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Water Quality Assessment of Hebbal Lake in Bangalore City

Poojashri R Naik, Sankalpasri S S, Bhavya B S, ReshmaT V

Abstract: ***Bangalore city consists of many artificial lakes which was constructed for domestic water supply, industrial, agricultural and also for recreational purposes. Due to huge population growth, pollution and urbanization the lakes of Bangalore is depleting day by day. Hebbal lake is one among the oldest lake in Bangalore, with its source being rainwater. Hence there is a need to study, restore and protect this lake. The present study deals with studying and analyzing the physico-chemical parameters of Hebbal Lake at its different sampling points. The following parameters were analyzed in laboratory using different analytical methods i.e Temperature, Dissolved oxygen, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Electrical conductivity, Total hardness, Total dissolved solids (TDS), and chloride. All other parameters were well within the permissible limits. The BOD exceeded the maximum limit as per the standards 6mg/lit prescribed by BIS. Water quality index was plotted to know its water quality fluctuations at different sampling points. The obtained results revealed the importance of lake restoration and management of the hebbal lake. It was concluded that the lake water could be used for domestic purpose, irrigation, and also for drinking purpose with proper filtration. This paper presents the qualitative assessment of hebbal lake and its remedial measures for water crisis in Bangalore city.***

Keywords: Bangalore City, Hebbal Lake, Physico-chemical parameters, Water Quality Assessment

I. INTRODUCTION

A lake is an open area filled with water, surrounded by land. Lakes lie on the land which is larger and deeper than ponds. Many lakes in Bangalore is artificial, which was constructed for domestic water supply, industrial and agricultural use and also for recreational purposes. Bangalore region consists of many lakes which was constructed in 16th century by damming the natural valley systems by constructing bunds. The effect of urbanization has taken some heavy toll on the beautiful lakes in Bangalore. Due to urbanization in the city of Bangalore, 19 lakes have been converted into residential colonies, apartments, bus stands, play grounds, golf clubs etc. Historically, lakes in Bangalore region where managed by public works department, but the Hebbal lake was managed by Karnataka state forest department .

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As the management was transferred to lake development authority in 2002. This nonprofit organization started with an aim to manage lakes in Bangalore region..

In the beginning of 1998, A Norwegian environment program started an venture to protect and restore the lake ecosystem by contributing 27 millions.

They desilted the soil from this project and created two artificial islands. These islands became root sites for many water birds. De silting was ostensibly taken up in 2003 as a part of this program.

Fig 1: Hebbal Lake View

At the junction of Bellary and ring road, and at the mouth of NH-7, north of Bangalore Hebbal lake is located. The catchment area of lake is 3750ha and area includes the area of Yeshwanthpur, Mathikere, Rajmahal Vilas extension, Bharat Electronics Limited and Hindustan Machine Tools Limited colonies.

The lake area was depleted from 77.9 ha in 1974 to 57.75 ha in 1998. Based on annual rainfall data, the annual catchment was estimated at 15.2 million cubic meter with 3.04 million cubic meter during the northeast monsoon, 10.12 million cubic meter during southwest monsoon and 3.28 million cubic meter in the dry season.

II. SELECTION OF THE STUDY AREA

Hebbal lake was selected as a study area to analyze and assess its water quality, which is nearly 150 acre in area. It is one of the three lakes created by kempegowda in the year 1537. The hebbal lake receives water from rainfall covering catchment area localities like BEL, HMT colonies, nagavara, narsipura, mathikere, yaswanthpur and other locations.

III. WATER SAMPLES COLLECTION AND STORAGE

The following steps were followed to analyze the water quality of hebbal lake

1. Initially, sample bottles were cleaned using soap solution and then by distilled water for several times until it was free from dust particles and was maintained at room temperature.

