DETERMINATION OF WATER QUALITY INDEX OF AN URBAN WATERBODY OF BELLANDUR LAKE IN BANGALORE CITY, KARNATAKA, INDIA

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ABSTRACT- *The present study was intended to calculate Water Quality Index (WQI) of an urban waterbody of Bellandur Lake in Bangalore city in order to ascertain the quality of water assessed for public consumption, recreation and other purpose. Water quality index (WQI) is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers as it is an important parameter for the assessment and management of surface water. In the study water quality index was determined on the basis of various Physicochemical parameters like Turbidity, Electrical Conductivity, Total Dissolved Solids, pH, Total Hardness, Calcium, Magnesium, Alkalinity, Sulphate, Nitrate, Chloride, Phosphate, Fluoride , Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD). The study reveals that the water quality index was above 100 which indicate the water is completely unfit for human use. Urbanization around this lake is likely to degrade water quality which could be a threat to public health. Immediate restoration management to protect the Bellandur Lake is essential and hence the public health is mandatory for a sustainable development of Bangalore city, Karnataka, India.*

Keywords—lakewater, water quality index, pollution, physicochemical parameters, lake .

I. INTRODUCTION

Water is one of the most important natural resource available to mankind. Knowing the importance of water for sustenance of life, the need for conservation of water bodies especially the fresh water bodies is being realized everywhere in the world [2]. Global fresh water is the most precious human resource frequently earth is called "blue planet" because water covers about 75% of the globe, but most of the water is saline. Less than 5% of water is fresh and much of this water is in the ice caps, glaciers and groundwater. Most of the remainder is in lakes, streams and soil moister [3].The global water scenario is very much alarming. It is predicted that if at all a third world war takes place; the reason for it will be water [4]. The World Health Organisation (2006) reports mentioned that approximately 36% of urban and 65% of rural Indian's were without access to safe drinking water [7]. Fresh Water is essential to existence of life. Water of acceptable quality is essential not only for drinking and domestic purposes but also for agriculture, industrial and commercial uses [5]. The availability of water is an important factor in the establishment of the earliest settled communities and even today, the evolution of public water supply systems is tied directly to the growth of cities and towns. Water is present in abundant quantities on and under the earth surface but less than 1% of it is liquid fresh water. Most of the earth's estimated 1.4 billion cubic kilometer (326 million cubic miles) of water is in the oceans or is frozen in polar ice caps and glaciers. Ocean water contains about 35 g/litre (4.5 ounces per gallon) of dissolved minerals or salts. These make it unfit for drinking and for most industrial or agricultural uses. Although it may not always be available at the times and place it is needed, and it is not uniformly distributed over the earth. In many locations, however, the availability of good quality water is reduced as a result of rapidly increasing urbanization and industrialization with their attendant environmental pollution problems [6]. 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. All life is depend on water and exists in nature in many forms like ocean, river, lake, clouds, rain, snow and fog etc. [1]. Due to growth of Population, advancement in agriculture, urbanization and industrialization has made surface water pollution a great problem and decreased the availability of drinking water. Many parts of the world face such a scarcity of water. Most of wastewaters are dumped straight into rivers, lakes and estuaries without any treatment. Lakes are important feature of the Earth"s landscape which are not only the source of precious water, but provide valuable habitats to plants and animals, moderate hydrological cycles, influence microclimate, enhance the aesthetic beauty of the landscape and extend many recreational opportunities to humankind [8].

