WATER QUALITY ANALYSIS OF BHISHMA LAKE AT GADAG CITY

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Abstract

The water bodies are facing a severe threat of pollution all over the world. Eutrophication in lakes is widespread all over the world and the severity is increasing especially in the developing countries like India. The main objective is to study the effects of pollution of water quality in Bhishma lake due to rapid urbanization and to identify the sources of pollution in lake. The samples were collected from January to April and bi-monthly tests were carried out. The physico-chemical characteristics of water samples like pH, turbidity, alkalinity, total hardness, total dissolved solids, nitrate, phosphate, chloride, potassium, sodium, dissolved oxygen, BOD were analyzed in order to determine the level of contaminants present in lake water and its possible mitigation measures. Water qualities such as pH, Total Dissolved solids (TDS), turbidity, alkalinity, total hardness, chloride, sodium, nitrate, phosphate, potassium, Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) were determined for water samples collected from five stations in lake. The analysis of lake water parameters showed that the total hardness, turbidity, total dissolved solids and alkalinity values exceeding the desirable limit and due to presence of organic and inorganic pollutants Dissolved Oxygen (DO) has reduced, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) has increased which shows the poor quality of water and is not suitable for human consumption these values have been graphically plotted.

Keywords: *Lake Water Quality analysis, BOD, COD.*

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1. INTRODUCTION

Water is a primary source of life and sustains all human activities such as domestic needs, agriculture, industries etc., the allocation and management of water resource is becoming a difficult task due to increasing demands, decreasing supply and diminishing quality. This calls for judicious use of water resources. [1]

The use of water by man, plants and animals is universal, without it there can be no life. Every living thing requires water. Man and animal not only consume water but they also consume vegetation, for their food. Vegetation in turn cannot grow without water. The use of water is increasing rapidly with growing population. Already there is an acute shortage of both surface and underground water in many parts of the country. Careless pollution and contamination of the streams, lakes, reservoirs, wells and other underground water sources has greatly impaired the quality of available water. [1]

1.2: Water Pollution.

Water pollution is the contamination of the water body like lake, pond, river and ocean. Water pollution occurs when pollutants directly or indirectly enters in to the water bodies without proper treatment. [2]

1.3: Classification of Sources Of Pollution.

The sources of pollution may be classified into two parts. [2]

- Point source.
- Non point source.
- Point sources: A point source is a stationary location or fixed facility from which pollutants are discharged or emitted or any single, identifiable discharge point of pollution such as a pipe or ditch. [2]
- Non-point sources : The term non-point source is used to identify source of pollution that are diffuse and do not have a point of origin or that are not introduced into a receiving stream from a standard outlet.[2]

1.4: Sources of Pollution In Lakes.

- It includes land use from agriculture, urban and urban development and other uses which contribute to pollution. Untreated domestic waste discharge from the cities also contributes to the pollution of lakes. [3]
- Daily human activities like vehicles deposit oil on to roads ,driveway and parking lots , flowing water picks up fertilizers applied to lawns and crops, pet and livestock waste which contains bacteria and virus.[3]

1.5: Eutrophication.

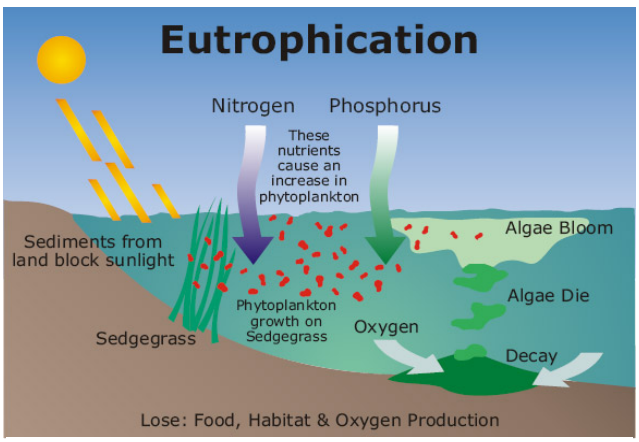

Fig 1.1: Typical representation of causes of eutrophication in lake. [5]