2. Sampling record sheets was taken to sampling site to make a note of the sampling date, sample name (code should be given to avoid confusion), an accurate position for the sampling site (map of G.I.S. position), nature of surrounding sampling site, general observations like movement of stray animals, surrounding waste deposition, color of lake etc should be observed.
3. The bottle was held near its base and plunged, with its neck pointed downwards, below the surface.
4. The bottle was turned until the neck points slightly upward and the mouth is directed towards the current. If there was no current, the bottle was moved horizontally in a direction away from hand.
5. Labels was stuck on each bottle which contained sample number, sampling date.
6. Samples was immediately transferred to a laboratory (within an hour of collection) in an ice box.

After transferring sample bottles to laboratory, it was kept in refrigerator. Analyses of samples were carried out in laboratory. pH, turbidity, temperature and DO was tested immediately after collection as they could change during storage and preservation.

Fig. 2: Sample collection at Hebbal lake

Table -I: List of the Physico-chemical parameters of water quality according to BIS Standards

Sl NO	PARAMETERS	DESIRABLE LIMITS	PERMISSIBLE LIMITS	METHODS OF TESTING PARAMETERS
1	pH	6.5-8.5	No relaxation	pH
2	Turbidity (NTU)	1	5	Nephelometer
3	Conductivity (μmho/cm)	-	-	Conductivity meter
4	Total dissolved solids (mg/l)	500	2000	EPA
5	Total hardness ($CaCO_3$) (mg/l)	200	600	EDTA Method
6	Calcium (mg/l)	75	200	EDTA Method
7	Total acidity (mg/l)	30	100	Analytical method
8	Chloride (mg/l)	250	1000	Analytical method
9	Total alkalinity (mg/l)	200	600	Analytical method
10	Total suspended solids	250	500	EPA
11	Residual chloride (mg/l)	0.2	No relaxation	Analytical method
12	DO (mg/l)	-	5	Analytical method
13	BOD (O_2) (mg/l)	-	6	Analytical method
14	Sulphates (mg/l)	45	-	Analytical method

IV. RESULTS

Around 19 samples were collected from the sampling points surrounding the lake during the month of February and march. The following results are shown below.

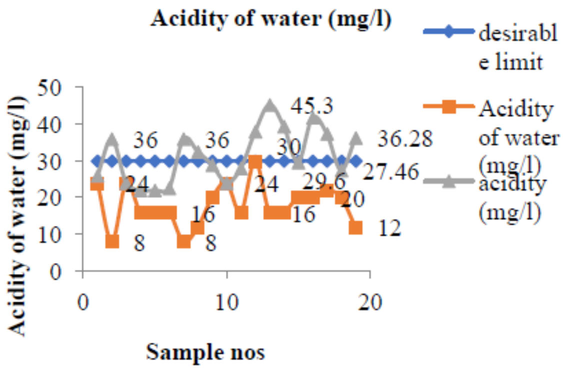

Fig. 3: Acidity of water (Feb and March)

Acidity of hebbal lake varied periodically due to environmental conditions. Samples were taken from different places of Hebbal Lake due to which variation in acidity was observed. Acidity of water was more in the month of march i.e 45.3 mg/l.

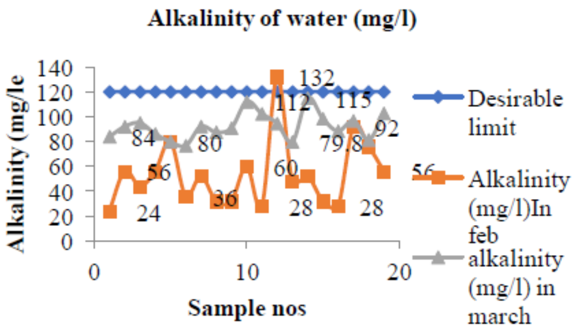

Fig. 4: Alkalinity of water (Feb and March)

Alkalinity of hebbal lake at different sampling points it was found that the 19 samples had less alkalinity due to less presence of minerals. Due to inflow of water into the inlet point, the 12th sample had high alkalinity because of more minerals.

