Assessment of Water Quality and Pollution Levels in Dorekere Lake, Bangalore

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ABSTRACT

This study investigates the water quality of Dorekere lake, which has faced significant anthropogenic activities leading to environmental degradation. Ten sampling sites were selected for the study, four locations within the lake, four borewell sources nearby, and two inlet/outlet points. These samples were analyzed for pH, Conductivity, Dissolved Oxygen, BOD, COD, Alkalinity, Solids, Chloride, Sulphate, Fluoride, Sodium, Potassium, Boron, Hardness, Calcium, Magnesium, Nitrates, Ammoniacal nitrogen and heavy metals etc. by standard procedure and results were analyzed to know the pollution level. The results reveal that BOD values exceeded limits in all lake samples, while high counts of Total Coliform and E. coli indicated significant microbial contamination. Borewell water samples collected from residences reveals elevated Total Coliform and E. coli counts, rendering them unfit for consumption. These findings show the urgent need for effective management strategies to restore water quality and protect the ecological integrity of Dorekere Lake.

KEY WORDS: Water quality, Dissolved Oxygen, BOD, COD, Ammoniacal Nitrogen, Total Coliform

1. INTRODUCTION

The increase in anthropogenic influences in the recent years in and around aquatic system and their catchments areas have contributed to deterioration of water quality and dwindling of water bodies leading to the accelerated eutrophication. Lakes were created basically for hydrological reasons. To sustain the complex natural cycle coupled with hydrological and biological roles of a lake, it is important that a proper maintenance is ensured. Every lake has three components naturally viz. the catchment area, the lake itself and the achkat. Lake Catchment and the lake itself need protection and monitoring to prevent decline and abuse. The water quality of lakes plays an important role for maintenance of lakes. Rapid industrialization and urbanization are the major sources for causing adverse effects. About few decades back, Bangalore was having >260 lakes, but presently few of them exist. The water quality of these lakes is badly affected due to sewage flow and urbanization. Due to relatively high human population density, the lakes are being threatened by development pressure and misuse. One of such lakes is Dorekere Lake. Dorekere Lake is located on Uttarahalli hobli of southern side of Bangalore. As per BBMP records, the total area of the lake, including its catchment area, is 27 acres and 23guntas. The area of the water body is about 81,306 sq. meters. However, what exists to the naked eye is a pipeline, with little trace of water. So, this program is initiated to know the water quality of this lake. In view of all reasons mentioned above, the project is intended to evaluate water quality of the Dorekere lake and its surroundings. The satellite view of Dorekere Lake and Gowdanapalya Lake and its surrounding is shown in **Figure 1-5**.

Figure 1: The satellite photo of Dorekere Lake and its surrounding area with sewage entry point.

Figure 2: Residential flats on the periphery of the Lake

Figure 3: Discharge of Municipal sewage

Figure 4: Algal growth in the Lake

Figure 5: SPOT-BILLED DUCKS AT DOREKERE

2. MATERIALS AND METHODS

2.1 Study Area

As per BBMP records, the total area of the lake, including its catchment area, is 27 acres and 23 guntas. The area of the water body is about 81,306 sq. meters. The lake is irregular in shape and the position of the lake on the Google map is Latitude 12°54'08.40"N and Longitude 77°33'02.49"E. The highest point was 863 m above sea level.

2.2 Climate of the Study Area

Bangalore enjoys a pleasant and equable climate throughout the year. The highest temperature recorded was 38.9°C (102.0°F) on 22 May 1935 and the lowest was 7.8°C in 1884. Winter temperatures rarely drop below 11°C (52°F) and summer temperatures seldom exceed 36°C (97°F). Bangalore receives about 970 mm of rain annually, the wettest months being August September, October and in that order. The summer heat is moderated by fairly frequent thunderstorms and occasional squalls causing power outages and local flooding.

2.3 Vegetation of the Area

Maintenance of different aquatic vegetation is crucial for the presence and survival of most of the birds. Excessive growth of some of the aquatic vegetation like water hyacinth and typha reeds that play an important role by providing foraging and nesting conditions for several birds need to be maintained by restricting their excessive spread by controlling their growth by regular monitoring and removal of this excessive growth.