For healthy living, potable safe water is absolutely essential. It is a basic need of all human being to get the adequate supply of safe and fresh drinking water. One of the most effective ways to communicate water quality is Water Quality Index (WQI), where the water quality is assessed on the basis of calculated water quality indices. Quality of water is defined in terms of its physical, chemical, and biological parameters. However, the quality is difficult to evaluate from a large number of samples, each containing concentrations for many parameters (Almeida, 2007). Horton (1965) proposed the first WQI, a great deal of consideration has been given to the development of index methods. A water quality index provides a single number that expresses overall water quality at a certain location on several water quality parameters and turns complex water quality data into information that is understandable and useable by the general people. WQI is a mathematical instrument used to transform large quantities of water quality data into a single number. A water quality index is a means to summarize large amounts of water quality data into simple terms (e.g., poor, good etc.) for reporting to management and the public in a consistent manner [17-18]. Water Quality Index (WQI) may be defined as the rating that reflects the composite influence of a number of water quality factors on the overall quality of water. It reduces the large amount of water quality data to a single numerical value. It is one of the most effective ways to communicate information on water quality trends to policy makers, to shape sound public policy and implement the water quality improvement programmes efficiently [19]. A water quality index is a means to summarize large amounts of water quality data into simple terms for reporting to management and the public in a consistent manner. Water quality index (WQI) is a single value indicator to the water quality. It integrates the data pool generated after collecting due weights to the different parameters. The advantages of an index include its ability to represent measurements of a variety of variables in a single number, its ability to combine various measurements in a variety of different measurement units in a single metric and its effectiveness as a communication tool [16]. Water quality index (WQI) is one of the most effective tools (Mishra and Patel 2001; Naik and Purohit 2001; Singh 1992; Tiwari and Mishra 1985) to communicate information on the quality of water to the concerned citizens and policy makers as it is an important parameter for the assessment and management of surface/ground waters [15]. WQI is to give a single value to water quality of a source along with reducing higher number of parameters into a simple expression resulting into easy interpretation of water quality monitoring data [14].

Hence, the present work has been carried out to determination of water Quality Index (WQI) of Bellandur Lake in Bangalore city, Karnataka, India by analyzing physico-chemical parameters.

II. STUDY AREA

Bangalore, the capital of Karnataka, has a history of over 400 years. The origin of Bangalore city can be traced back to 1537 when it was founded by Late Magadi Kempegowda. Bangalore is the principal administrative, cultural, commercial and industrial centre of the state of Karnataka. The city of Bangalore is situated at an altitude of 920 meters above mean sea level. Geographically it is located on 12.95º N latitude and 77.57º E longitude. The city enjoys a pleasant and equable climate throughout the year. Early 90’s boom in the software sector with consequent infrastructure initiatives, has contributed to rise in population, mainly due to migration. Bangalore is known as the Silicon Valley of India because of its position as the nation's leading IT exporter. The population of Bangalore as per the 2001 census was 5,686,844 while it was 163,091 in the beginning of the last century (1901). As per provisional reports of census of India, population of Bangalore in 2011 is 84, 25,970 and is the third densely populated city in India having density of 11,000 per square kilometer [9].

The earliest history of creation of lakes in and around the city is traced to the founders of Bangalore–the Kempe Gowdas –by damming the natural valley systems by constructing bunds. Most of the lakes and tanks were manmade for purposes of drinking water, irrigation and fishing needs and they have also favorably influenced microclimate of the city. The lake waters have also served as “Dhobhi Ghats” or places where washer–men („dhobis‟ is the locale usage in India), have traditionally used them as a means of livelihood for washing clothes and drying them. The lakes have also served to replenish ground water resources in the vicinity, which are tapped through wells for drinking water. The effect of urbanization has taken some heavy toll on the Beautiful lakes in Bangalore [8].

Bellandur Lake, the largest in Bangalore city spreads across an area of 892 acres. It is located at latitude of 12°58′ N and longitude of 77°35′ E at an altitude of 921 m above mean sea level and has a catchment area of 110.94 sq.miles or 287.33 sqm. The water storing capacity of Bellandur lake is 17.66 million cubic feet, being 3km in length and 2.75km in Width. It is one of the largest man-made lakes in Southeast Asia, located about 20 km from the city towards the south-east of Bangalore city which is extremely important ecological zone. It represents what was once a beautiful and wholesome source of water for the city of Bangalore. Storm water used to get stored in the lake, aquatic plants and animals functioned as live treatment plant. Bellandur Lake functioned as the kidney of the city. There was no bioaccumulation of organic waste. The lake was home to a wide variety of fauna and attracted many migratory birds from different parts of the country. The lake also provided drinking water to half the city‟s population, besides being a major fish trading center in the past. Thus Bellandur Lake formed an extremely important ecological zone of the Bangalore city. Bellandur tank is part of the Bellandur drainage system that drains the southern and the Southeastern parts of the city. The tank is a receptor from three chains of tanks. One chain, originates in the north, from Jayamahal, covers the eastern portion and has been referred to as the eastern stream. Another chain originates from the central part of the city, from around the K.R.Market area and covers the central portion and is called the central stream. The other chain, that reaches the tank is through the southwestern region and is called the western stream. Water from this tank flows further east to the Varthur tank, from where it flows down the plateau and eventually into the Pinakani river basin. In 1970s people from as many as 18 villages depended on the waters of Bellandur tank to lead their lives. These included Haralur, Aambalapura, Kudlu, Balagere, Hanathuru, Devara bisanahalli, Kadu bisanahalli, Nagasandra, Kempapura, Belur, Ramagondinahalli, Siddapura, Munne Kolalu, Yemlur, Kariyammana Agrahara, Bhoganahalli and Gunjur. Due to