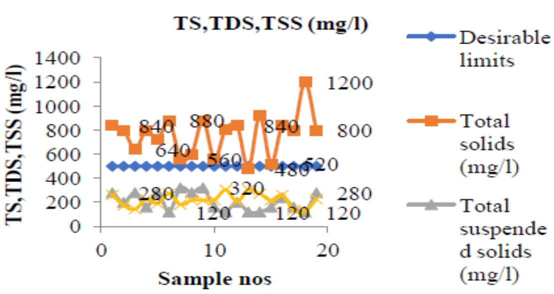

Fig. 5: Total solids, Total dissolved solids and Total suspended solids (Feb)

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The figure 5 shows the variation of TS, TSS, TDS with a graphical representation. The desirable limit of TS is 500-2000 mg/l, whereas TSS, TDS should be 200-500 mg/l. All samples which was collected in the month of February were within the desirable limits. Calcium, magnesium, sodium, potassium, carbonates and bicarbonates are inorganic salts present along with organic matter gets dissolved in water which comprises of TDS. 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. All the above three components are within the standard limits and hence causes no harm.

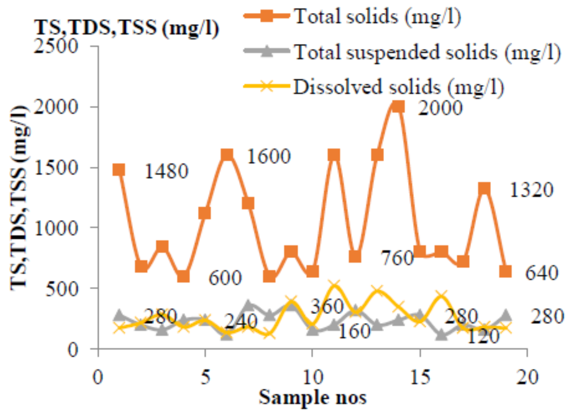

Fig. 6: TS, TDS, TSS Collection during March

The figure 6 shows the result of experimental study which was conducted on TS, TSS, TDS with the help of graphical representation. All samples are within the limit which was collected in the month of March. TDS adds up to drinking water from various sources like rainfall run-off, chemicals used in water treatment process, silt deposition etc. Hence it can be concluded that the value of TS, TDS and TSS which was collected in the month of March and February was well within the standard limits and caused no harm for the flora and fauna of the lake ecosystem.

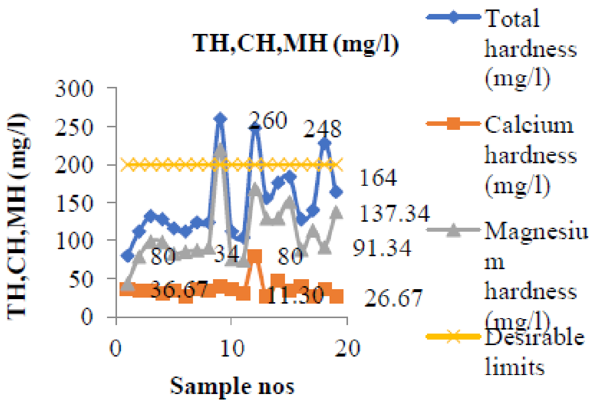

Fig. 7: Total hardness, Calcium hardness and Magnesium hardness (Feb)

The figure 7 shows the experimental study which was conducted on TH, CH, MH with a graphical representation .The desirable limit of total hardness should be within 200 mg/l, whereas calcium hardness should be 70-200 mg/l respectively. All samples were within the limit which was collected in the month of February. In the Lake Ecosystem, calcium precipitates adds up to water by various sources like plant precipitation, bone deposition underneath, shell construction etc. Concentration of magnesium is generally lower than calcium and is usually associated with calcium.