- Lakes are defined by stagnant water surrounded by land. Quality and quantity of water does not only shows difference in the stream flow regime but also damages ecosystem. physical, chemical and biological parameters show the hydrologic status of water which shows quality and quantity of lakes. Light, wind, water and temperature, etc., classified under physical parameters. The chemical inputs include minerals, gas, oxygen and other metals. [5]
- Eutrophication is a process taking place by enrichment of water by nutrients such as nitrogen and phosphorous. Eutrophication is the major problem faced by the surface water bodies that affects the quality of water. It damages fresh water and causes algal blooms, fish kills because of depletion of DO and effects other aquatic species. Domestic sewage include large quantity of phosphorus and nitrogen which effects lake water. Agriculture runoff also damages quality of lake water as it contains pesticides and fertilizers. [6, 7]
- Eutrophication is the major problem faced by developed and developing countries. Nutrients in the lakes usually come from point source e.g. municipal and industrial wastes and non-point source, e.g. agriculture run off. [7]
- Lakes are classified as oligotrophic, eutrophic and mesotrophic depending on the nutrients present in the water bodies. Climate, vegetation, inflow and topography also effects lake water. [7]

2. Objectives of the study

- ✓ To study the effects of point and non point pollution sources on water quality of Bhishma lake in Gadag city due to rapid urbanization.
- ✓ To identify the sources of pollution for Bhishma lake water and how much sewage is joining into the Bhishma lake with what characteristics?
- ✓ To study the characteristics of raw sewage and physico - chemical characteristics of Bhishma lake water and check it's suitability for drinking purpose.

3. MATERIALS AND METHODOLOGY

3.1:General

Physico-chemical parameters for the water samples in Bhishma lake were analyzed during the study period. Methods and equipments used in the study are given in the table 3.1.

Sl. No.	Parameters	Principle	Instrument / Technique used
1	pH	Electrometry	pH meter MK VI, Systronics,Sr.No-9872
2	Total Dissolved Solids	Ionometry	Conductivity meter/Ionometer 307,Systronics,Sr.No-373
3	Alkalinity	Titrimetric method	Titration, Volumetric glassware
4	Total Hardness	EDTA Titrimetric method	Titration, Volumetric glassware
5	Nitrate	Phenol Di-sulphonic Acid method	Digital Spectrophotometer
6	Phosphate	Colorimetry method	Digital Spectrophotometer
7	Sodium	Flame Photometry	Flame photometer,Systronics,type:128
8	Potassium	Flame Photometry	Flame photometer,Systronics,type:128
9	Chloride	Argentometric method	Titration, Volumetric glassware
10	Turbidity	Nephelometry method	Nephlometer, Elico 22A,Sr.No-0065
11	Dissolved Oxygen	Azide modification method	Volumetric glassware.
12	Biochemical Oxygen Demand	Dilution method	BOD incubator, BOD bottles & titration apparatus.
13	Chemical Oxygen Demand	Open Reflux method	COD digester.
14	Suspended Solids	Gravimetric method	Suction apparatus, desicator.

3.2: Characteristics of Sewage

Table 3.2: Standards for discharging effluents in surface water. [19]

SI. No	Characteristics	Tolerance limit
1.	Total suspended solids, mg/L, max	100
2.	Particles size of total suspended solids.	Shall pass IS sieve 850
3.	PH	5.5 to 9.0
4.	Temperature	Shall not exceed 40°C in any section of the streams within 15m downstream from the effluent outlet
5.	Color & Odor	Should be absent as far as practicable.
6.	COD, mg/L, max	250
7.	Oil & grease, mg/L ,max	10
8.	Phenolic compounds, mg/L max	1.0
9.	Cyanides (as CN), mg/L, max	0.2
10.	Sulphides (as S), mg/L, max	2.0
11.	Radioactive materials a. Alpha emitters µc/ml, max b. Beta emitters µc/ml, max	 10^{-7} 10^{-6}
12.	Insecticides	Absent
13.	Total residual chlorine, mg/L, max	1.0
14.	Fluorides (as F),mg/L, max	2.0
15.	Arsenic (as As),mg/L, max	0.2
16.	Cadmium (as Cd),mg/L, max	2.0
17.	Hexavelent Chromium (as Cr^{+6}),mg/L, max	0.1
18.	Lead (as Pb), mg/L, max	0.1
19.	Copper (as Cu), mg/L, max	3.0
20.	Mercury (as Hg), mg/, max	0.01
21.	Nickel (as Ni), mg/L, max	3.0
22.	Selenium (as Se), mg/L, max	0.05
23.	Zinc (as Zn), mg/L, max	5.0
24.	Ammonical nitrogen, mg/L, max	5.0
25.	BOD for 5 days a 20°C, mg/L, max	30