2.4 Sample Preparation

In this program, 10 locations all around the lake selected for sample collection and samples were collected as per standard procedure. Sample collection sites are shown in **Figure 6**. Out of ten samples, four samples were collected at different locations of the Dorekere Lake keeping in view the discharges that were entering the lake system and four Borewell waters of lake residence **(Figure 7)** and two samples near to the inlet and outlet points of the Dorekere Lake. These samples were analyzed for pH, Conductivity, Dissolved Oxygen, BOD, COD, Alkalinity, Solids, Chloride, Sulphate, Fluoride, Sodium, Potassium, Boron, Hardness, Calcium, Magnesium, Nitrates, Ammoniacal nitrogen and heavy metals etc. by standard procedure and results were analyzed to know the pollution level and the results are summarized in **Table 1, 2, 3,** and **4**.

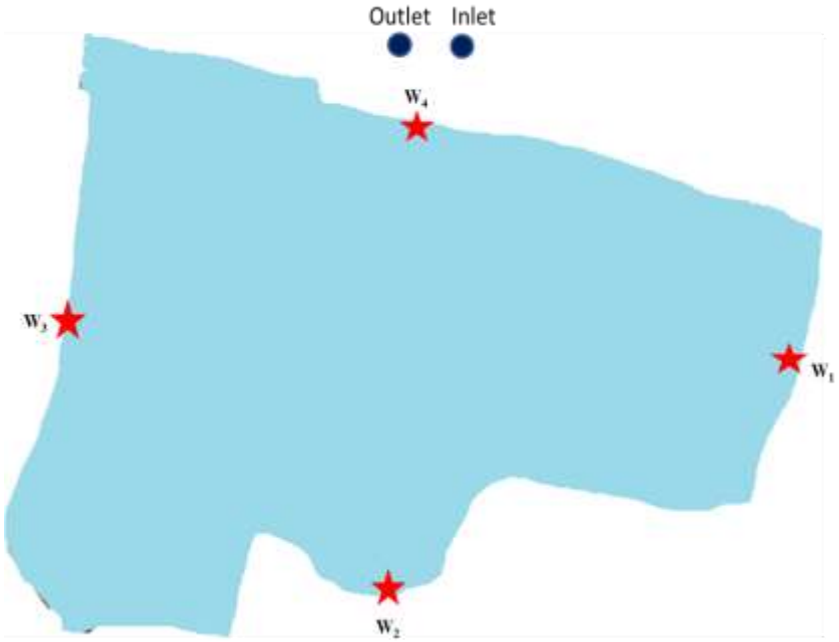

Fig.6 Sampling Site Of Dorekere Lake

W_1: Lake Water collected near Eastern side Lake; W_2: Water collected near Southern side; W_3: Lake Water collected near Western side; W_4: Lake Water collected near Northern side;