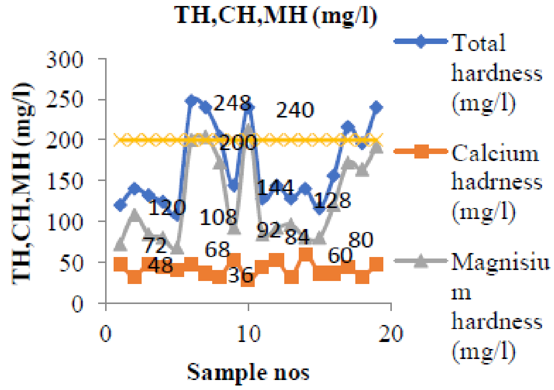

Fig. 8: Total hardness, Calcium hardness and Magnesium hardness (March)

The above figure 8 shows the experimental study which is conducted on TH,CH,MH during the month of march. All samples were within the desirable limits which were collected in the month of March.

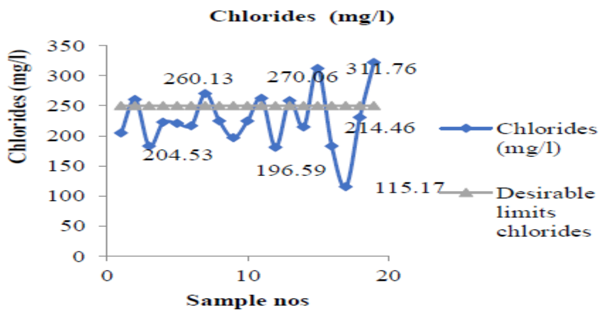

Fig. 9: Chlorides (Feb)

The figure 9 shows graphical representation of Chlorides collected on the month of February. The desirable limit of chlorides should be above 250 mg/l and less the 600 mg/l. The sample 19 which collected in month of February was below desirable limit the value was 115.17 mg/l. But whereas all the other samples were within the desirable limits.

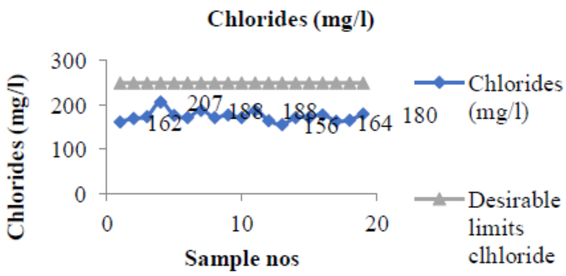

Fig.10: Chloride (March)

The figure 10 above shows graphical representation of Chlorides collected on the month of march. Chloride concentration should be above 250 mg/l and less the 600 mg/l.

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The sample 19 which collected in month of March is below desirable limit the value is 15.29 mg/l. but whereas the other are all samples are within the desirable limits.

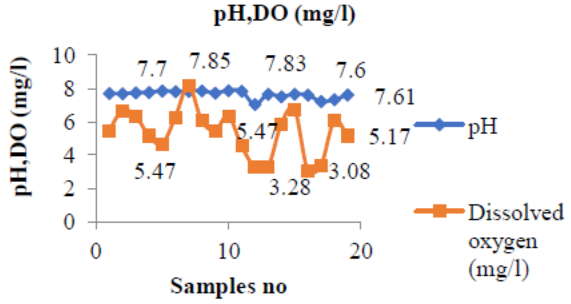

Fig. 11: pH, DO (Feb)

The figure 11 shows variation of pH, DO in the month of February. Generally as the pH decreases the concentration of H plus or the activity increases. Hydrogen ions and oxygen react with water, which results in a decrease of DO. An increase of the pH value can shift the redox reaction to the left. Almost for all the samples the value of DO was within 6-7 mg/l, which infers healthy environment in the lake ecosystem. Even pH was within the desirable limits.

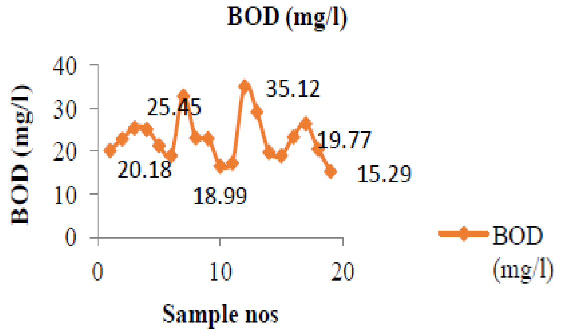

Fig. 12: pH, BOD (Feb)

The figure 12 shows variation of BOD at different sampling points in the lake. The BOD limit should be within 6 mg/l but as per the observation the sample 12 which was collected in month of February had BOD of 35.12 mg/l, similarly the value of DO was dropped to 3.28 mg/l. Higher BOD values are due to heavy organic load to lakes which eventually decreases dissolved oxygen content in the water.