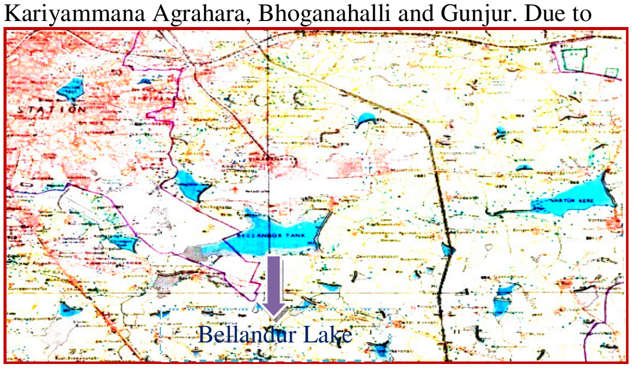

Figure 1. Extract of Topo sheet 57 H/9 showing the Bellandur Lake

urbanization in 1980s, there was breakage of chains of tanks feeding the lake.The breakage in chains, unchecked industrial, residential as well as commercial development, resulted in insufficient rainwater reaching the tank and excess untreated sewerage and effluents laden water flow to the tank. This further led to a decrease in aquatic life, which affected the livelihoods of the fishing community. During the nineties a land near the lake was notified as ring road. This was the period when the city of Bangalore witnessed the growth of Information Technology Industries. Presently a large part of the Bellandur tank is covered by weeds. The colour of the water is dark and opaque in appearance. There is also a foul stench coming from it. There are hardly any birds visible near the tank. At the outlets, downstream of the lake, heavy foaming is visible, indicative of the presence of effluents [8]. Bellandur Lake and its surrounding are shown in Figure 1. (Extract of Topo sheet 57 H/9). Research work has been carried out to determination of water Quality Index (WQI) of Bellandur Lake.

III. MATERIALS AND METHODS

The water samples from the water body were collected from twelve different sites selected which covered the whole area of the lake, the sampling locations are shown in Fig. 2. and analysed for 15 physico-chemical parameters. The parameters Turbidity, Electrical Conductivity, pH, Total Dissolved Solids, Total Hardness, Calcium Hardness, Magnesium Hardness, Alkalinity, Sulphate, Nitrate, Chloride, Phosphate, Fluoride, Dissolved Oxygen and Biological Oxygen Demand were analysed in the laboratory by using standard methods [10].

In the study, for the calculation of water quality Index, fifteen variables were chosen. The WQI has been calculated by using the standards of drinking water quality recommended by the Bureau of Indian Standards (BIS), Central Pollution Control Board (CPCB), World Health Organisation (WHO) and Indian Council for Medical Research (ICMR).

The weighted arithmetic index method (Brown et. al.,) has been used for the calculation of WQI of the water body. Further, quality rating or sub index (q_n) was calculated using the following equations. [14, 17, 18, 19, 20]

$$\mathbf{q_n = 100[(V_n - V_{io}/S_n - V_{io})]}$$

(Let there be **n** water quality parameters and quality rating or subindex (q_n) corresponding to $\mathbf{n^{th}}$ parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value.)

q_n = Quality rating for the **n^{th}** water quality parameter
V_n= Estimated value of the **n^{th}** parameter at a given sampling station.
S_n= Standard permissible value of the **n^{th}** parameter
V_{io}=Ideal value of **n^{th}** parameter in pure water. (i.e., 0 for all other parameters except the pH and Dissolved oxygen (7.0 and 14.6 mg/l respectively).