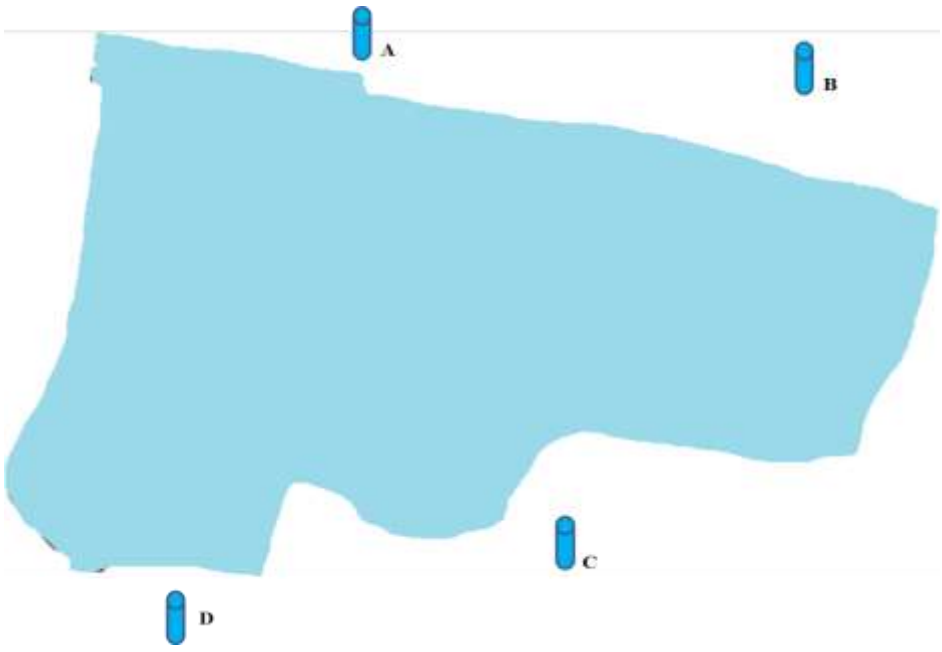

Fig.7 Borewell water Sampling Site near Dorekere Lake

A: Borewell water collected at 1st cross, Vittalanagar B: Borewell water collected at residence of Anil kumar; C: Borewell water collected at Kodisubramnyaswamy temple

3. RESULTS OR RESULTS AND DISCUSSIONS

3.1 Lake water samples

The results of four water samples collected at different locations of lake are compared with the limits prescribed by KSPCB. Bio-chemical oxygen demand (BOD) values exceeded the limits in all the four samples of the lake. Total Coliform count and E. coli (one of the most important indicators of pollution) are observed very high in all the samples.

3.2 Inlet and outlet samples

Results of Effluents before and after treatment are compared with the limits as per KSPCB. In outlet water all the chemical parameters are within the limits. Total Coliform count and E. coli are observed in both raw and treated effluents. In inlet water (raw effluent) BOD, COD, Nitrate and Iron are excess when compared with STP treated water

3.3 Borewell water Samples

The monitoring result reviles that, chemical parameters like total hardness, alkalinity and dissolved solids in all the four samples exceeded the desired limits but within the permissible limit. Out of four Borewell water samples, samples collected at residence of Anil Kumar (near upstream of lake) and residence in front of the main entrance of the Lake (near downstream of lake) showed high counts of Total coliforms and presence of E coli. Because of microbial contamination, these samples are considered as unfit for consumption. Samples collected at 1st cross road Vittal Nagar (near upstream of lake) and Kodi Subramanya Swamy temple (near downstream of lake) showed the values of chemical parameters within the permissible limit and above the desired limits. These sources could be used for potable purposes in absence of any other sources. Results are tabulated in **Table 3**.

4. CONCLUSIONS

The water quality data on Dorekere Lake and its surroundings are monitored and evaluated against the water quality criteria. As per the result of lake water evaluated clearly indicated that lake water is not in line with the water quality criteria of Class-A, B and C as specified by KSPCB, but lake water is suitable for Class-D and E. Microbiological contamination is observed in both raw effluents before treatment (inlet) and final STP treated water (outlet). Out of four Borewell waters which are collected at different locations surrounding the lake, two samples showed microbial contamination and considered as unfit for drinking. Overall, Bio-chemical oxygen demand (BOD) & Coliform bacterial count gives the indication of extent of water quality degradation of Dorekere Lake. It is observed that nearly 50% of the observations are having BOD greater than 2-3 mg/l. Similarly, Total coliforms &E. coli which indicate the presence of pathogens in water are also a major concern. About 80% observations are having Total Coliform count and among them, 30% observation are having Total Coliforms >500 MPN and 80% observations showed the presence of E. coli.

The assessment of water quality in Dorekere Lake has revealed alarming levels of pollution, significantly attributable to ongoing urbanization and inadequate waste management practices in the surrounding areas. The analysis indicates that biochemical oxygen demand (BOD) and microbial contamination, evidenced by high levels of total coliform and E. coli, exceed acceptable limits, posing serious risks to both human health and the aquatic ecosystem. Moreover, borewell water sourced from areas adjacent to the lake also exhibited microbial contamination, further threatening drinking water safety for residents.

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Table 1: Chemical and Microbiological results of Lake Water collected at different locations of Dorekere Lake.