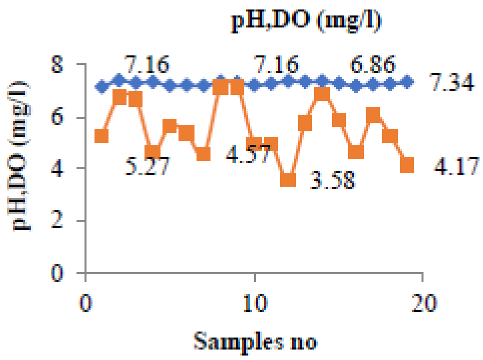

Fig. 13: pH, DO (march)

The figure 13 shows variation of pH, DO in the month of march. The variation can be seen in values of DO which is within desirable limit. The aquatic organism has a narrow pH tolerance range of 6.5 to 8.5. Acidic waters can cause toxic heavy metals released into the water. Dissolved oxygen is most important parameter, where aquatic organisms need oxygen to survive.

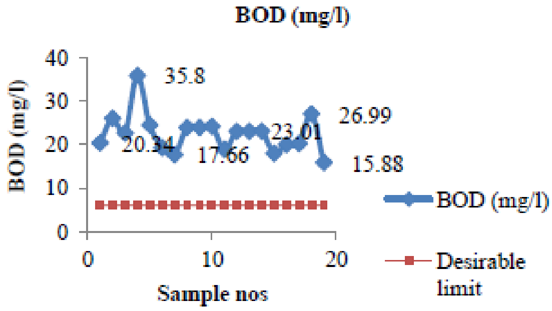

Fig.14: BOD (March)

The BOD limit should be within 6 mg/l. But the sample 12 which was collected in month of February and march had BOD of 35.8 mg/l. High BOD is an indication of high amounts of biodegradable organic matter present in a water sample.

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Table –II: Analysis of parameters for sample collected during month of February

Sample No	pH	Acidity of water (mg/l)	Alkalinity (mg/l)	Turbidity	Dissolved oxygen (mg/l)	Total solids (mg/l)	Total suspended solids (mg/l)	Dissolved solids (mg/l)	Chlorides (mg/l)	Total hardness (mg/l)	Calcium hardness (mg/l)	Magnesium hardness (mg/l)	Sulphates (mg/l)	BOD (mg/l)
1	7.7	24	24	2.9	5.47	840	280	261	162	80	36.67	43.34	1.8	20.18
2	7.68	8	56	5.6	6.67	800	200	174	170	112	33.33	78.67	1.1	22.87
3	7.74	24	44	3.6	6.36	640	280	143	174	132	33.33	98.67	1.4	25.45
4	7.76	16	56	6.2	5.17	800	160	227	207	128	30	98	4	25.14
5	7.85	16	80	1.4	4.67	720	280	190	177	116	33.33	82.67	2	21.34
6	7.81	16	36	5.6	6.26	880	120	273	172	112	26.67	85.34	8.6	18.99
7	7.83	8	52	8.2	8.15	560	320	181	188	124	36.67	87.34	1.1	32.88
8	7.86	12	32	6.4	6.06	600	280	217	172	124	33.33	90.67	2.7	23.13
9	7.72	20	32	3.6	5.47	880	320	217	178	260	40	220	2.6	22.99
10	7.87	24	60	3.2	6.36	560	160	219	172	112	36.67	75.34	1.3	16.55
11	7.83	16	28	5.6	4.57	808	120	304	188	104	30	74	4.3	17.26
12	7.04	30	132	5.8	3.28	840	200	208	165	248	80	168	1.2	35.12
13	7.65	16	48	8.1	3.28	480	120	304	156	156	26.67	129.34	1.2	28.2
14	7.5	16	52	3.2	5.87	920	120	272	172	176	46.67	129.34	2.1	19.77
15	7.66	20	32	3.6	6.76	520	160	217	172	184	33.33	150.67	1.2	18.91
16	7.6	20	28	5.6	3.08	840	240	260	178	128	40	88	2.5	23.34
17	7.22	22	92	4.2	3.38	800	160	136	164	140	26.67	113.34	2.6	26.43
18	7.33	20	76	5.3	6.06	1200	120	125	166	228	36.67	91.34	2.7	20.54
19	7.61	12	56	5.8	5.17	800	280	227	180	164	26.67	137.34	3.4	15.29