3.3: Sampling Technique

3.3.1: Grab Sampling

A grab sample is one discrete sample where the sample is collected at once and can only represent the conditions at a particular time. It can be done manually by dipping the container directly into the water to be sampled or by using a pump. [21]

3.3.2: Collection of Sample

Samples were collected and stored in bottles. Diluted hydrochloric acid or detergents were used for cleaning the bottles. Once the bottles were cleaned thoroughly rinsed with the reagent water and sealed properly. All samples were properly labeled with time of sampling and date of sampling and the source. The samples were tested in laboratory within the 24 hours. If the time exceeds 24 hours the samples have to be preserved at 4^0 C and the analysis should be done within 48 hours. [21]

The samples from the lake were collected from January 2015 to April 2015. Bi-monthly samples were collected periodically during morning hours between 8 am to 10 am. The physico-chemical parameters such as turbidity, pH, DO, TDS, BOD, nitrate, phosphate, potassium, sodium, chloride, hardness, suspended solids, COD & alkalinity were analyzed in both, Environmental laboratory, Department of Civil Engineering, KLE Dr. MSSCET Belgavi and Krishi Vigyana Kendra, Hulkoti according to APHA AWWA standard methods. [21]

4. RESULTS AND DISCUSSION

4.1: Characteristics of Raw Sewage Joining Into Bhishma Lake.

Parameters	Raw sewage January-20	Raw sewage February-20	Raw sewage Marh-20	Raw sewage April-20
pH	6.20	6.30	6.50	6.70
Chloride	55.20 mg/L	58.32 mg/L	64.20 mg/L	68.12 mg/L
Total Dissolved Solids	580.10 mg/L	6OO.23 mg/L	630.11mg/L	648.18 mg/L
Dissolved Oxygen	0.00	0.00	0.00	0.00
Biochemical Oxygen Demand	208.32 mg/L	220.12 mg/L	232.80 mg/L	238.72 mg/L
Chemical Oxygen Demand	335.12 mg/L	355.16 mg/L	372.12 mg/L	392.20 mg/L
Nitrate	54.17 mg/L	56.21 mg/L	57.23 mg/L	58.11mg/L
Phosphate	6.32 mg/L	6.29 mg/L	6.30 mg/L	6.33 mg/L
Suspended Solids	192.23 mg/L	222.35 mg/L	243.14 mg/L	273.21 mg/L

The raw sewage which is joining into Bhishma lake is dark grey in color with stinking smell and the temperature is 28^0C which is measured with the help of thermometer.

Grab sampling was carried out monthly for four months from January 2015 to April 2015. Monthly once the raw sewage was collected in a bottle 30cm from the surface and tested for the above parameters in the lab rotary.

4.2.1:pH.

The pH values analyzed for the water samples at sampling stations 1, 2, 3, 4 and 5 are given below.

Table 4.2: shows the pH values analyzed at five sampling stations for Bhishma lake, Jan 2015 to Apr 2015.

