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ASSESSMENT OF WATER QUALITY OF UPPER LAKE BHOPAL.

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ABSTRACT

Limnological studies of Upper Lake Bhopal were carried out during November 2010 to October 2012. The present study deals with physico –chemical parameters such as, total dissolved solids, total hardness, calcium hardness, magnesium hardness, chloride, nitrate nitrogen and phosphate. The minimum and maximum range of physico – chemical parameters were as, total dissolved solids 105-170 mg/l from site 2 in monsoon season and from site 2 in summer season respectively, total hardness 61-98 mg/l from site 2 in winter season and from site 2 in summer season respectively, minimum calcium hardness 44mg/l from site 2 in monsoon season and maximum 76.4mg/l from site 1in summer season, minimum magnesium hardness 2.9 mg/l from site 1 in post- monsoon season and maximum 8.8 mg/l from site 1in summer season, minimum chloride 15mg/l from site 2 in winter season and maximum 41 mg/l from site 2 in winter season, minimum nitrate nitrogen 0.41µg/l from site 1 in summer season and maximum 1.14µg/l from site 2 in monsoon season and minimum phosphate 0.16µg/l from site 1 in post- monsoon season and maximum 0.30µg/l from site 2 in monsoon season. It was concluded that the anthropogenic pressure, domestic sewage and season is mainly responsible for the variation of physico-chemical parameter of Upper Lake.

KEYWORDS:- Pollution, surface run-off, physico –chemical parameter, Upper lake.

INTRODUCTION

water is the soul and hope of the nature and is also the prime necessity of life. It is required by the human beings for various activities like fishery, transport, industry, navigation, agriculture and recharge of ground water etc. A sudden but remarkable development in the field of science and technology and agriculture due to the recent industrial revolution has lead to the disposal of untreated (raw) or partially treated effluents and industrial wastes into aquatic ecosystem. Abrupt increase in the human population has greatly contributed towards

discharge of large amount of unused /waste chemical/toxic compounds and other similar pollutants into the environment which has converted fresh water bodies like rivers, lakes and tanks to impending contamination sinks giving rise to water pollution problems (Venkatesan, 2007;[1]) (Adhikari et al., 2009.[2]). The ecosystem of the lake is fragile and complex. Since the rate of discharge of pollutants is much more than the rate of self cleaning ability they tend to readily accumulate such pollutants (Lokeshwari and Chandrappa, 2006.[3]). This series of changes in the physico –chemical characteristics of water, have been the subject of several investigations (Mahananada et al., 2010.[4]).

The requirement of the water is a serious challenge today because all the water resources are polluted due to the unplanned urbanization and industrialization (Singh et al., 2002.[5]) Rural areas now getting converting into the urban areas, these developments have increased the anthropogenic pressure on the lake, thus increasing its microbial contamination and eutrophication. Fresh water has become a scare commodity due to overexploitation and pollution (Gupta and Shukla 2006[6]; Patil et al., 2001[7]; Singh and Mathur 2005[8]). (Vyas et al., 2006[9]) reported about the negative effect of the idol immersion on water quality of Bhopal Lake. (Garg and Garg 2002[10]) worked on three lakes of Bhopal (Mansover, lower lake and upper lake) to assess the potential fertility of lentic waters and analyzed their floral ecology. The seasonal variations in the physico – chemical characteristics in the Upper Lake Bhopal was found by parashar et al., (2006.[11]).

Hence, the present work has been carried out to determine the quality of water of Upper Lake Bhopal, Madhya Pradesh India by analyzing its physico- chemical parameters and also to assess the degree of pollution caused due to input of waste water from its catchment areas.

Study area

Upper Lake also called Bada Talab lies on the western side of the Bhopal city. It is one of the oldest water resource in the state which was built in the 11^{th} century by Raja Bhoj while the constructing an earthen dam across the Kolans River by virtue of that it is known as Bhoj Wetland. It is the major potable source of water for the Bhopal city. Upper Lake has a catchment area of 36.1sq km, maximum depth of 11.7m, storage capacity 101.5m, cm and the surface area is 32.29 sq. Km. The lake lies within the geo-graphical co-ordinate of $77^{0}18'$ longitudes and $23^{0}12'$ N latitudes. In view of its ecological importance, the Ministry of Environment and Forestry Government of India has recognized Upper Lake along with another lake (Lower Lake) located downstream of Upper Lake as wetland of national

importance in 1998 and later declared as Ramsar site in the year 2002. Majority of conservation works for Upper Lake was started from year 1995 under Bhoj Wetland Conservation Project through financial assistance of Japan Bank for International Corporation (JBIC) and completed in year 2004. Some of the important salient features of the lake are mentioned below in the table 1.