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Table –IIII: Analysis of parameters for sample collected during month of March

Sample No	pH	Acidity (mg/l)	Alkalinity (mg/l)	Turbidity	Dissolved oxygen (mg/l)	Total solids (mg/l)	Total suspended solids (mg/l)	Dissolved solids (mg/l)	Chlorides (mg/l)	Total hardness (mg/l)	Calcium hardness (mg/l)	Magnesium hardness (mg/l)	Sulphates (mg/l)	BOD (mg/l)
1	7.16	26	84	5.6	5.27	1480	280	174	204.53	120	48	72	1	20.34
2	7.4	36	92	6.4	6.76	680	200	217.39	260.13	140	32	108	1	25.99
3	7.31	24	95	7.5	6.67	840	160	285.71	182.68	132	48	84	1.2	22.6
4	7.35	22	86.2	7.9	4.67	600	240	181.81	222.4	124	44	80	1.2	35.6
5	7.2	22	80	6.7	5.67	1120	240	238.09	220.41	108	40	68	1.3	24.44
6	7.22	22.6	76.8	5.9	5.37	1600	120	136.36	216.44	248	48	200	1.5	19.28
7	7.2	36	92.1	6.5	4.57	1200	360	181.81	270.06	240	36	204	1.5	17.66
8	7.36	32.5	87.6	7.4	7.16	600	280	130.43	224.39	204	32	172	3	23.88
9	7.32	28.9	90.9	6.8	7.16	800	360	391.3	196.59	144	52	92	1.5	23.88
10	7.22	24	112	6.3	4.97	640	160	208.33	224.39	240	28	212	1.9	24.12
11	7.28	28	102.3	5.4	4.97	1600	200	521.73	262.12	128	44	84	2.5	18.88
12	7.38	38	94.6	6.2	3.58	760	320	304.34	180.7	144	52	92	1.6	23.01
13	7.35	45.3	79.8	5.8	5.77	1600	200	478.26	258.14	128	32	96	1.4	23.17
14	7.37	39.4	115	7.2	6.86	2000	240	347.82	214.46	140	60	80	1.3	23.04
15	7.29	29.6	98.4	7.8	5.87	800	280	227.27	311.76	116	36	80	2.1	17.99
16	7.19	41.8	88.46	5.7	4.67	800	120	434.78	182.68	156	36	120	1.6	19.99
17	7.25	37.42	96.76	5.4	6.06	720	200	173.91	115.17	216	44	172	1.1	20.22
18	7.27	27.46	81.45	6.9	5.27	1320	160	181.81	230.34	196	32	164	1	26.99
19	7.34	36.28	102.75	7.5	4.17	640	280	173.91	321.69	240	48	192	2.4	15.88

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V. WATER QUALITY INDEX

It may be defined as a rating, reflecting the composite influence of different water quality parameters on the overall quality of water.

Importance of WQI

Assessment of water quality based on WQI application of WQI is a useful method in assessing the suitability of water for various beneficial uses. Temperature: temperature of water is basically important because it effects bio-chemical reactions in aquatic organisms.