Month	Sampling station-1	Sampling station-2	Sampling station-3	Sampling station-4	Sampling station-5	BIS:10500-2012
Jan 27th	7.5	8.0	8.2	8.3	7.8	6.5-8.5
Feb 11th	7.7	8.1	8.0	8.1	7.7	
Feb 26th	7.4	8.2	7.9	8.0	7.6	
Mar 13th	7.8	8.0	8.1	8.2	7.9	
Mar 27th	7.6	7.9	8.2	8.0	8.1	
Apr 11th	7.5	7.8	7.9	8.1	8.0	
Apr 26th	7.8	8.3	8.3	8.3	7.9	
Mean pH	**7.5**	**8.0**	**8.0**	**8.0**	**7.6**	

The desirable limit of pH is 6.5-8.5 for drinking water as per Bureau of Indian Standards (BIS):10500-2012. The pH values at all the sampling stations were found to be within the desirable limit.

4.2.2: Alkalinity.

The alkalinity values analyzed for the water samples at sampling stations 1, 2, 3, 4 and 5 are given below.

Table 4.3: shows the alkalinity values analyzed at five sampling stations for Bhishma lake, Jan 2015 to Apr 2015.

Month	Sampling station-1	Sampling station-2	Sampling station-3	Sampling station-4	Sampling station-5	BIS:10500-2012
Jan 27th	160.00	250.00	165.00	230.00	260.00	DL
Feb 11th	158.00	245.21	162.00	232.00	264.00	200 mg/L
Feb 26th	162.16	251.40	163.22	235.10	262.40	
Mar 13th	164.28	252.36	161.80	231.60	265.00	
Mar 27th	166.00	253.70	166.43	233.55	261.60	
Apr 11th	159.13	256.00	160.80	234.00	267.63	
Apr 26th	157.04	254.50	167.40	230.64	260.50	
Mean Alkalinity	**160.92**	**253.14**	**163.80**	**232.38**	**263.01**	

The desirable limit of alkalinity is 200 mg/L for drinking water as per Bureau of Indian Standards (BIS):10500-2012. Tests were carried out from Jan 2015- April 2015. The average alkalinity values at sampling stations 1, 2, 3, 4 and 5 are 160.92, 253.14, 163.80, 232.38 and 263.01 mg/L respectively. At stations 2, 4 and 5 were found to be exceeding the desirable limit for Bhishma lake.

4.2.3: Dissolved Oxygen (Do).

The DO values analyzed for the water samples at sampling stations 1, 2, 3, 4 and 5 are given below.

Table 4.4: shows the DO values analyzed at five sampling stations for Bhishma lake, Jan 2015 to Apr 2015.

Month	Sampling station-1	Sampling station-2	Sampling station-3	Sampling station-4	Sampling station-5	BIS: 10500-2012
Jan 27th	1.86	2.89	3.10	3.56	3.84	NG
Feb11th	1.83	2.88	3.15	4.0	3.65	
Feb 26th	1.80	2.86	3.20	4.2	4.20	
Mar 13th	0.80	2.83	3.24	3.9	4.13	
Mar 27th	0.84	2.84	2.89	4.00	4.00	
Apr 11th	0.89	2.75	2.88	4.22	3.97	
Apr 26th	0.90	2.60	2.80	4.10	4.10	
Mean DO	**1.27**	**2.80**	**3.03**	**3.90**	**3.97**	

4.2.4: Nitrate.

The nitrate values analyzed for the water samples at sampling stations 1, 2, 3, 4 and 5 are given below.

Table 4.5: Nitrate values analyzed at five sampling stations for Bhishma lake, Jan 2015 to Apr 2015.

Month	Sampling station-1	Sampling station-2	Sampling station-3	Sampling station-4	Sampling station-5	BIS:10500- 2012
Jan 27th	15.00	15.00	12.00	17.00	12.00	DL
Feb 11th	14.00	12.00	10.00	15.00	11.00	45 mg/L
Feb 26th	15.00	13.00	11.00	17.00	10.00	
Mar 13th	13.00	16.00	13.00	14.00	12.00	
Mar 27th	12.00	14.00	12.00	13.00	13.00	
Apr 11th	10.00	12.00	14.00	16.00	11.00	
Apr 26th	11.00	15.00	11.00	13.00	14.00	
Mean Nitrate	**12.85**	**13.85**	**11.82**	**15.00**	**11.85**	

It is found that the average values of nitrate for all the sampling stations 1, 2, 3, 4 and 5 are 12.85, 13.85, 11.82, 15.00 and 11.85 mg/L respectively were found to be within desirable limit. The desirable limit for nitrate is 45 mg/L for drinking water as per Bureau of Indian Standards (BIS):10500-2012.

