Water Quality Assessment of Bhimtal Lake

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Abstract*— The study focuses on the monitoring of water quality of Bhimtal Lake and identification of sources of pollution of the Lake through field observations and discussions with local people. Bhimtal Lake is the largest lake in a chain of water bodies (Nainital Lake, Sattal Lake, Naukuchiyatal Lake and many more) in Nainital District (The Lake District) of Uttarakhand. These lakes are the major sources of drinking water and also a major attraction for tourism, hence their water quality assessment and conservation is of utmost importance. To monitor the Bhimtal Lake water quality, the samples were collected from five cross sections starting from November 2013 to May 2014. Collected samples were analyzed in the laboratories of the university. The various parameters of water such as pH, Colour, Odour, Taste, Turbidity, Temperature, Total Dissolved Solids (TDS), Total Suspended Solid(TSS), Hardness, Chloride, Iron, Nitrate, Alkalinity, Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD), MPN(most probable number) of coliforms were examined for water of each sampling point to monitor the level of these parameters whether it exceeds or are within the permissible limits of the Indian standards. Monitoring results showed the fluctuations in chemical composition of lake water both spatially and temporally, but overall the water quality assessment showed that the quality of water is good enough and water can be used as potable water with necessary treatments. It is observed that pH has slight seasonal variation throughout the study period with the values of 6.52 to 7.92. In dry season average pH value is 7.0 while in wet season value is 7.7.The pH of Bhimtal lake water is high in wet season. The Lake water has been characterized by very healthy DO (all above 6 mg/l) & negligible BOD_5 indicating insignificant organic pollution. Among the tested parameters – Hardness, TDS and TSS showed the most significant spatial as well as seasonal variation. It was observed that the concentration of TDS increased in winter season and concentration of TSS increased during the summer season. The variation of hardness was from 75 mg/L to 300 mg/L throughout the study. The parameters like colour, hardness, turbidity, iron, chloride, alkalinity showed a very little variation both temporally and spatially. The MPN (most probable number) test for coliforms showed a high spatial and temporal variation of Coliforms in the lake. The spatial variation showed the variation of 1100 organisms/100 mL in the extremities and 43 organisms/100 mL in the mid points signifying the pollution in the extremities due to the dumping of wastes by the local people and tourists. The overall test showed a range of 4 organisms/100 mL to 1100 organisms/100 mL throughout the study. The study that was carried out created awareness regarding the environmental issues in Bhimtal Lake. Various attempts should be taken to manage the water quality of the Bhimtal Lake such as waste dumping should be controlled through implementation of existing laws and regulations and proper maintenance of the perimeter by the local authorities. Moreover public awareness is necessary. It is very important to develop a comprehensive management plan for management of all lakes within Uttarakhand State.

Keywords—Organic Pollution, Parameters, Seasonal Variation, Indian Standards, coliforms.

I. INTRODUCTION

Bhimtal lake (29o21' N latitude and 79o24' E longitude) is located about 22 km from Nainital at an altitude of 1346 m above mean sea level. The 'C' shaped lake has a surface area of 47.8 ha and a catchment of 10.77 sq.km. It is 1701 m long and 451 m wide (average) and has a maximum depth of 18 m. The useful live storage capacity of the lake is 3.54 Mcu.m and total capacity is 4.61 Mcu.m. The annual inflow is 1.756 Mcu.m. The subsurface flow into the lake constitutes about 35 to 80% of the total surface runoff in monsoon and non-monsoon months. The water is released through sluice gates for utilization in Haldwani. The lake has a small island in its middle. An aquarium has recently been set up on the island as a tourist attraction.

Bhimtal is an ancient place named after Bhima of Mahabharata. Bhimeshwara Mahadev Temple, an old Shiva temple in the bank of Bhimtal lake, is believed to have been built when Bhima visited the place during the banishment (vanvas) period of Pandavas. Bhimtal, earlier known as Bhimsarovar, is believed to be the stamping ground of the Pandavas. According to the locals the town is named so because when the Pandanvas had been exiled in this region they could not find a water body from which they could quench their thirst. It was then that Bhima, the powerful, hit the ground with his "gada" or club thus creating a cavity in the ground, which was filled with an underground source of water.

