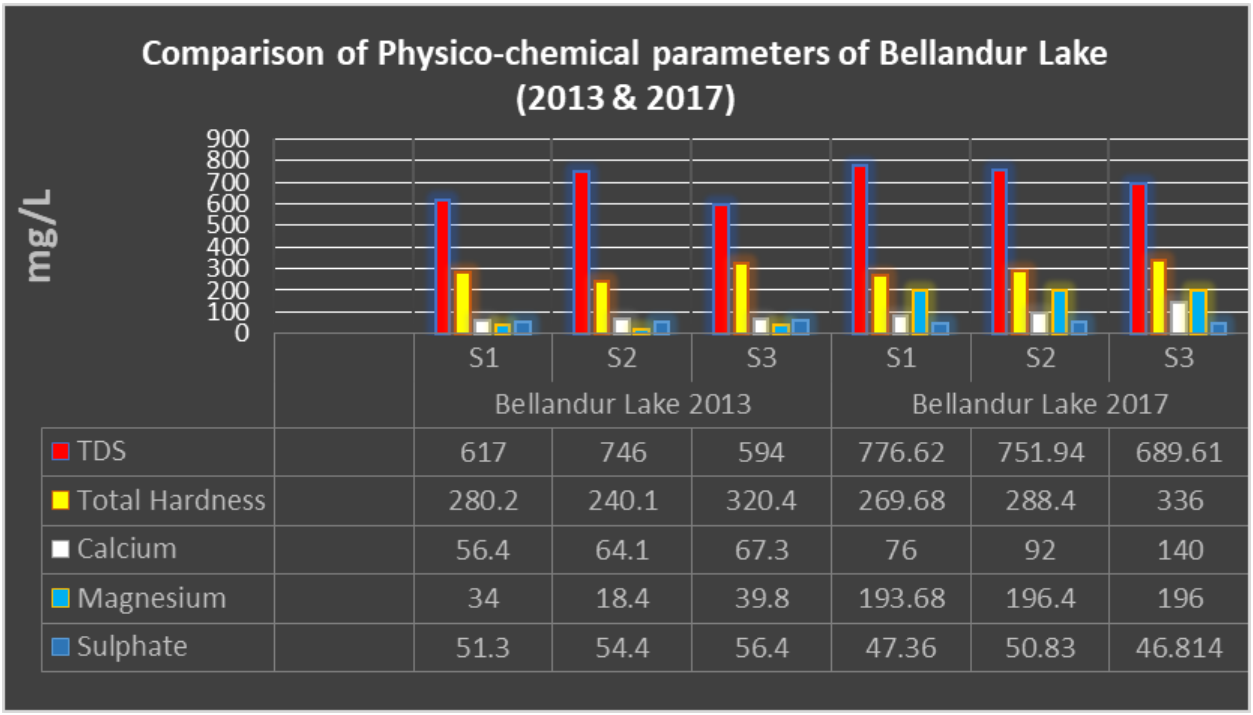

Figure 4: Graphical representation of physico-chemical parameters of Bellandur Lake.