4.2.5: Phosphate.

The phosphate values analyzed for the water samples at sampling stations 1, 2, 3, 4 and 5 are given below.

Table 4.6: Phosphate values analyzed at five sampling stations for Bhishma lake, Jan 2015 to Apr 2015.

Month	Sampling station-1	Sampling station-2	Sampling station-3	Sampling station-4	Sampling station-5	BIS:10500-2012
Jan 27th	0.024	0.028	0.026	0.030	0.029	NG
Feb 11th	0.022	0.026	0.024	0.028	0.026	
Feb 26th	0.021	0.025	0.025	0.026	0.027	
Mar 13th	0.024	0.024	0.027	0.024	0.025	
Mar 27th	0.023	0.023	0.028	0.025	0.028	
Apr 11th	0.025	0.027	0.024	0.027	0.029	
Apr 26th	0.022	0.028	0.022	0.023	0.027	
Mean Phosphate	**0.023**	**0.025**	**0.025**	**0.026**	**0.027**	

It is found that the average phosphate values for all the sampling stations 1, 2, 3, 4 and 5 are 0.023, 0.025, 0.025, 0.026 and 0.027 mg/L respectively. These values are significant for leaching of fertilizers and pesticides.

4.2.6: Biochemical Oxygen Demand (Bod).

The BOD values analyzed for the water samples at sampling stations 1, 2, 3, 4 and 5 are given below.

Table 4.7: BOD values analyzed at five sampling stations for Bhishma lake, Jan 2015 to Apr 2015

Month	Sampling station-1	Sampling station-2	Sampling station-3	Sampling station-4	Sampling station-5	BIS: 10500-2012
Jan 31st	4.5	5.2	4.8	4.5	5.1	NG
Feb 16th	4.1	5.0	4.6	4.3	5.0	
Mar 2nd	4.3	4.8	4.4	4.2	4.8	
Mar 16th	4.0	4.6	4.9	4.4	4.6	
Mar 30th	4.2	5.1	4.5	4.6	4.4	
Apr 14th	4.1	4.9	4.7	4.7	4.4	
Apr 30th	4.6	5.2	4.5	4.8	5.3	
Mean BOD	**4.25**	**4.97**	**4.62**	**4.50**	**4.80**	

It is observed that average BOD values at all the five sampling stations 1, 2, 3, 4 and 5 are 4.25, 4.97, 4.62, 4.50 and 4.80 mg/L respectively. From the analysis it is clear that average BOD values are high and water is contaminated with organic matter and inorganic pollutants.

4.2.13: Chemical Oxygen Demand (Cod).

The COD values analyzed for the water samples at sampling stations 1, 2, 3, 4 and 5 are given below.

Table 4.2.8: COD values analyzed at five sampling stations for Bhishma lake, Jan 2015 to Apr 2015.

Month	Sampling station-1	Sampling station-2	Sampling station-3	Sampling station-4	Sampling station-5	BIS:10500-2012
Jan 31st	10.0	11.0	12.00	10.0	13.0	NG
Feb 16th	8.62	9.53	10.26	9.31	12.0	
Mar 2nd	8.54	9.52	8.46	8.70	9.90	
Mar 16th	9.42	10.23	9.00	9.52	8.60	
Mar 30th	9.67	9.21	8.62	9.72	7.52	
Apr 14th	9.40	10.40	8.31	10.25	7.60	
Apr 30th	9.52	9.40	11.30	9.72	7.65	
Mean COD	**9.31**	**9.89**	**9.70**	**9.60**	**9.46**	

It is observed that average COD values at all the five sampling stations 1, 2, 3, 4 and 5 are 9.31, 9.89, 9.70, 9.60 and 9.46 mg/L respectively. These average values of COD indicate the extent of pollution because of organic and inorganic pollutants present in the water.

4.2: Sewage Quantity Discharging Into Bhishma Lake.