II. RESEARCH DESCRIPTION

Bhimtal Lake is the largest lake among the many lakes present in the Nainital district. Nainital district being a famous tourist spot is under the threat of overpopulation and hence, pollution. The major threat to the lakes is the deterioration of water quality due to water pollution. Bhimtal Lake is the only source of water supply for the entire Bhimtal town; hence it is necessary to maintain its water quality according to the set standards. The first step towards this end would be to test the water quality so that the necessary steps can be taken by the authorities for its betterment.

This research deals with the study of water quality of Bhimtal Lake. Through this research we present a database on Bhimtal Lake which encompasses its water quality during different seasons in a year-post monsoon season, winter season and pre-monsoon season. It also provides an overview about the sources of pollution of the lake as observed during the field visits and their consequent effects on the quality of water of the lake. Several parameters have been checked, tabulated and compared to the safe limits of these parameters for drinking water .Accordingly a conclusion has been prepared enlisting the various threats to the safe water quality of the lake and proposing the measures that can be taken to uplift the water quality of the lake.

III. LOCATION AND FREQUENCY OF SAMPLES

According to the general practices for every one lakh people accessing the water body there must be one sampling point. The estimated population of Bhimtal is under one lakh according to 2011 census so accordingly there must be one sampling point.

We have taken five sampling points for better results and a more detailed study. The location of these five points has been influenced by the shape of the lake. A sampling point is located at each end of the lake (one at Mallital end and one at Tallital end). The other three points are located at the centre of the lake surrounding the island.

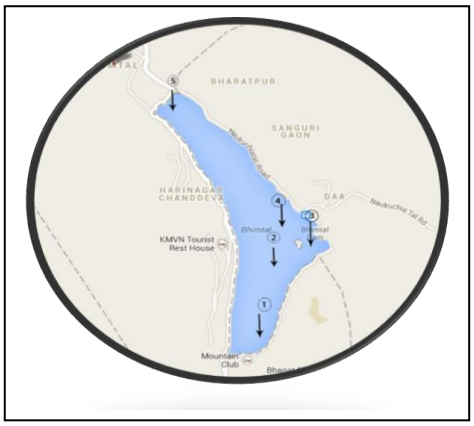

Fig. 1 MAP OF THE SITE

IV. TEST RESULTS

TABLE 1 POINT 1

S.no	***Parameters***	***Post monsoon (autumn)***	***winter***	***Pre monsoon (summer)***
1.	Turbidity	Agreeable	Agreeable	Agreeable
2.	Colour	Agreeable	Agreeable	Agreeable
3.	Temperature	15 ° C	10 ° C	22° C
4.	Odour	None	None	None
5.	Taste	Agreeable	Agreeable	Agreeable
6.	Total Dissolved Solids (mg/l)	90	108	101
7.	Suspended Solids (mg/l)	5	12	8
8.	Ph	7.92	7.52	6.9
9.	Hardness(mg/l)	100	200	200
10.	Chloride(mg/l)	9.99	10	10
11.	Nitrate(mg/l)	4	8	6
12.	Dissolved Oxygen(mg/l)	8.2	10.3	6.2
13.	Biochemical Oxygen Demand(mg/l)	0.2 (Negligible)	0.15 (Negligible)	0.3 (Negligible)
14.	Iron(mg/l)	0.075	0.1	0.09
15.	Alkalinity(mg/l)	Phenolphthalein: 6 Total: 124	Phenolphthalein:8 Total:130	Phenolphthalein:7 Total:127
16.	MPN(organisms/100ml)	-	43	1100