Table-1: Salient features of the Upper Lake

S.NO.	Features	Upper Lake Bhopal
1.	Period of formation	11th century A.D.
2.	Longitudes	77^{0}18′- 77^{0}23′ E.
3.	Latitudes	23^{0}12′- 23^{0}16′ N.
4.	Catchment area	361 sq. Km.
5.	Submergence area at FTL	36.54 sq. Km.
6.	Storage capacity	117.05 M. Cum.
7.	Maximum depth	11.7 m.
8.	Maximum water level(RL)	508.65m.
9.	Main water uses	Potable water supply.
10.	Source of water	Rain water.
11.	Sewage inflow	50.47 MLD.
12.	Type of Dam	Earthen.
13.	Climate	Humid.
14.	Inflow points	31.
15.	Design flood discharge	2208m^3/sec.

MATERIAL AND METHODS

The present investigation has been carried out during the period from 2010-2012. Seasonal samples of water were collected from the surface layers by using Van Dorn plastic bottles (1.5 L capacity) from the 2 spots of selected sites namely kamla park and Bairagarh of Upper Lake randomly. After reaching at the Laboratory 2 water samples collected from each site were mixed in an acid washed bucket to make one composite sample, rinsed with ultra pure water and kept under 4^{0}C till further analysis. The determination of physico- chemical parameters were done by Standard methods of analysis (APHA, 1998).[12] Total dissolved solids were determined with digital laboratory grip TDS meter. Standard titration methods were used to determine total hardness, calcium hardness, magnesium hardness with (EDTA), and chloride with (silver nitrate).Nitrate nitrogen and phosphate was determined by Spectrophotometrically. The analytical procedure and units of physico –chemical parameters are summarized in (Table 2).

Table 2. Physico – chemical parameters of Upper Lake and their analytical procedure during 2010-2012.

Serial no.	Variables	Abbreviations	Units	Analytical methods
1.	Total dissolved solids	TDS	mg /l	TDS meter
2.	Total hardness	TH	mg /l	Titration (EDTA)
3.	Calcium hardness	Ca	mg /l	Titration (EDTA)
4.	Magnesium hardness	Mg	mg /l	Titration (EDTA)
5.	Chloride	Cl-	mg/l	Titration (silver nitrate)
6.	Nitrate nitrogen	No_3-N	mg /l	pectrophotometrically.
7.	Phosphate	Po_4-P	mg/l	Spectrophotometrically.

RESULT AND DISCUSSION

In aquatic habitats, environmental factors include chemical factors such as nitrates, phosphates and hardness is very important for the growth of primary productivity on which zooplanktons and other organisms depend for their survival.

Total Dissolved solids

Total dissolved solids is a direct measure of all the dissolved substances, both organic and inorganic in waters. Total dissolved solids may be organic or inorganic but precisely, the dissolved solids are composed mainly of carbonates, bicarbonates, sulphates, calcium, magnesium, chloride, phosphate, nitrate, sodium, potassium and iron (Trivedy 1986[13], Esmaeili 2005[14] and Suresh 2015.[15]).

Total dissolved solids varied from (105mg/l) in the monsoon season at site 2 in the year 2011-2012 to (170mg/l) in the summer season at site 2 in the year 2010-2011. The low value of Total dissolved solids is due to the dilution effect and the high value of Total dissolved solids in hot season is due to increase in the amount of bicarbonates (Verma et al., 1978[16]) recorded the high value of Total dissolved solids during summer season.

Table 3:- Seasonal variation in total dissolved solids (mg/l).

Seasons	Year 2010-2011		Year 2011-2012	
Stations	Site 1	Site 2	Site 1	Site 2
Winter	163	135	127	110
Summer	123	170	167	140
Monsoon	123	157	130	105
Post-monsoon	160	130	125	120
Mean	142	148	137	119

Total Hardness

Total hardness is governed by the contents of magnesium and calcium and the major contribution to hardness is usually calcium. Carbonates and bicarbonates of calcium and magnesium cause temporary hardness.