Location	**W_1 Lake Water near Eastern side**	**W_2 Lake Water near Southern side**	**W_3 Lake Water near Western side**	**W_4 Lake Water near Northern side**	**LIMITS**				
Parameters	**Results**	**Results**	**Results**	**Results**	**A**	**B**	**C**	**D**	**E**
pH Value	7.66	7.8	8.2	7.9	6.5 - 8.5	6.5 - 8.5	6.5-8.5	6.5-8.5	6.5-8.5
Biochemical Oxygen Demand, mg/L (for 3days at 27°C)	5.2	6.4	5.7	6.4	2	3	3	-	-
Nitrates (as NO3), mg/L	14	15.3	14.8	17.2	20	-	50	-	-
Sulphate (as SO_4), mg/L	13.9	15.6	15.4	15.5	400	400	-	-	1000
Free Ammonia as N	<0.05	<0.05	<0.05	<0.05	-	-	-	1.2	-
S.A. Ratio	1.64	1.74	1.59	1.63	-	-	-	-	26
Phosphates as PO_4^-, mg/L	0.4	0.5	0.4	0.3	-	-	-	-	-
Boron (as B), mg/L	<0.1	<0.1	<0.1	<0.1	-	-	-	-	2
Lead (as Pb), mg/L	<0.01	<0.01	<0.01	<0.01	0.1	-	0.1	-	-
Copper (as Cu), mg/L	<0.02	<0.02	<0.02	<0.02	1.5	-	1.5	-	-
Zinc (as Zn), mg/L	<0.05	0.42	<0.05	0.07	15	-	15	-	-
Cadmium (as Cd), mg/L	<0.003	<0.003	<0.003	<0.003	-	-	-	-	-
Iron (as Fe), mg/L	<0.05	0.21	0.07	0.5	0.3	-	0.5	-	-
Fluoride (as F), mg/L	0.48	0.58	0.52	0.48	1.5	1.5	1.5	-	-
Conductivity, µs/cm	545	536	534	545	-	-	-	1000	2250
Dissolved oxygen, mg/L	6.4	6.2	6.2	7.8	6	5	4	4	-
Microbiological Test:									
Total Coliform Bacteria/100ml	210	920	180	240	50	500	5000	-	-
Escherichia coli/100ml	Present	Present	Present	Present	Absent	Absent	Absent	Absent	Absent

Note: A Drinking water source without conventional treatment but after disinfection. B. Outdoor bathing (Organized) C. Drinking water with conventional treatment followed by disinfection D. Propagation of wild life, Fisheries E. Irrigation, industrial cooling-controlled waste disposal

Table 2 (A): Chemical and Microbiological results of effluents collected before treatment.

Locations	**Raw effluent water (Inlet)**
Parameters	**Result**
Description	Pale yellow coloured liquid having objectionable odor with suspended solids
pH	6.7
Color (hazen units)	<5.0
Odour	Objectionable
Temparature ˚C	27.6
Particulate Size of Suspended solids	>850 micron
Total Suspended Solids, mg/L	110
Total Chromium as Cr^{+}, mg/L	<0.05
Hexavalent Chromium as Cr+6, mg/L	<0.1
Total Residual Free Chlorine, mg/L	<0.2
Copper as Cu, mg/L	0.16
Fluoride as F, mg/L	1.62
Disoolved Phosphates as P, mg/L	3.06
Sulphide as S, mg/L	Absent
Arsenic as As, mg/L	<0.01
Iron as Fe, mg/L	2.77
Cadmium as Cd, mg/L	<0.003
Mercury as Hg, mg/L	<0.01
Cyanide as CN, mg/L	Absent
Lead as Pb, mg/L	<0.01
Zinc as Zn, mg/L	0.37
Nickel as Ni, mg/L	<0.05
Selenium as Se, mg/L	<0.01
Vanadium as V, mg/L	<0.1
Phenolic Compounds as C_6H_5OH, mg/L	Absent
Radioactive Materials:	
Alpha emitter, micro curie/ml	ND
Beta emitter, micro curie/ml	ND
Bio-assay test	20% Survival of fish after 96 hours in 100% effluent
Manganese as Mn, mg/L	0.15
Nitrate Nitrogen, mg/L	59.2
Chemical Oxygen Demand, mg/L	498
Biochemical Oxygen Demand, mg/L (for 3days at 27°C)	56

Total Kjeldhal Nitrogen as N, mg/L	64
Ammoniacal Nitrogen as N mg/L	37.7
Free Ammonia as NH_3,mg/L	0.4
Oil & Grease, mg/L	<1.0
Microbiological tests:	
Escherichia coli/100ml	Present