TABLE 2 POINT 2

S.no	***Parameters***	***Post monsoon (autumn)***	***winter***	***Pre monsoon (summer)***
1.	Turbidity	Agreeable	Agreeable	Agreeable
2.	Colour	Agreeable	Agreeable	Agreeable
3.	Temperature	15.5 °C	10°C	21°C
4.	Odour	None	None	None
5.	Taste	Agreeable	Agreeable	Agreeable
6.	Total Dissolved Solids (mg/l)	70	120	100
7.	Suspended Solids (mg/l)	4	5	2
8.	Ph	7.89	7.4	7.57
9.	Hardness(mg/l)	75	150	150
10.	Chloride(mg/l)	9.99	6	10
11.	Nitrate(mg/l)	3	7	7
12.	Dissolved Oxygen(mg/l)	10	12	6.8
13.	Biochemical Oxygen Demand(mg/l)	0.1 (Negligible)	0.15 (Negligible)	0.25 (Negligible)
14.	Iron(mg/l)	0.1	0.05	0.15
15.	Alkalinity(mg/l)	Phenolphthalein:5 Total:133	Phenolphthalein:7 Total:140	Phenolphthalein: 5 Total:136
16.	MPN(organisms/100ml)	-	4	460

TABLE 3 POINT 3

S.no	***Parameters***	***Post monsoon (autumn)***	***winter***	***Pre monsoon (summer)***
1.	Turbidity	Agreeable	Agreeable	Agreeable
2.	Colour	Agreeable	Agreeable	Agreeable
3.	Temperature	15.8°C	10°C	21°C
4.	Odour	None	None	None
5.	Taste	Agreeable	Agreeable	Agreeable
6.	Total Dissolved Solids (mg/l)	75	126	110
7.	Suspended Solids (mg/l)	4	4	3
8.	Ph	7.90	7.134	7.1
9.	Hardness(mg/l)	100	150	150
10.	Chloride(mg/l)	15	6	5
11.	Nitrate(mg/l)	4	7	5
12.	Dissolved Oxygen(mg/l)	9.5	11	7.4
13.	Biochemical Oxygen Demand(mg/l)	0.2 (Negligible)	0.15 (Negligible)	0.3 (Negligible)
14.	Iron(mg/l)	0.1	0.08	0.15
15.	Alkalinity(mg/l)	Phenolphthalein:6 Total:125	Phenolphthalein:9 Total:130	Phenolphthalein:8 Total:126
16.	MPN(organisms/100ml)	-	4	460

TABLE 4 POINT 4

S.no	***Parameters***	***Post monsoon (autumn)***	***winter***	***Pre monsoon (summer)***
1.	Turbidity	Agreeable	Agreeable	Agreeable
2.	Colour	Agreeable	Agreeable	Agreeable
3.	Temperature	16°C	10°C	21.5°C
4.	Odour	None	None	None
5.	Taste	Agreeable	Agreeable	Agreeable
6.	Total Dissolved Solids (mg/l)	100	151	120
7.	Suspended Solids (mg/l)	3	4	3
8.	Ph	7.81	7.25	7.3
9.	Hardness(mg/l)	100	125	125
10.	Chloride(mg/l)	10	8	9
11.	Nitrate(mg/l)	3	6	5
12.	Dissolved Oxygen(mg/l)	9.8	11	7.5
13.	Biochemical Oxygen Demand(mg/l)	0.15 (Negligible)	0.1 (Negligible)	0.1 (Negligible)
14.	Iron(mg/l)	0.1	0.15	0.12
15.	Alkalinity(mg/l)	Phenolphthalein:5 Total:128	Phenolphthalein:8 Total:135	Phenolphthalein:6 Total:131
16.	MPN(organisms/100ml)	-	4	460

TABLE 5 POINT 5

S.no	***Parameters***	***Post monsoon (autumn)***	***winter***	***Pre monsoon (summer)***
1.	Turbidity	Agreeable	Agreeable	Agreeable
2.	Colour	Agreeable	Agreeable	Agreeable
3.	Temperature	16°C	15°C	22.5°C
4.	Odour	None	None	None
5.	Taste	Agreeable	Agreeable	Agreeable
6.	Total Dissolved Solids (mg/l)	95	101	98
7.	Suspended Solids (mg/l)	10	16	12
8.	Ph	7.2	6.95	6.5
9.	Hardness(mg/l)	100	300	200
10.	Chloride(mg/l)	15	12	9
11.	Nitrate(mg/l)	5	9	7
12.	Dissolved Oxygen(mg/l)	10.3	11.5	6.7
13.	Biochemical Oxygen Demand(mg/l)	0.15 (Negligible)	0.1 (Negligible)	0.15 (Negligible)
14.	Iron(mg/l)	0.1	0.09	0.1
15.	Alkalinity(mg/l)	Phenolphthalein: 5 Total: 121	Phenolphthalein:8 Total:135	Phenolphthalein:6 Total:128
16.	MPN(organisms/100ml)	-	460	39