Unit weight was calculated by a value inversely proportional to recommended standard value **S_n** of the corresponding parameter.
$W_n = K/S_n$

W_n = Unit weight for the **n^{th}** parameters
S_n= Standard value of the **n^{th}** parameters
K = Constant for proportionality

Proportionality constant was calculated by using the equation:

$K= 1/\Sigma\ (1/S_n)$

The overall Water Quality Index was calculated by aggregating the quality rating with the unit weight linearly.

$WQI=\Sigma\ q_nW_n\ /\ \Sigma\ W_n$

TABLE:1 Water Quality Rating as per Weight Arithmetic Water Quality Index Method

WQI Value	Rating of Water Quality	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very Poor water quality	D
Above 100	Unsuitable for drinking purpose	E

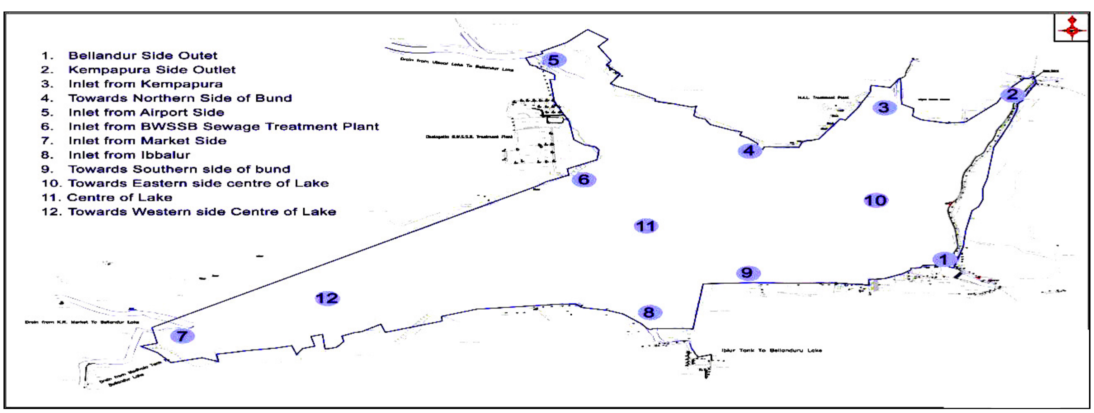

Figure 2. Sampling locations of Bellandur lake

TABLE:2 Drinking Water standards recommending Agencies and unit weights.

Sl.No.	**Parameters**	**Standards** (Sn)	**Recommended agency**	**Unit Weight** (Wn)
1	Turbidity, NTU	5	IS10500	0.0878
2	EC, µs/cm	300	ICMR	0.00146
3	TDS, mg/l	500	IS10500	0.00088
4	pH	6.5 – 8.5	IS10500	0.05164
5	Total Hardness, mg/l	300	IS10500	0.00146
6	Calcium, mg/l	75	IS10500	0.00585
7	Magnesium, mg/l	30	IS10500	0.01463
8	Alkalinity, mg/l	200	IS10500	0.00219

9	Sulphate, mg/l	200	IS10500	0.00219
10	Nitrate, mg/l	45	IS10500	0.00975
11	Chloride, mg/l	250	IS10500	0.00176
12	Phosphate, mg/l	5	WHO	0.0878
13	Fluoride, mg/l	1	IS10500	0.439
14	DO, mg/l	6.00	CPCB	0.0731
15	BOD, mg/l	2.00	CPCB	0.2195
ΣW_n				0.99901