In the present investigation, total hardness was found to be in the range of (61.3mg/l to 98mg/l) in the winter season and summer season at site 2 in the year 2011-2012 and 2010-2011 respectively. High concentration of total hardness recorded in summer season may be attributed due the decomposition of organic matter in the system. Hardness of the water is due to the regular addition of large quantities of sewage and detergents in the water body from the nearby villages as there is high population pressure. Similar findings have also been reported by (Kaur et al., 1996[17]) and (Altaf et al., 2010.[18]). Lower hardness in winter season was due to less photosynthesis and the necessity of nutrients by other microbes was same.

Table 4:- Seasonal variation in total hardness (mg/l).

Seasons	**Year 2010-2011**		**Year 2011-2012**	
Stations	Site 1	Site 2	Site 1	Site 2
Winter	96	85.5	76.7	61.3
Summer	91.3	98	90.7	72
Monsoon	81.3	91.7	78.7	81
Post-monsoon	84	92	75	85
Mean	88	92	80	75

Calcium Hardness

The source of calcium in natural waters is basically leaching from calcium rich mineral rocks such as lime stone or mineralization of organic matter by the bacteria. calcium hardness varied from (44mg/l) in the monsoon season at site 2 in the year 2011-2012 to (76.4mg/l) in summer season at site 1 in the year 2010-2011. The calcium hardness shows lower trend in monsoon season but higher in summer season is due to less water volume and the lower values for these parameters indicated that they were diluted in the rainy season (Sharma et al., 1990[19], Yeole and Patil, 2005.[20]). Higher values may be due to the addition of sewage and detergents by human activities.

Table 5:- Seasonal variation in calcium hardness (mg/l).

Seasons	Year 2010-2011		Year 2011-2012	
Stations	Site 1	Site 2	Site 1	Site 2
Winter	65.6	57.9	60.1	45
Summer	76.4	74	54.6	59.9
Monsoon	56.5	73.6	54.3	44
Post-monsoon	60.5	67	63	69.5
Mean	64.75	68.13	58	54.6

Magnesium Hardness

As like calcium, msgnessium also exists in divalent form Mg^{2+} ion in the water. Usually, magnesium is always found with calcium in the waters but in very low concentration (Venkatasubramani and Meenambal 2007.[21]). The magnesium hardness varied from (2.9mg/l to 8.8mg/l) in the post-monsoon season and summer season at site 1 in the year 2011-2012 respectively. Magnesium hardness showed well within the normal range as also reported by Sakhre and Joshi (2003b[22]) and Pawar et al.,(2006[23]).

Table 6:- Seasonal variation in magnesium hardness (mg/l).

Seasons	Year 2010-2011		Year 2011-2012	
Stations	Site 1	Site 2	Site 1	Site 2
Winter	7.4	6.7	4	4
Summer	3.6	5	8.8	6.8
Monsoon	6	4.4	5.9	5.1
Post-monsoon	5.7	6.1	2.9	3.8
Mean	5.67	5.55	5.4	4.9

Chloride

Chloride plays a very important role to determine a quality of water. Chloride is one of the major inorganic anion which is the only significant form of chlorine in natural waters. Chloride ranged from (15mg/l to 41mg/l) in winter season at site 2 in the year 2011-2012 and 2010-2011 respectively. The overall higher concentration of chloride in the lake is on account of pollution through anthropogenic impact. Higher values during winter and monsoon seasons which may be attributed due to the presence of large amounts of organic matter of both allochthonous and autochthonous origin (Pandith,1999[24]). Higher concentration of chlorides associated with higher degree of pollution (Ravish verma 2012[25], Ameetha Sinha 2014[26] and John Mohammad 2015[27]).

Table 7:- Seasonal variation in chloride (mg/l).