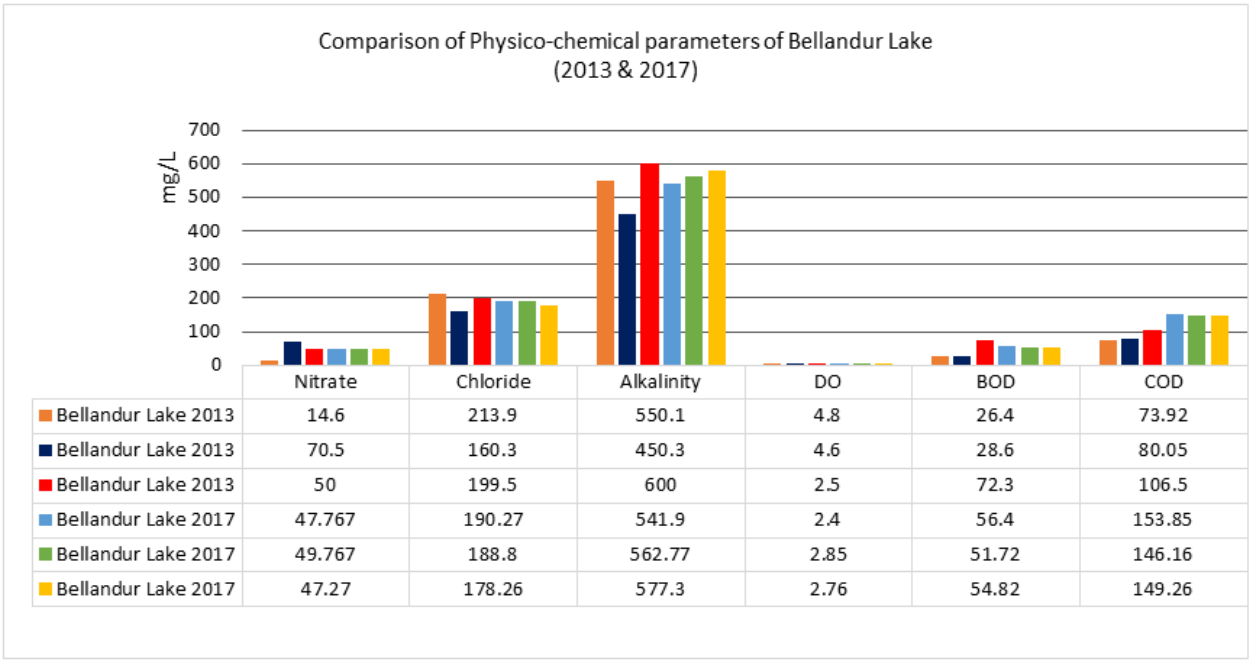

Figure 5: Graphical representation of physico-chemical parameters of Bellandur Lake

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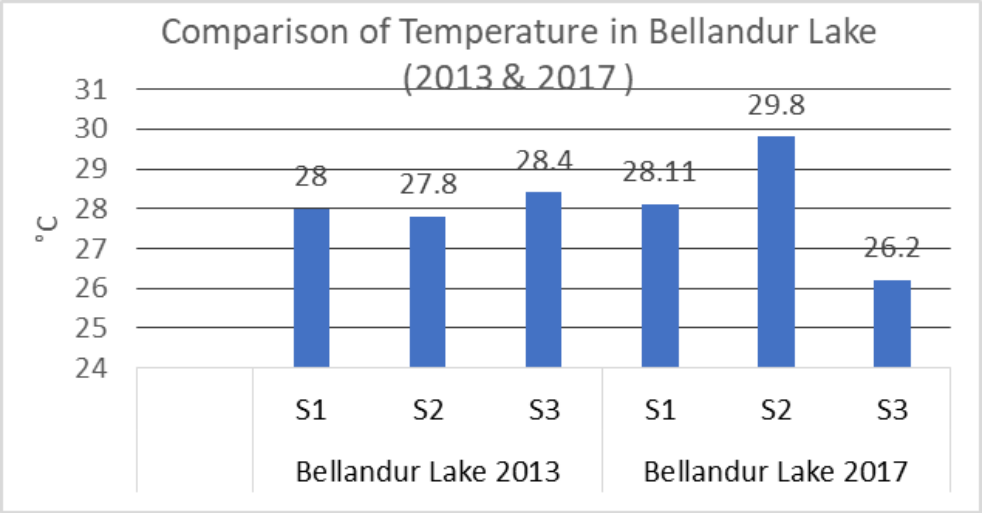

Figure 6: Graphical representation of Temperature in Bellandur Lake.