With the virtual absence of impairment, water quality is being protected to pristine levels. These index values can only be obtained if all measurements meet recommended guidelines virtually all of the time. (WQI value 95-100).The water quality is almost always impaired; conditions usually depart from desirable levels (WQI value 0-44)

The aim of present study is to estimate the WQI which is necessary for resolving lengthy, multi parameter, water analysis reports into single digit scores. This, in turn, is essential for comparing the water quality of different sources and in monitoring the changes in the water quality of a given source as a function of time and other influencing factors. Quality index software was used to calculate water quality index of hebbal lake in Bangalore.

Table-IV: WQI range and water type

WQI Value	Status
91-100	Excellent water quality
71-90	Good water quality
51-70	Medium water quality
26-50	Bad water quality
0-25	Very bad water quality

VI. WATER QUALITY INDEX ASSESSMENT OF HEBBAL LAKE IN BANGALORE

Table-V: Compare to the water quality index

SAMPLE NO	LATITUDE	LONGITUDE	FEB	MARCH	QUALITY
1	13.044663	77.58465	87	84	Good water quality
2	13.044592	77.584462	86	82	Good water quality
3	13.044579	77.584354	75	75	Good water quality
4	13.044689	77.584139	81	78	Good water quality
5	13.045708	77.583697	78	74	Good water quality
6	13.044425	77.584812	87	87	Good water quality
7	13.04442	77.58489	86	80	Good water quality
8	13.044367	77.585141	81	79	Good water quality
9	13.0444548	77.584417	71	74	Good water quality
10	13.0444387	77.584853	84	82	Good water quality
11	13.0444387	77.58502	77	75	Good water quality
12	13.044144	77.585389	61	65	Medium water quality
13	13.0444	77.584664	80	78	Good water quality
14	13.044663	77.584417	82	79	Good water quality
15	13.0444505	77.584597	81	83	Good water quality
16	13.04442	77.585599	73	72	Good water quality
17	13.044419	77.585901	71	70	Good water quality
18	13.044305	77.58573	83	86	Good water quality
19	13.044663	77.584417	75	74	Good water quality

All the samples showed good water quality index, whereas sample collected at inlet (i.e sample no 12) showed medium water quality.

VII. APPLICATION OF STUDY

1) As there is water crisis in Bangalore city for drinking and other domestic purposes, Hebbal lake water can be suggested to use for the purpose of drinking after filtration process, irrigational and other domestic use.
2) From the present study, it was observed that all the parameters were below the standards prescribed by BIS. The results revealed the need of restoration and management of the Hebbal Lake.
3) Restoration can brought about by many ways, through various physical, chemical and biological methods. It is also a concern to educate stakeholders and the local population on the importance for restoring the lake ecosystem.

VIII. CONCLUSION

1) In this present study, water samples were collected from different sampling points and analyzed at laboratory using analytical methods.The physico chemical parameters which were analyzed for hebbal lake was pH, Turbidity, DO, BOD, Total solids, Total dissolved solids, Total suspended solids, Total hardness, Magnesium, calcium, Chlorides, all parameters were within the desirable limits.

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2) Inlet points to hebbal lake is from tumkur road and bellary- Bangalore highway, these two inlet points are closed since many years, no proper maintaince of rainwater channel through these inlet points and lot of weed growth was observed during investigation process. If local bodies and government bodies could take up this matter seriously, flow of rainwater can be easily channeled to hebbal lake followed with mechanical screening, which can solve the water crisis problem to some extent in Bangalore city.
3) BOD was not within the desirable limits. BOD value was higher when compared to the water quality index. The reason behind higher value of BOD was presence of higher concentration of biological contaminants that is lake is surrounded by trees, garden area, tree leaves and plants grown in lake.
4) The analyzed values were compared to water quality index ,the water quality was 86,representing good water quality. The sample collected at the inlet showed 65, representing medium water quality.
5) After comparing with water quality index the water stored in hebbal lake can be used for domestic purpose, irrigation. If the water is filtered it can be used for drinking purpose also.
6) Hence by observing and analyzing the physico-chemical parameters, hebbal lake can be used as source of water supply to nearby areas if properly maintained, restored and protected. This is an eye opener for the water crisis problem in bangalore city.

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