Seasons	Year 2010-2011		Year 2011-2012	
Stations	Site 1	Site 2	Site 1	Site 2
Winter	31.7	41	17.3	15
Summer	29.6	31.6	34.7	17
Monsoon	31.6	23.9	37.3	17
Post-monsoon	29	30.9	22	16.5
Mean	30.48	31.85	27.83	16.38

Nitrate Nitrogen

Nitrates are essential nutrients for many photosynthetic autotrophs and in some cases have been identified as growth limiting nutrient. Nitrate concentration in surface waters is normally low but as a result of agricultural runoff or contamination with human or animal wastes can reach high levels (Nas and Berktay 2006[28]).

Nitrate nitrogen varied from (0.41µg/l) in summer season at site 1 in the year 2010-2011 to (1.14µg/l) in monsoon season at site 2 in the year 2011-2012. Now the lake which is under consideration shows higher values in the rainy season is on account of increase in the anthropogenic pressure by way of agricultural intensification in the paddy fields which lie close to the lake. The concentration and rate of supply of nitrates is intimately connected with the land use practices of the surrounding area (Goldman and Horne 1983[29]).

Table 8:- Seasonal variation in nitrate nitrogen (µg/l).

Seasons	Year 2010-2011		Year 2011-2012	
Stations	Site 1	Site 2	Site 1	Site 2
Winter	0.52	0.62	0.61	0.65
Summer	0.41	0.61	0.42	0.63
Monsoon	0.65	0.86	0.84	1.14
Post-monsoon	0.44	0.63	0.71	1.11
Mean	0.50	0.62	0.64	0.65

Phosphate

Phosohate occurs almost soley as phosphates in natural waters. It also occurs in different forms like active phosphate, particulate phosphorous and orthophosphate phosphate etc. (Pradhan, V. P., 2014[30]). phosphate is a nutrient considered to be a limiting nutrient causing eutrophication of fresh water systems (Rabalais, 2002.[31]). Phosphate compounds are present in fertilizers and in many detergents. Consequently they carried into both ground and surface waters with sewage, industrial waste and agricultural runoff. High concentration of

phosphorous compounds may produce a secondary problem in water bodies where algal growth is normally limited by phosphorous. In such situation the presence of additional phosphorous compounds can stimulate algal productivity and enhance eutrophication.

In upper Lake Waters, low value of phosphate (0.16µg/l) in post-monsoon at site 1 in the year 2010-2011was recorded to a higher value (0.30µg/l) in monsoon season at site 2 in the year 2011-2012. The higher value of the phosphate is due to the anthropogenic activities, sewage and industrial effluent coming from the catchment area. In the present study, the water body with phosphate content more than (0.1mg/l) represent a fresh water body of meso-eutrophic status. Phosphate content of 0.05mg/l to 0.1mg/l is a threshold of it as a nutrient for natural waters (Jappesen et al., 1997[32]).

Table 9:- Seasonal variation in phosphorous (µg/l).

Seasons	**Year 2010-2011**		**Year 2011-2012**	
Stations	Site 1	Site 2	Site 1	Site 2
Winter	0.17	0.21	0.22	0.27
Summer	0.22	0.23	0.28	0.27
Monsoon	0.25	0.17	0.27	0.30
Post-monsoon	0.16	0.2	0.22	0.27
Mean	0.2	0.2	0.25	0.28

Table 10:-Mean and ranges of physico–chemical water parameters of Upper Lake during 2010-2012.

Parameters	**Maximum**	**Minimum**	**Mean**
Total dissolved solids	170mg/l (Summer)	105mg/l (Monsoon)	137.5
Total hardness	98mg/l (Summer)	61.3mg/l (Winter)	79.5
Calcium hardness	76.4mg/l (Summer)	44mg/l (Monsoon)	60.2
Magnesium hardness	8.8mg/l (Summer)	2.9mg/l (Postmonsoon)	10.3
Chloride	41mg/l (Winter)	15mg/l (Winter)	28
Nitrate nitrogen	1.14µg/l (Monsoon)	0.41µg/l (Summer)	0.77
Phosphate	0.30µg/l (Monsoon)	0.16µg/l(Post monsoon)	0.38

CONCLUSION

The present study revealed that the Upper Lake is of better water quality. The water of Upper Lake is good for drinking and irrigation purposes. The physico-chemical parameters of lake showed that they were within tolerance limit for the aquatic biota. No any other parameter is found in excess, so the water of Upper Lake is suitable for the growth of aquatic organisms.

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