IV. RESULTS AND DISCUSSION

TABLE:3 Physico-chemical characteristics of Bellandur Lake water

Sl. No.	Sampling points/ Parameters	1	2	3	4	5	6	7	8	9	10	11	12
1	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
2	EC, µs/cm	1128	1150	1190	1170	1190	1120	1220	1200	1190	1220	1180	1170
3	TDS, mg/l	617	746	594	641	723	827	735	722	789	735	607	732
4	pH	7.34	7.35	8.09	7.4	7.42	7.3	7.46	7.12	7.26	7.78	7.16	7.01
5	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
6	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
7	Magnesium, mg/l	34	18.4	39.8	24.3	19.4	20.5	29.1	22.3	14.8	30.1	14.8	25.6
8	Alkalinity, mg/l	550.1	450.3	600	550.4	500	600.7	610.1	560.8	550	550.5	480	510.2
9	Sulphate, mg/l	51.3	54.4	56.4	50.9	39.2	32	50.3	41.7	63.2	42.5	56.1	51.2
10	Nitrate, mg/l	14.6	70.5	50	15.4	49.8	12.1	27.9	85.4	24.1	21.3	36.7	79.2
11	Chloride, mg/l	213.9	160.3	199.5	231.6	163.9	178.2	217.4	201.4	194.5	196	181.7	142.5
12	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
13	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
14	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
15	BOD, mg/l	26.4	28.6	72.3	31.5	86.9	64.6	62	70.5	69.7	41.8	39.4	55

TABLE:4 Calculaton of Water Quality Rating (q_n) of Bellandur Lake water

Sl. No.	Sampling points/ Parameters	1	2	3	4	5	6	7	8	9	10	11	12
1	Turbidity, NTU	330.00	366.00	536.00	402.00	424.00	394.00	468.00	618.00	512.00	324.00	302.00	280.00
2	EC, µs/cm	376.00	383.33	396.66	390.00	396.66	373.33	406.66	400.00	396.66	406.66	393.33	390.00
3	TDS, mg/l	123.40	149.20	118.80	128.20	144.60	165.40	147.00	144.40	157.80	147.00	121.40	146.40
4	pH	22.67	23.33	72.67	26.67	28.00	20.00	30.67	8.00	17.33	52.00	10.67	0.67
5	Total Hardness, mg/l	93.40	80.03	106.80	94.87	81.43	82.83	94.86	97.40	66.90	100.30	92.07	96.13
6	Calcium, mg/l	75.20	85.47	89.73	96.67	85.46	89.73	85.46	107.60	96.80	102.53	75.47	98.40
7	Magnesium, mg/l	113.33	61.33	132.67	81.00	64.67	68.33	97.00	74.33	49.33	100.33	49.33	85.33
8	Alkalinity, mg/l	275.05	225.15	300.00	275.20	250.00	300.35	305.05	280.40	275.00	275.25	240.00	255.10
9	Sulphate, mg/l	25.65	27.2	28.2	25.45	19.6	16.00	25.15	20.85	31.6	21.25	28.05	25.60
10	Nitrate, mg/l	32.44	156.67	111.11	34.22	110.67	26.89	62.00	189.78	53.56	47.33	81.56	176.00
11	Chloride, mg/l	85.56	64.12	79.80	92.64	65.56	71.28	86.96	80.56	77.80	78.40	72.68	57.00
12	Phosphate, mg/l	184.00	30.00	29.20	49.60	47.00	61.00	31.20	55.20	62.80	62.40	51.80	121.60
13	Fluoride, mg/l	130.00	140.00	120.00	110.00	150.00	120.00	180.00	120.00	140.00	130.00	140.00	160.00
14	DO, mg/l	113.95	116.27	140.69	129.06	132.56	147.67	137.20	141.86	141.86	137.20	140.69	138.37
15	BOD, mg/l	1320.0	1430.0	3615.0	1575.0	4345.0	3230.0	3100.0	3525.0	3485.0	2090.0	1970.0	2750.0