Table 2 (B): Chemical and Microbiological results of effluents collected after treatment

Sample Particulars	**W_1-Outlet point in STP plant**	**Limit**			
Parameters	**Results**	**Inland surface water**	**Public sewers**	**Land for irrigation**	**Marine coastal areas**
Description	Colourless Liquid	-	-	-	-
pH	6.9	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
Colour (hazen units)	<5.0	See 6 of Annexture-	-	See 6 of Annexture	See 6 of Annexture-1
Odour	Agreeable	See 6 of Annexture	-	See 6 of Annexture	See 6 of Annexture-1
Temperature, °C	27.6	Shall not exceed 5ºC above the receiving	-	-	Shall not exceed 5ºC above the receiving water temperature
Particulate Size of Suspended solids	<850 micron	Shall pass 850 micron IS Sieve	-	-	a) floatable solids, max 3mm b) Settable solids, max 850 microns
Total Suspended Solids,mg/L	16	100	600	200	a) For process waste water-100 b) For cooling water effluent 10% above total suspended mater of 10% above
Total Chromium as Cr^{+},mg/L	<0.05	2	2	-	2
Hexavalent Chromium as Cr^{+6},	<0.1	0.1	2	-	2
Total Residual Free Chlorine,	<0.2	1	-	-	1
Copper as Cu, mg/L	<0.02	3	3	-	3
Fluoride as F, mg/L	1.13	2	15	-	15

Dissolved Phosphate as P, mg/L	2	5	-	-	-
Sulphide as S, mg/L	Absent	2	-	-	5
Arsenic as As, mg/L	<0.01	0.2	0.2	0.2	0.2
Iron as Fe, mg/L	<0.05	3	3	-	3
Cadmium as Cd, mg/L	<0.003	2	1	-	20.01
Mercury as Hg, mg/L	<0.01	0.01	0.01	-	0.01
Cyanide as CN , mg/L	Absent	0.2	0.2	0.2	0.2
Lead as Pb, mg/L	<0.01	0.1	1	-	2
Zinc as Zn, mg/L	0.05	5	15	-	15
Nickel as Ni, mg/L	<0.05	3	3	-	5
Selenium as Se, mg/L	<0.01	0.05	0.05	-	0.05

Table 2 (B): Chemical and Microbiological results of effluents collected after treatment

Sample Particulars	**W_1-Outlet point in STP plant**	**Limit**			
Parameters	**Results**	**Inland surface water**	**Public sewers**	**Land for irrigation**	**Marine coastal areas**
Phenolic Compounds as C_6H_5OH, mg/L	Absent	1	5	-	5
Vanadium as V, mg/L	<0.1	0.2	0.2	-	0.2
Radioactive Materials:					
Alpha emitter, micro curie/ml	ND	10^{-7}	10^{-7}	10^{-8}	10^{-7}
Beta emitter, micro curie/ml	ND	10^{-6}	10^{-6}	10^{-6}	10^{-6}
Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hrs in 100% effluent	90% survival of fish after 96 hrs in 100% effluent	90% survival of fish after 96 hrs in 100% effluent	90% survival of fish after 96 hrs in 100% effluent
Manganese as Mn, mg/L	<0.05	2	2	-	3
Nitrate Nitrogen, mg/L	9.9	10	-	-	20
Chemical Oxygen Demand, mg/L	ND	250	-	-	250
Biochemical Oxygen Demand, mg/L (for 3days at	4.4	30	350	100	100

Total Kjeldhal Nitrogen as N, mg/L	1.5	100	-	-	100
Ammoniacal Nitrogen as N mg/L	ND	50	50	-	50
Free Ammonia as NH_3, mg/L	<0.05	5	-	-	5
Oil & Grease, mg/L	<1.0	10	20	10	20
Microbiological tests:					
Escherichia coli/100ml	Present	Absent	Absent	Absent	Absent

Table 3: Chemical and Microbiological results of Borewell water collected at residence near the Lake.