Table 4.2.9: Sewage quantity discharging into Bhishma lake. [22]

Months	Jan	Feb	Mar	Apr
Sewage quantity in liter/ month	15,25,440	15,25,520	15,25,405	12,25,612
Average sewage quantity in liter	14,50,494			

5. CONCLUSIONS

Bhishma lake is situated in the Gadag city. Total area of lake is 20,234m^2. Five sampling stations were selected for the water quality analysis. A part of city sewage and domestic waste is entering into lake. Five sewage points are joining the Bhishma lake 1) Karyappa circle, 2) Near Mahatma Gandhi hospital, 3) Hotel Shivani Inn cross, 4) Bellary road idiga maidhan and 5) Dambal naka. 2,542.4 liter of sewage is joining from each point. Per day 50,848 liter of sewage is discharged for four hours into the Bhishma lake. It is a rain fed natural lake and from the analysis it was found that the major problem faced by lake is sewage discharge, waste dumping and other human activities such as washing cloth, animals and vehicles. Water is available throughout the year in the Bhishma lake.

- During the study period of four months from January 2015 to April 2015 the raw sewage sample were collected monthly once and the following parameters were tested such as pH, Chloride, DO, BOD, COD, TDS, Nitrate, Phosphate and Suspended solids. The values obtained for pH varied from 6.20 to 6.70, Chloride varied from 55.20 to 68.12 mg/L, DO were found to be 0, BOD varied from 208.32 to 238.72 mg/L, COD varied from 335.12 to 392.0 mg/L, TDS varied from 580.10 to 648.18 mg/L, Nitrate varied from 54.17 to 58.11 mg/L, Phosphate varied from 6.32

to 6.33mg/L and Total Suspended Solids varied from 192.23 to 273.21 mg/L. From the obtained values the strength of the sewage is considered to be medium.

- The average alkalinity values at sampling stations 1, 2, 3, 4 and 5 were 160.92, 253.14, 163.80, 232.38 and 263.01 mg/L respectively. At stations 2, 4 and 5 were found to be 253.14, 232.38 and 263.01 mg/L respectively exceeding the desirable limit of 200 mg/L for drinking water as per Bureau of Indian Standards (BIS):10500-2012.
- The average chloride values at sampling stations 1, 2, 3, 4 and 5 were 152.61, 233.25, 161.61, 232.02 and 231.74 mg/L respectively for the Bhishma lake were found to be within the desirable limit of 250 mg/L for drinking water as per Bureau of Indian Standards (BIS):10500-2012.
- The average DO values at all the five sampling stations 1, 2, 3, 4 and 5 were 1.27, 2.80, 3.03, 3.90 and 3.97 mg/L respectively. Due to presence of organic and inorganic pollutants in the water DO in the Bhishma lake water is very less. There is no consistency in the average DO values as per the findings.
- From the present study it was found that the average nitrate values at sampling stations 1, 2, 3, 4 and 5 were 12.85, 13.85, 11.82, 15.00 and 11.85 mg/L respectively were found to be within desirable limit. For drinking water as per Bureau of Indian Standards (BIS):10500-2012 the desirable limit of nitrate is 45 mg/L. These values signify fertilizer leaching.
- It is observed that average BOD values at all the five sampling stations 1, 2, 3, 4 and 5 were 4.25, 4.97, 4.62, 4.50 and 4.80 mg/L respectively. Due to presence of organic and inorganic pollutants in the Bhishma lake water the BOD values are high. These average values directly signify presence of organic matter and the microbial activities.
- It is observed that average COD values at all the five sampling stations 1, 2, 3, 4 and 5 were 9.31, 9.89, 9.70, 9.60 and 9.46 mg/L respectively. These average values of COD indicate the presence of non-biodegradable contaminants in the Bhishma lake water.
- From the present study it can be concluded that the Bhishma lake is getting polluted by the entry of raw sewage, so the sewage should be diverted away from the lake or allowed to join the lake after treatment.
- Human activities which directly load the lake with pollutants must be monitored. Waste dump is also contributing for the pollution of the lake so the waste dump should be shifted to a place away from the lake and its watershed areas.

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