TABLE:5 Calculaton of Water Quality Index of Bellandur Lake water

Sl. No.	Sampling points/ Parameters	1	2	3	4	5	6	7	8	9	10	11	12
1	Turbidity, NTU	28.97	32.13	47.06	35.30	37.23	34.59	41.09	54.26	44.95	28.45	26.52	24.58
2	EC, µs/cm	0.55	0.56	0.58	0.57	0.58	0.55	0.59	0.58	0.58	0.59	0.57	0.57
3	TDS, mg/l	0.11	0.13	0.10	0.11	0.13	0.15	0.13	0.13	0.14	0.13	0.11	0.13
4	pH	1.17	1.20	3.75	1.38	1.45	1.03	1.58	0.41	0.89	2.69	0.55	0.03
5	Total Hardness, mg/l	0.14	0.12	0.16	0.14	0.12	0.12	0.14	0.14	0.10	0.15	0.13	0.14
6	Calcium, mg/l	0.44	0.50	0.52	0.57	0.50	0.52	0.50	0.63	0.57	0.60	0.44	0.58
7	Magnesium, mg/l	1.66	0.90	1.94	1.19	0.95	1.00	1.42	1.09	0.72	1.47	0.72	1.25
8	Alkalinity, mg/l	0.60	0.49	0.66	0.60	0.55	0.66	0.67	0.61	0.60	0.60	0.53	0.56
9	Sulphate, mg/l	0.06	0.06	0.06	0.06	0.04	0.04	0.06	0.05	0.07	0.05	0.06	0.06
10	Nitrate, mg/l	0.32	1.53	1.08	0.33	1.08	0.26	0.60	1.85	0.52	0.46	0.80	1.72
11	Chloride, mg/l	0.15	0.11	0.14	0.16	0.12	0.13	0.15	0.14	0.14	0.14	0.13	0.10
12	Phosphate, mg/l	16.16	2.63	2.56	4.35	4.13	5.36	2.74	4.85	5.51	5.48	4.55	10.68
13	Fluoride, mg/l	57.07	61.46	52.68	48.29	65.85	52.68	79.02	52.68	61.46	57.07	61.46	70.24
14	DO, mg/l	8.33	8.50	10.28	9.43	9.69	10.79	10.03	10.37	10.37	10.03	10.28	10.11
15	BOD, mg/l	289.74	313.89	793.49	345.71	953.73	708.99	680.45	773.74	764.96	458.76	432.42	603.63
$\Sigma\ q_nW_n$		405.46	424.22	915.08	448.19	1076.12	816.86	819.17	901.53	891.58	566.65	539.26	724.37
$WQI=\Sigma\ q_nW_n\ /\ \Sigma\ W_n$		405.00	424.00	915.00	448.00	1077.00	817.00	819.00	902.00	892.00	567.00	539.00	725.00

Mean Value of $\Sigma\ q_nW_n = 710.71$
$WQI=\Sigma\ q_nW_n / \Sigma\ W_n = 711.41$

The physico-chemical examination of the water samples carried out for the various water quality parameters. The analytical results of the various stations have been shown in table No. 3. In the present study the data revealed that there were considerable variations in the quality with respect to their physicochemical characteristics.