Sample Locations	**Sample A**	**Sample B**	**Sample C**	**Sample D**	**IS 10500:2012**	
Parameters	Results	Results	Results	Results	**Maximum Desirable Limit**	**Maximum Permissible Limit**
Description	Colourless liquid	Colourless liquid	Colourless liquid	Colourless liquid		
pH Value	6.7	7.4	7.5	6.9	6.5 to 8.5	6.5 to 8.5
Turbidity, NTU	0.4	0.4	0.5	0.9	-	-
Chloride as Cl, mg/L	83.9	80.64	74.2	77.4	250	1000
Total hardness as	404.3	376.3	204.1	244.2	200	600
Calcium as Ca, mg/L	86.5	62.5	62.5	60.9	75	200
Magnesium as Mg,	45.7	53.5	11.6	22.3	30	100
Dissolved Solids,	794	782	564	572	500	2000
Sulphate as SO4,	29.56	37.3	20.74	20.2	200	400
Fluoride as F, mg/L	1	1.15	1	0.76	1	1.5
Sulphide as S, mg/L	Absent	Absent	Absent	Absent	0.05	0.05
Ammonia as N,	0.37	0.4	0.2	0.38	0.5	0.5
Chromium as Cr^{+},	<0.01	<0.01	<0.01	<0.01	0.05	0.05
Alkalinity as $CaCO_3$,	505.7	457.3	285.1	306.6	200	600
Nitrates as NO_3^-,	9.54	7.86	11.2	21.5	45	45
Copper as Cu, mg/L	<0.02	<0.02	<0.02	<0.02	0.05	1.5
Iron as Fe, mg/L	<0.05	<0.05	<0.05	<0.05	0.3	0.3
Manganese as Mn,	0.27	<0.05	<0.05	<0.05	0.1	0.3
Phenolic compounds as C_6H_5OH, mg/L	Absent	Absent	Absent	Absent	0.001	0.002

Cadmium as Cd,	<0.003	<0.003	<0.003	<0.003	0.003	0.003
Nickel as Ni, mg/L	<0.05	<0.05	<0.05	<0.05	0.02	0.02
Cyanide as CN,	Absent	Absent	Absent	Absent	0.05	0.05
Lead as Pb, mg/L	<0.01	<0.01	<0.01	<0.01	0.01	0.01
Zinc as Zn, mg/L	<0.05	<0.05	<0.05	<0.05	5	15
Boron as B, mg/L	<0.1	<0.1	<0.1	<0.1	0.5	1
Microbiological test:						
Total coliform count/100ml	<1	92	<1	8	Nil	Nil
Escherichia	Absent	Present	Absent	Present	Nil	Nil

Note: Sample A: Borewell water collected from 1st cross vital nagar -Sample B: Borewell water collected from residence of Anilkumar-Sample C: Borewell water collected from kodi subramanya temple-Sample D: Borewell water collected from residence in front of entrance of lake.

Table 4: Dorekere Lake water analysis

Sl. No.	Name of Ward and Number	No. of Samples	Location	Water Analysis			
				E. Coli	Total Coliform Count	BOD	Results
1	Lake water	4	Lake water collected near Eastern side of Dorekere Lake.	Present	210	5.2	Fail
			Lake water collected near southern side of Dorekere Lake.	Present	920	6.4	Fail
			Lake water collected near western side of Dorekere Lake.	Present	180	5.7	Fail
			Lake water collected near northern side of Dorekere Lake.	Present	240	6.4	Fail
2	Borewell water	4	Borewell water (Upstream of lake) collected at residence of Anil kumar, No. 31, Behind National convent, Vittalnagar, Vasanthpura ward 197.	Absent	<1	NA	Pass
			Borewell water (Upstream of lake) collected at residence of Anil kumar, No. 31, Behind Nation23al convent, Vittalnagar, Vasanthpura ward 197.	Present	92	NA	Fail

			Borewell water (near downstream of lake) collected from kodi subramanya swamy temple, Vittal nagar, and Vasanthpura ward 197.	Absent	<1	NA	Pass
			Borewell water (near downstream of lake) collected at residence in front of main entrance of Dorekere lake.	Present	8	NA	Fail
3	Effluents	2	Final treated STP water (Outlet) at STP located at Dorekere Lake.	Present	540	59	Fail
			Raw effluent before treatment (Inlet) near STP located at Dorekere Lake.	Present	1610	4.4	Fail

NA-Not applicable