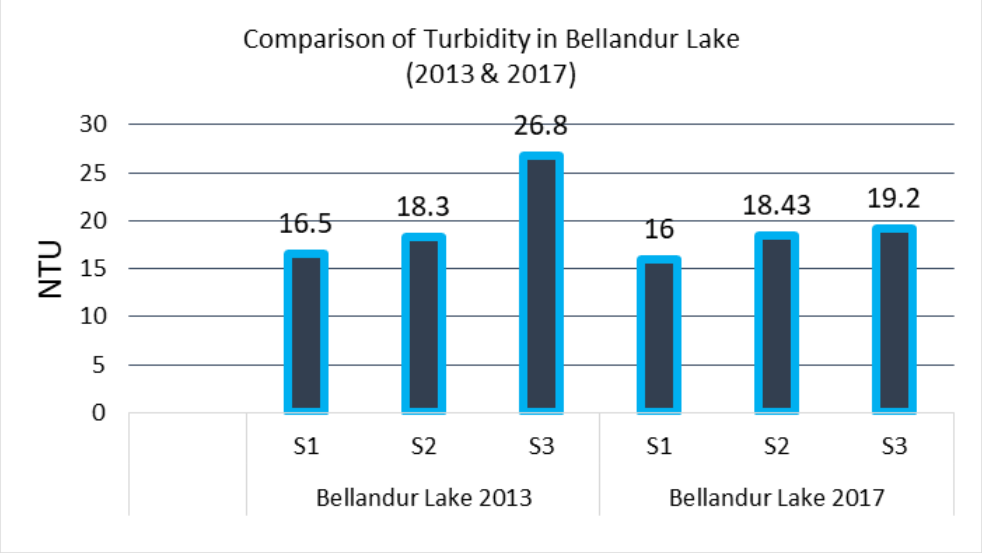

Figure 7: Graphical representation of Turbidity in Bellandur Lake.

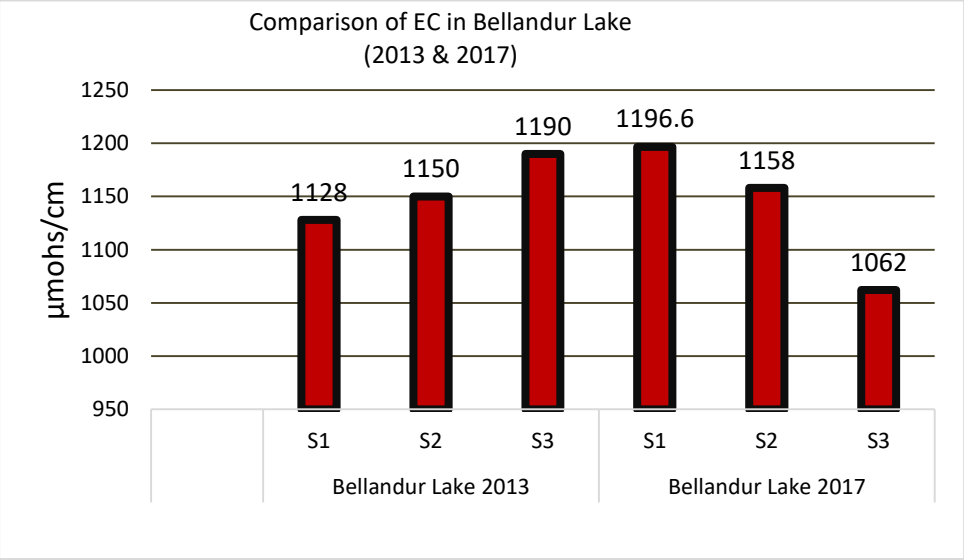

Figure 8. Graphical representation of EC in Bellandur Lake

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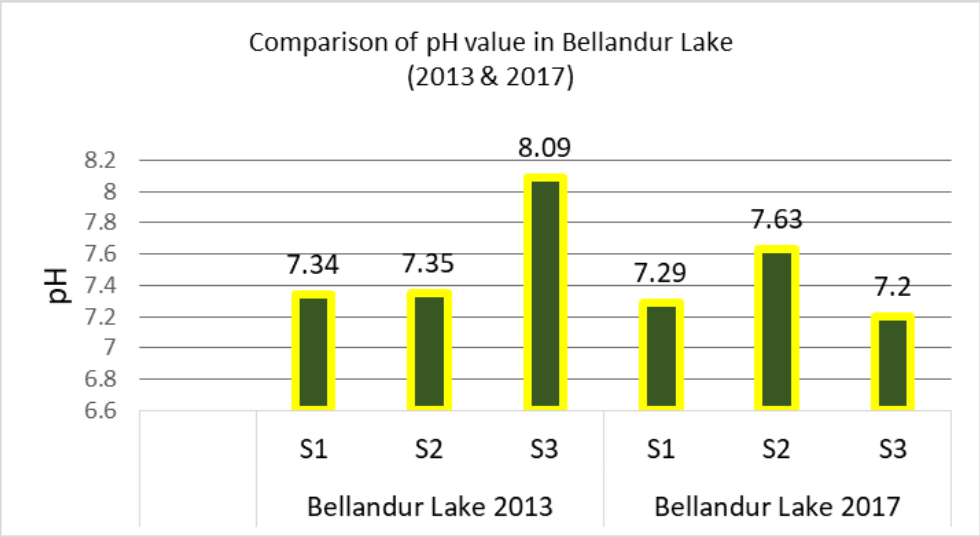