TABLE 6 COMPARISONS BETWEEN THE SAFE LIMITS OF PARAMETERS AND THEIR OBSERVED RANGE

Parameter	*Safe Limit*	*Observed Range*
Turbidity (NTU)	Less than 5 is agreeable	agreeable
Color (Hazen Unit)	Less than 5 is agreeable	agreeable
Odor	unobjectionable	unobjectionable
Taste	agreeable	agreeable
Total Dissolved Solids (mg/l)	500	75-151
Suspended Solids (mg/l)	100	3-16
Ph	6.5-8.5	6.5-7.92
Hardness(mg/l)	300	75-300
Chloride(mg/l)	250	5-15
Nitrate(mg/l)	45	3-9
Dissolved Oxygen(mg/l)	Not less than 6	6.2-12
Biochemical Oxygen Demand(mg/l)	0 (for drinking water)	0.1-0.3
Iron(mg/l)	0.3	0.05-0.15
Alkalinity(total) (mg/l)	200	121-140
MPN(organisms /100ml)	10	4-1100

V. CONCLUSION

As is evident from the test results all the parameters except MPN count are under the safe limits of drinking water. Although there is slight $B.O.D._5$ but it is negligible.MPN count indicates the presence of coliforms in water which in turn indicates contamination of water from human or animal waste. Total coliform bacteria are not likely to cause illness, but their presence indicates that the water supply may be vulnerable to contamination by more harmful microorganisms.

Thus, it can be inferred that the lake water is safe enough to be considered for drinking (after elementary treatment) as all the chemical and physical properties are under the safe limits. However, proper check should be applied on contamination of lake water from human and animal wastes, dumping of wastes and rubbish should be avoided (see Photo 4). Also, there is a storm water drain opening into the lake near point 5(see Photo 5), installation of screens at these openings will prevent contamination of lake. It is also evident from Photo 6 that during peak summer season the lake dries up on the sides. At this time the dried part of he lake is frequently visited by animals (adding to fecal contamination) and dumping of wastes (knowingly or unknowingly) also takes place. So it is of utmost importance that strict rules and regulations are set up by the concerned authorities with regards to dumping of wastes in the lake and their strict enforcement is followed. Most of all creating public awareness is a major task in the region. Regular cleanliness camps must be held in which students of local schools and colleges can be involved. Thus, it can be said that Bhimtal Lake which at present has a good quality of water needs to be properly managed and taken care of. All the factors that may lead to the deterioration of the water quality of the lake in future should be identified and dealt with at their embryonic stage so that the quality standards of the lake water are maintained.

VI. REFERENCES

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Photo 1-Sample collection

Photo 2-Sample collection

Photo 3-Sample testing

Photo 4-Wastes and rubbish in the lake

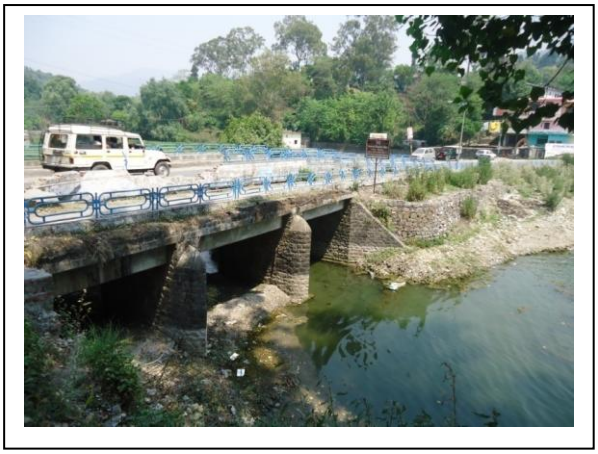

Photo 5-Storm water drain opening into the lake

Photo 6-Bhimtal Lake in peak summer season