Turbidity is a measurement of the cloudiness of water. Cloudiness is caused by material suspended in water. Clay, silt, organic matter, plankton and other microscopic organisms cause turbidity in natural water. This has been recognized as a valuable limiting factor in the biological productivity of the water bodies. In the present study the turbidity found in the range between 14 to 30.9 NTU. At all the locations exceeds the permissible limit, above 5 NTU consumer acceptance decreases. Electrical Conductivity (EC) - Higher the concentration of acid, base and salts in water, a higher will be the EC, the maximum permissible limit of 300µs/cm, in drinking waters as recommended by ICMR. In this study the value of EC found in the range 1120 to 1220 above the maximum permissible limit. Total dissolved solids (TDS) - It is an important parameter in drinking water quality standard. It develops a particular taste to the water and at higher concentration reduces its potability Water and may cause gastro intestinal irritation with more than 500mg/l. TDS usually have a disagreeably strong taste. High TDS levels generally indicate hard water, which can cause scale buildup in pipes, valves and filters. In the present study the value of TDS found in the range 594 to 827mg/l is above the desirable limit but within the permissible limit as per BIS standard. pH range of 6.5 to 8.5 is normally accepted as suggested by BIS. In this study pH values were found in the range of 7.01to 8.09 in the water samples. At all the locations of sampling points are within the desirable limit. The total hardness found in the range of 200.7 mg/l to 320.4mg/l, except sampling point 3, at all the locations within the desirable limit as per BIS standard. Calcium hardness found in the range of 56.4 mg/l to 80.7 mg/l except sampling point 8 & 10 at all the locations within the desirable limit as per BIS standard and Magnesium hardness found in the range of 14.8 mg/l to 39.8 mg/l except sampling point 1, 3 & 10 at all the locations within the desirable limit as per BIS standard. Hardness exceeds the desirable limit, can cause encrustation in water supply structure and adverse effects on domestic use. Alkalinity found in the range of 450.3 mg/l to 610.1mg/l, at sampling point 6 & 7 exceeds permissible limit and remaining sampling point are between the desirable and permissible limits as per BIS standard .The Alkalinity exceeds the desirable limit, can cause taste become unpleasant. Sulphate found in the range of 32.0 mg/l to 63.2 mg/l, at all the sampling points within the desirable limit as per BIS standard. Nitrate concentration depends on the activity of nitrifying bacteria which in turn get influenced by presence of dissolved oxygen. In the present study the values of nitrate ranged from 12.1to 85.4mg/l, at sampling points 2, 3, 5, 8 & 12 are exceeds the desirable limit as per BIS standard, can cause Methemoglobinemia or blue baby disease. This may be due to the higher phytoplanktonic production, decaying macrophytes and concentration of nutrients owing to the evaporation of lake water with subsequent increase in nitrate value. Chloride found in the range of 142.5 mg/l to 231.6mg/l, at all the sampling points within the desirable limit as per BIS standard. Phosphate found in the range of 1.49 mg/l to 9.2 mg/l. Fluoride found in the range of 1.1 mg/l to 1.8 mg/l, at sampling point 7 & 12 exceeds permissible limit and remaining sampling point are between the desirable and permissible limits as per BIS standard. High fluoride may cause fluorosis. Dissolved oxygen found in the range of 1.9 mg/l to 4.8 mg/l, this can be attributed to addition of effluents containing oxidizable organic matter and consequent biodegradation and decay of vegetation at higher temperature leading to consumption of oxygen from water. Concentration below 5 mg/l may adversely affect the functioning and survival of biological communities and below 2 mg/l may lead to fish mortality. Water without adequate DO may be considered waste water. The DO values obtained in the present study are less compared to CPCB standards. Biochemical oxygen demand (BOD) found in the range of 26.4 mg/l to 86.9 mg/l, is the measurement of the amount of biologically oxidizable organic matter present in the waste. The increased levels of BOD indicated the nature of chemical pollution. The BOD values obtained in the present study are exceeds the CPCB standards 5.0mg/l, leads to decreases the level of dissolved oxygen [1, 5, 11, 12 & 13].

Water quality index of the present waterbody is established from important various physicochemical parameters. Water quality index calculations are depicted in the Table 4 and 5. Since the WQI is a good indicator of pollution. The water quality index at all locations was above 100 and the mean WQI for the waterbody is 711.41, which indicates the water is completely unfit for human use. Urbanization around this lake is likely to degrade water quality which could be a threat to public health. WQI value so assessed clearly indicated the extent of pollution.

V. CONCLUSION

It is concluded from the present study that the turbidity exceeds
the permissible limit as recommended by BIS and Electrical Conductivity exceeds the permissible limit as recommended by ICMR, Total dissolved solids found above the desirable limit but within the permissible limit as per BIS standard, at some samples point Hardness and Nitrate concentration exceeds the desirable limit as per BIS standard, at some samples point Alkalinity and Fluoride exceeds permissible limit as per BIS standard, Dissolved oxygen found less as recommended by CPCB standards and the values of Biochemical oxygen demand found higher, in lake water samples. WQI for the waterbody is 711.41, which indicates the water is completely unfit for human use. Urbanization around this lake is likely to degrade water quality which could be a threat to public health. The study result is expected to provide valuable information in connection with the use of Bellandur Lake water. WQI value so assessed clearly indicated the extent of pollution. Immediate restoration management to protect the Bellandur Lake is essential and hence the public health is mandatory for a sustainable development of Bangalore city, Karnataka, India. Hence application of WQI technique for the overall assessment of water quality of a waterbody is a useful tool.

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