Figure 9: Graphical representation of pH in Bellandur Lake

TABLE 3. RESULTS

Bellandur Lake 2013	**Bellandur Lake 2017**
Result ❖ The pH ranged from 7.34 – 8.09, of water samples which is exceeded to permissible limit. The three main processes affecting Lake pH are photosynthesis, respiration and nitrogen assimilation. ❖ Electrical conductivity (EC) ranged between 1128-1190 µmohs/cm, which was within the desirable limit of BIS. ❖ Total Dissolved Solids (TDS) ranged between 594-746 mg/L, which was within the desirable limit of BIS. ❖ Dissolved Oxygen (DO) was below the desirable limit of BIS. It was in the range of 2.5-4.8 mg/L. ❖ Biological Oxygen Demand (BOD) ranged from 26.4 –72.3 mg/L. which is above the permissible limit of BIS. ❖ Chemical Oxygen Demand (COD) ranged from 73.92 – 106.5 mg/L which shows high value and cross the permissible limit of BIS. ❖ Total hardness (TH) ranged from 280.2-320.4 mg/L which is slightly in the higher from desirable limit and it is within the permissible limit of BIS. ❖ Chlorides ranged between 160.3-213.9 mg/L which was within the desirable limit. ❖ Total Alkalinity (TA) ranged between 450.3 –	**Result** ❖ The pH ranged from 7.2 – 7.63, of water samples which is within the prescribed standard limit. ❖ Electrical conductivity (EC) ranged between 1062-1196 µmohs/cm, which was within the desirable limit of BIS. ❖ Total Dissolved Solids (TDS) ranged between 689.61-776.62 mg/L, which was within the desirable limit of BIS. ❖ Dissolved Oxygen (DO) was below the desirable limit of BIS. It was in the range of 2.4-2.85 mg/L. which shows more acidic condition. ❖ Biological Oxygen Demand (BOD) ranged from 51.72-56.4 mg/L. which is above the permissible limit of BIS. ❖ Chemical Oxygen Demand (COD) ranged from 146.16 – 153.85 mg/L which is alarmingly high and cross the permissible limit of BIS. ❖ Total hardness (TH) ranged from 269.69-336 mg/L which is slightly higher from desirable limit and it is within the permissible limit of BIS. ❖ Chlorides ranged between 178.26-190.27 mg/L which was within the desirable limit. ❖ Total Alkalinity (TA) ranged between 542 – 580 mg/L. which was above the desirable limit and within the permissible limit of BIS.

600.0 mg/L. which was above the desirable limit and reached the permissible limit of BIS. ❖ Nitrate (Nitrogen) ranged between 14.6-70.5mg/L. Nitrate (nitrogen) is above the desirable limit. ❖ Sulphates ranged between 51.3 – 56.4 mg/L which is within the desirable limits. ❖ Turbidity is in the range of 16.5- 26.8 NTU which is very high when compared to permissible limits. ❖ Magnesium ranges between 18.4-39.8mg/L which is within the permissible limit of BIS	❖ Nitrate (Nitrogen) ranged between 47.767-49.767 mg/L. Nitrate (nitrogen) slightly exceeds standard limit. ❖ Sulphates ranged between 46.814 – 50.83 mg/L which is within the desirable limits. ❖ Turbidity is in the range of 16- 19.2 NTU which is very high when compared to permissible limits. ❖ Magnesium ranges between 193.68-196.4 mg/L which is above the permissible limit of BIS

V. CONCLUSION

According to the present comparative study/work it is concluded that the some major Physico-chemical parameters such as COD, BOD, Total Dissolved solid (TDS), Electrical Conductivity (EC), Total Hardness (TH), Calcium and Magnesium showed higher value also it considered that the water is more acidic in the year 2017 .The Lake water has Grey black color and highly turbidity, Sulphates and Magnesium level is at higher rate, and presence of sewage in the lake causing reduce Dissolved Oxygen (DO) and increase in Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD. These situations in the lake indicated the pollution condition of Bellandur Lake. As the CPCB in the year 2013 categories this Lake (Bellandur Lake) in E class where the water comes for Irrigation, Industrial cooling and Controlled Waste disposal category. Solving the problem at end point is a temporary measure with more serious repercussions. The solution is to tackle this problem at source points with strict enforcement of environmental laws and regulations.

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